Are Large Language Models Good or Bad for Brain Health? | Neurology | JAMA Internal Medicine | JAMA Network

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Large language models (LLMs), advanced artificial intelligence systems, have been rapidly adopted and now have over 100 million daily users. Volumes have been written on how LLM-enabled tools will affect society. Proponents have focused on the technology's ability to enhance productivity, including in health care settings. Critics have urged caution given the potential for algorithmic bias, job displacement, and intellectual property theft. In this Viewpoint, we discuss the potential impacts of LLM use on long-term cognitive health and risk of dementia.

While popular media outlets have reported adverse mental health–related incidents linked with short-term use of LLMs, the effect of long-term use on neurocognitive health may take decades to become apparent. The prevalence of dementia in the US population is lower than previously predicted, in part explained by a decades-long upward trend in educational attainment among the US population.[1] Whether cognitive offloading offered by LLMs counteracts these education gains or enhances learning may have a profound effect on the cognitive health of the population in the coming decades.

Links Among Education, General Cognitive Ability, LLMs, and Dementia

Both years of education and general cognitive abilities are associated with dementia risk. The correlation between higher levels of educational attainment and reduced risk of Alzheimer disease suggests that the process of obtaining knowledge is neuroprotective, although the exact mechanisms are still unclear.[2] It is likely that education affects cognitive health in many ways given the association of education with both healthy behaviors and socioeconomic status. Educational level is often measured in exposure to information (ie, years of schooling). In contrast, general cognitive abilities are modifiable performance-based skills, like attention, reasoning, and verbal comprehension. Formal education can improve general cognitive abilities but

so can learning at work or other settings. In one cohort, general cognitive ability in high school predicted cognitive impairment risk decades later.[3]

The impact of LLMs on education and general cognitive abilities is currently unknown. It is plausible that LLMs will act as teacher extenders to expand formal educational access. LLMs might also have positive impacts on cognitive abilities. A meta-analysis of observational studies suggested that using other (non-LLM) digital technologies, such as smartphones and email, is associated with reduced risk of cognitive impairment.[4] These digital technologies are hypothesized to affect cognitive abilities through multiple mechanisms, including off-loading minor tasks to allow more time for higher-order reasoning and increasing social connectivity, which strengthens abilities related to linguistic processing and working memory.[4,5] Chatbots and related LLM-enabled devices could positively affect brain health via similar mechanisms.

Alternatively, LLMs might have negative impacts on education and cognitive abilities. They could make higher education less economically advantageous and therefore less appealing. Additionally, emerging evidence suggests the possibility that LLM offloading of higher-order cognitive tasks could lead to cognitive atrophy; one study found a negative correlation in young people between frequent LLM use and critical thinking scores.[6] Similarly, early experimental evidence shows that completing writing tasks with LLM assistance leads to lower cognitive loads and weaker electroencephalography-assessed neural connectivity.[7] It may turn out that using LLMs for cognitive offloading is like using a forklift to achieve a personal best on the bench press—the bar may be easily lifted, but achieving the result does not build the lifter's own strength.

Generating the Data Needed to Study LLMs and Cognitive Health

In the 3 years since the introduction of public-facing LLMs, more than half of all US individuals now use them for at least some tasks[8]; it took approximately 20 years for automobiles, 10 years for social media, and 7 years for the internet to reach the 50% use milestone. We should not wait to see if

population-level changes in dementia manifest before beginning to assess the impacts of LLMs on brain health.

The first step is to harmonize definitions of LLM exposure, cognitive offloading, and general cognitive ability for use in medical research. For example, should LLM exposure be measured as a binary variable or as an area under the curve incorporating elements of intensity of use and time? Currently, because studies use different definitions for each variable, it is impossible to generate even rudimentary back-of-the-envelope estimates for the impact of LLMs on population health. At the beginning of the 21st century, the need to accurately measure computer use led to the creation of the Internet Addiction Test and the Compulsive Internet Use Scale; similar efforts are required for LLMs.

As a second step, cohort studies should include these standardized measures so we can generate the type of epidemiologic evidence that has successfully assessed the impacts of other exposures on delayed outcomes. For example, adding measures of LLM use to an ongoing cohort study, such as the Health and Retirement Study, which already includes measures of cognition, may allow for assessments of how this new technology is related to cognition and dementia risk later in life. Additionally, it is important to incorporate these measures in cohorts of children and adolescents, such as the Adolescent Brain Cognitive Development Study.

A third step is to create a research infrastructure that links LLM use, health, and survey data. This step will likely require companies that own LLMs to invest in data-sharing platforms. After offering users the opportunity to share their device, health, and survey data, one company partnered with academics to elucidate smart device markers that correlate with illnesses, including some related to cognitive impairment.[9] While some LLM products promise users the opportunity to link their health records, it is unclear whether this integration will generate data for studying the impact of LLM tools on cognitive health. Every LLM interaction generates user data; users should be able to access those data and contribute them for research. Allowing users to opt in to research platforms that track LLM use to study health outcomes is a critical step for evidence gathering.

Bolstering Human Cognition

Asking whether LLMs could be associated with cognitive trajectories is just the latest in a long history of wondering how technologic advances will impact brain health. In the fifth century BCE, Socrates worried that the written word would damage human intellect. More recently, there has been fear that the printing press, the telegraph, and the radio would cause inattention, anxiety, and addiction. Now, understanding how LLMs can affect long-term cognition has enormous stakes for public health. Proactive collaboration across health, research, and technology sectors to develop measurement and data collection is necessary to chart a path forward. Clinicians should continue to promote evidence-based interventions to protect cognitive health, such as cardiovascular risk management, engaging in regular physical activity, and staying socially engaged. While the evidence base regarding LLMs matures, clinicians can communicate with patients that the potential long-term impacts—positive or negative—of LLMs on cognition are still unclear.