Study shows glucose levels affect cognitive performance in people with type 1 diabetes differently

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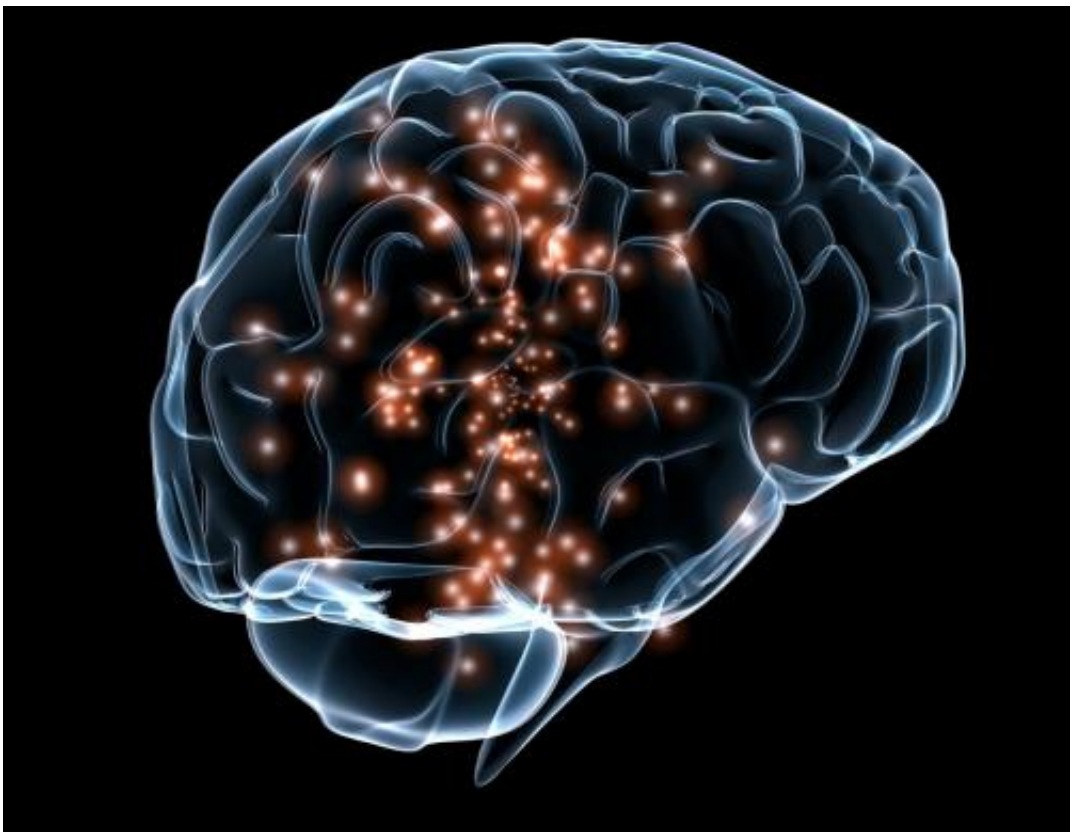

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A new study led by researchers at McLean Hospital (a member of Mass General Brigham) and Washington State University used advances in digital testing to demonstrate that naturally occurring glucose

fluctuations impact cognitive function in people with type 1 diabetes (T1D).

Results of the study, published in *npj Digital Medicine*, show that cognition was slower in moments when glucose was atypical—that is, considerably higher or lower than someone's usual glucose level. However, some people were more susceptible to the cognitive effects of large glucose fluctuations than others.

"In trying to understand how diabetes impacts the brain, our research shows that it is important to consider not only how people are similar, but also how they differ," said Zoë Hawks, Ph.D., lead author on the paper and research investigator at McLean.

T1D is an autoimmune disease characterized by glucose variability. Previous laboratory studies have shown that very low and very high glucose levels impair cognitive function. However, technological limitations made it difficult to study the impact of naturally occurring glucose fluctuations on cognition outside of the laboratory, preventing researchers from obtaining repeated, high-frequency measurements within the same individuals over time. High-frequency measurements are necessary to understand whether glucose fluctuations impact cognition similarly for everyone.

In the new study, researchers used digital glucose sensors and smartphone-based cognitive tests to collect repeated, high-frequency glucose and cognitive data in 200 individuals with T1D. Glucose data were collected every five minutes and cognitive data were collected three times per day for fifteen days.

Collecting glucose and cognitive data unobtrusively, as participants went about their daily lives, allowed researchers to examine the cognitive impact of naturally occurring glucose variability. With many data points

from each individual, they were able to use machine learning to test whether the impact of glucose on cognition differed from person to person.

The study showed that cognitive function was impaired when glucose was considerably higher or lower than usual, and this effect was observed for processing speed but not sustained attention. It is possible that processing speed is impacted by short-term, moment-to-moment fluctuations in glucose, whereas sustained attention is impacted by high or low glucose that persists over longer periods of time.

The researchers also found that people differed from each other in terms of how much glucose fluctuations impacted their cognitive speed, and some people—including older adults and adults with certain health conditions—were much more impacted by glucose fluctuations than others.

"Our results demonstrate that people can differ a lot from one another in how their brains are impacted by glucose," said Laura Germine, Ph.D., co-senior author of the paper and director of McLean's Laboratory for Brain and Cognitive Health Technology.

"We found that minimizing glucose fluctuations in daily life is important for optimizing processing speed, and this is especially true for people who are older or have other diabetes-related health conditions."

One surprise discovery was that participants' peak cognitive performance coincided with glucose levels that were slightly above their normal range, though performance dropped off as glucose levels rose even further.

"This was an important finding because people with diabetes often report feeling better at a glucose level that is higher than what is

considered healthy," said co-senior author Naomi Chaytor, Ph.D., a professor and department chair in the Washington State University Elson S. Floyd College of Medicine.

"It could be that your brain habituates to a glucose level that it is used to. So a next step in this research is to see whether the glucose level associated with peak performance shifts down into the normal range when the amount of time spent above range is reduced, which can be achieved through use of automated diabetes management systems."

More information: Dynamic associations between glucose and ecological momentary cognition in Type 1 Diabetes, *npj Digital Medicine* (2024). DOI: 10.1038/s41746-024-01036-5 , www.nature.com/articles/s41746-024-01036-5

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