Pilot study opens new possibilities for AI to enhance cognitive performance

May 22 2019

Professor Dean Ho (first from left) showing a schematic mobile version of CURATE.AI, while Mr. Theodore Kee (seated) demonstrates the flight operations simulator software. With them are Assistant Professor Christopher L. Asplund (second from left) and Dr. Agata Blasiak (third from left). Credit: National University of Singapore

In a recent pilot study, researchers from the National University of Singapore (NUS) have shown that a powerful artificial intelligence (AI) platform known as CURATE.AI could potentially be used to customise training regimens for individuals to personalise learning and improve cognitive performance. Using performance data from a given person, CURATE.AI creates an individualised profile that enables cognitive training to be tailored to the individual's learning habits and competencies so as to enhance training effectiveness.

Such dynamic AI-guided personalisation overcomes the current limited improvement produced by using traditional training methods which often involve repetitive behavioural exercises. The results of the study provide evidence that the CURATE.AI platform has the potential to enhance learning, and paves the way for promising applications for personalised digital therapy, including the prevention of cognitive decline.

The research, led by Professor Dean Ho and Assistant Professor Christopher L. Asplund from the N.1 Institute for Health (N.1) of NUS, which was formerly the Singapore Institute for Neurotechnology (SINAPSE), was published in the journal *Advanced Therapeutics* on 22 May 2019.

Limitations of traditional cognitive training

Traditional learning approaches often rely on repetition, where participants are continuously trained under the same level of intensity, or steadily increasing intensity levels over time. While such approaches can result in improved performance, they may not achieve optimal outcomes in every participant. In addition, the best trajectory of improvement will be specific to the individual, and the task needs to be adjusted to fit the individual.

Over the years, several approaches to improve cognitive performance have been studied, ranging from drug treatments to video games and mental exercises. More recently, the field of digital therapeutics has emerged, with mobile applications being explored as replacements for drug treatments.

"Everyone is unique, so when it comes to training or learning, performance outcomes will certainly vary substantially from person to person. Harnessing technology to enhance learning is a good way to address the challenges confounding conventional learning approaches. What is lacking is approaches that can properly attune each user's performance to drive rapid training improvement. This is where CURATE.AI can come in to plug the gap," shared Prof Ho, who is the Director of N.1, and also a Provost's Chair Professor from the Biomedical Engineering and Pharmacology departments at NUS, as well as a member of the Biomedical Institute for Global Health Research and Technology (BIGHEART) at NUS.

CURATE.AI is an artificial intelligence platform developed by a team of engineers led by Prof Ho. It works by using a person's own data, such as training intensity and corresponding task performance scores, to calibrate the person's unique response. This calibration is then used to create an individualised CURATE.AI profile, which can map and pinpoint the best possible training regimen to boost the person's performance to its optimum.

Harnessing AI to optimise cognitive performance

To derive how optimal cognitive performance can be achieved, the NUS research team first examined how people perform tasks. The team employed a flight operations simulator software developed by the United States Air Force and National Aeronautics and Space Administration. Tasks in the software include managing fuel tank levels, tracking a target

using a joystick, adjusting a radio in response to verbal commands, and responding to indicator lights and gauges.

A group of 28 participants were tested on how well they were able to perform multiple tasks required by the software simultaneously. Even with the same activity sequences and control settings, the participants performed differently. For instance, for a task requiring a reaction to a warning signal, the best performer could respond two times faster than the worst performer. Most participants improved over time, but their respective rates of improvement were highly varied. In addition, the same participant's improvement often varied from day to day.

"The stark differences show clearly that a one-size-fits-all training regimen based on static repetition is not suitable to optimise learning. We need a strategy that adjusts the training—which can involve many tasks that interfere with each other—according to the participant's changing responses," said Asst Prof Asplund, who is also from Yale-NUS College.

As such, the research team conducted a pilot study using CURATE.AI to create individualised training profiles.

Three participants underwent training using the flight operations simulator software, with low, medium and high intensity levels. Their performance scores at these levels revealed highly individualised outcomes.

Results of the pilot study showed that while some participants may thrive under high levels of intensity, others may perform better under lower intensity levels. This indicates that to optimise performance, training intensity should be dynamically varied at a given point in time as maintaining the same intensity throughout a training session may impede the improvement trajectory. In addition, the different trajectories

observed between each participant were striking, reinforcing the need to personalise the cognitive training process, since no two subjects are alike.

"With prolonged studies, we may be able to identify the continuously changing regimens that can further enhance performance in the long run. This can open up opportunities for CURATE.AI to be used for other applications such as the prevention of cognitive decline, and digital therapy," explained Mr Theodore Kee, the first author of the study and also a member of N.1.

Further studies

The NUS team is planning to develop mobile software integrated with CURATE.AI that can be expanded to other digital therapy and personalised learning applications. In addition, the team plans to conduct prospective studies where participants interact with the flight operations simulator software for longer periods of time, in order to determine if CURATE.AI training can enable long-term retention of optimised training performance.

More information: Theodore Kee et al, Harnessing CURATE.AI as a Digital Therapeutics Platform by Identifying N-of-1 Learning Trajectory Profiles, *Advanced Therapeutics* (2019). DOI: 10.1002/adtp.201900023

Provided by National University of Singapore

Citation: Pilot study opens new possibilities for AI to enhance cognitive performance (2019, May 22) retrieved 23 June 2024 from https://phys.org/news/2019-05-possibilities-ai-cognitive.html

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