People's everyday pleasures may improve cognitive arousal and performance

August 8 2023

Subject undergoing MINDWATCH testing. Credit: Hamid Azgomi

Listening to music and drinking coffee are the sorts of everyday pleasures that can impact a person's brain activity in ways that improve cognitive performance, including in tasks requiring concentration and memory.

That's a finding of a new NYU Tandon School of Engineering study

involving MINDWATCH, a groundbreaking brain-monitoring technology.

Developed over the past six years by NYU Tandon's Biomedical Engineering Associate Professor Rose Faghih, MINDWATCH is an algorithm that analyzes a person's brain activity from data collected via any wearable device that can monitor electrodermal activity (EDA). This activity reflects changes in electrical conductance triggered by emotional stress, linked to sweat responses.

In this recent MINDWATCH study, published in *Nature Scientific Reports*, subjects wearing skin-monitoring wristbands and brain monitoring headbands completed cognitive tests while listening to music, drinking coffee and sniffing perfumes reflecting their individual preferences. They also completed those tests without any of those stimulants.

The MINDWATCH algorithm revealed that music and coffee measurably altered subjects' brain arousal, essentially putting them in a physiological "state of mind" that could modulate their performance in the working memory tasks they were performing.

Specifically, MINDWATCH determined the stimulants triggered increased "beta band" brain wave activity, a state associated with peak cognitive performance. Perfume had a modest positive effect as well, suggesting the need for further study.

"The pandemic has impacted the mental well-being of many people across the globe, and now more than ever, there is a need to seamlessly monitor the negative impact of everyday stressors on one's cognitive function," said Faghih. "Right now MINDWATCH is still under development, but our eventual goal is that it will contribute to technology that could allow any person to monitor his or her own brain cognitive

arousal in real time, detecting moments of acute stress or cognitive disengagement, for example. At those times, MINDWATCH could 'nudge' a person towards simple and safe interventions—perhaps listening to music—so they could get themselves into a brain state in which they feel better and perform job or school tasks more successfully."

The specific cognitive test used in this study—a working memory task, called the n-back test—involves presenting a sequence of stimuli (in this case, images or sounds) one by one and asking the subject to indicate whether the current stimulus matches the one presented "n" items back in the sequence. This study employed a 1-back test—the participant responded "yes" when the current stimulus is the same as the one presented one item back—and a more challenging 3-back test, asking the same for three items back.

Researchers tested three types of music—energetic and relaxing music familiar to the subject, as well as novel AI-generated music that reflected the subject's tastes. Consistent with prior MINDWATCH research, familiar energetic music delivered bigger performance gains—as measured by reaction times and correct answers—than relaxing music. While AI-generated music produced the biggest gains among all three, further research is needed to confirm those results.

Drinking coffee led to notable but less-pronounced performance gains than music, and perfume had the most modest gains.

Performance gains under all stimulations tended to be higher on the 3-back tests, suggesting interventions may have the most profound effect when "cognitive load" is higher.

Ongoing experimentation by the MINDWATCH team will confirm the efficacy of the technology's ability to monitor brain activity consistently,

and the general success of various interventions in modulating that brain activity. Determining a category of generally successful interventions does not mean that any individual person will find it works for them.

The research was performed as a part of Faghih's work on the Multimodal Intelligent Noninvasive brain state Decoder for Wearable AdapTive Closed-loop arcHitectures (MINDWATCH) project. The study's diverse dataset is available to researchers, allowing additional research on the use of the safe interventions in this study to modulate brain cognitive states.

Faghih served as the senior author for this paper. Its first author is Hamid Fekri Azgomi, who earned his Ph.D. under Faghih and is now a postdoctoral scholar of neurological surgery at the University of California San Francisco School of Medicine.

More information: Hamid Fekri Azgomi et al, Regulation of brain cognitive states through auditory, gustatory, and olfactory stimulation with wearable monitoring, *Scientific Reports* (2023). DOI: 10.1038/s41598-023-37829-z

Provided by NYU Tandon School of Engineering