

Important results for brain machine interfaces

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Credit: Ecole Polytechnique Federale de Lausanne

Data from Mental Work project, conducted as an experimental artwork at EPFL's Artlab, indicates that BMI is robust and accessible to the general public, spurring new research collaborations in Switzerland on user experience.

Brain-machine interfaces are rarely found outside of medical clinics,

where the disabled receive hours or days of training in order to operate wheelchairs with their minds. Now the largest-ever BMI experiment Mental Work, conducted as an experimental artwork at EPFL's Artlab, has provided preliminary evidence that training time can be shortened, the use of dry electrodes are a robust solution for public BMI and that user performance tends to improve within a relatively short period of time. The still-to-be-published results suggest that BMI may soon reach a much larger and more diverse population. A new collaboration between the Foundation Campus Biotech Geneva, the EPFL and the HEIG-VD in Yverdon will build on the promising results will build on the promising results of Mental Work to further develop user-friendly and publicly accessible interfaces to interact with the physical and digital world using only one's mind.

"This is the first demonstration that installation art can be used as an experimental platform for breakthrough science," says Jonathon Keats, the artist and experimental philosopher who conceptualized Mental Work.

According to Professor José Millán, the EPFL scientist whose lab developed the BMI system for the exhibit, "The initial results from Mental Work show that it is possible for a large portion of the population to successfully use BMI to interact with their environment and with a much shorter training period than was previously thought necessary." The team has collected a unique dataset with almost 800 subjects, each contributing with around one hour of brain signals during an interaction experience of increasing complexity. This dataset will be shared with the BMI scientific community once the scientists finish a basic analysis of its integrity, primary outcomes and standardization.

Successful training for BMI at 30 minutes instead of hours

One of the most significant challenges for any BMI integration into an exhibition or the daily lives of its users is the relatively long and tedious training period, where the user learns to interact with the system and the system learns the user's unique brain pattern for a specific activity, often for hours over a period of days and weeks. "To our great satisfaction, we achieved a significant reduction in training time needed to use a BMI to 30 minutes during the exhibition," says Millán. This reduction was achieved through a robust feature-selection algorithm, streamlined onboarding process as well as a systematic implementation of rigorous protocol over hundreds of users.

BMI is difficult, but it's possible to quickly improve

Mental Work visitors, who answer a standardized questionnaire that was embedded into the exhibit and coupled to the brain-activity data, constantly reported that the mental tasks required were very demanding—contrasting with a widespread assumption that BMI controls effortless. And while more than one-third of the users were able to deliver commands more than 55% during their first try continued to improve, the data also shows that many Mental Workers who failed upon the first attempt eventually acquired robust BMI skills as they progressed through the exhibit. "We are now studying how brain patterns vary, with a particular focus on exploring how these patterns evolve during this learning process in order to uncover principles to enhance and accelerate the acquisition of reliable brain control," says Millán.

Dry electrode technology in a public space

An enabling technology for the Mental Work exhibit, and for a greater use of BMI in general, is the advent of dry electrode technology for measuring EEG. Dry electrodes avoid the time consuming and off-putting ordeal of using conductive gel to obtain the signals. Mental Work

producer, Michael Mitchell says that "When we first had the idea for the project in 2012, the dry EEG technology wasn't robust enough for a public exhibit. Then the Wearable Sensing system of dry electrodes with research grade signals was developed and the company came on board as a commercial sponsor. Our ideas finally matched up with the reality of the technology." According to the lab's preliminary analysis of 530 participants in Lausanne, 23% of their EEG recordings exhibited a high signal quality, while 47% presented medium-to-high quality, and only 12% presented low signal quality—an extremely encouraging finding as it supports the validity of using these new technologies in real-life settings.

Future of Mental Work

Mental Work is now becoming a collaborative, cross-disciplinary platform for neuroengineering and [user experience](#) research in Switzerland. Campus Biotech in Geneva will host one of four Mental Work machines for the next three years in collaboration with EPFL and HEIG-VD in Yverdon, offering the opportunity to develop and test both the BMI back-end technology and front-end user interface at two different centers of excellence in French-speaking Switzerland. In addition, clinical discoveries and improvements to the machine-learning algorithms that drive the BMI will continue to be developed within the Human Neuroscience Platform operated by the Campus Biotech Foundation in an ongoing collaboration with José Millán at the University of Texas in Austin. Those with severe disabilities will not only benefit from better control of their neuroprosthetics, but the increased ease of use and potentially shorter training periods will reduce the overall effort needed to take and maintain control—a significant advantage for those whose lives are dominated by their handicap and where each additional effort multiplies the risk of frustration and rejection of the technology.

"Mental Work was always intended to be a research platform, artistically, philosophically and scientifically. With this new phase, the three areas of research will be fully integrated, reenforcing Mental Work's value as an engine of discovery," says Keats.

Provided by Ecole Polytechnique Federale de Lausanne

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