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Novel Technology to Read Neuronal Cells and Stimulate Them to Alter Thoughts

Tanvee Sinha

"If you could have one superpower, would you choose to read minds or fly?"

The choices in this jovial question always used to seem so surreal, almost magical. The latter has been done, through airplanes and other technologies, but reading minds always seemed so impossible.

Schanechi's Development of Mind Reading Technology

However, Maryam Shanechi, electrical engineering researcher at the University of Southern California in Los Angeles, has made progress towards making mind reading a reality. Shanechi doesn't just tap into overall brain activity to map signals; rather, she develops algorithms to first translate electrical signals emitted by specific brain cells, then convert them into machine commands.

By understanding what specific cells control, Shanechi has moved onto a new frontier of attempting to read minds. Her progress in creating a machine to translate electrical signals from specific brain cells rather than a general translation of firing patterns, could eventually lead to her manipulation of these identified cells to offer more effective treatment to a number of people plagued with psychiatric disorders.

Shanechi began testing her machinery by using monkeys as initial test subjects. The rates of successful completion of each task took both accuracy and speed into account in attempts to assess control and feedback rates in these monkeys. Performing comparisons between these animals with uniform recording quality eliminates the possibility of confounding results. Additional factors including task proficiency, motivation, recording, and quality were addressed by this calculation of correct percentage, time, and movement error.

Methodologies of the Experiment

The monkeys were put in front of a computer and made to move a cursor from one point on the screen to a specific destination. After an initial blank screen, a "go cue" appeared, prompting monkeys to move the cursor from the initial point to two different randomized targets in a specific order. An individual's working memory is concerned with immediate conscious thought and short term memory, what people normally use in complex cognitive tasks. In this case, the monkey's working memory was defined as the blank screen interval placed between the presentation of the second target and before the "go" cued the start of the task. Their working

memory was tested through this activity, in which monkeys were required to continuously update their working memory to properly move the cursor in order on the dual targets.

Two types of machines were used. One machine processed the motions of the monkeys at 50-100 millisecond intervals and the other predicted a series of movements. The latter (programmed by Shanechi's algorithm) collected signals from electrodes on the monkey's pre-motor cortex (higher thought processing and advanced decision-making region) and tracked specific neuronal firings at millisecond timescales, in attempts to anticipate the monkey's set of movements. When comparing the two types of machines, the machine with Shanechi's algorithm significantly outperformed the other, increasing success rates in monkeys by 20-30 percent. Monkeys using her machine were able to move the cursor quickly and showed higher precision.

Conclusive Results from Shanechi's Team

These results revealed that the premotor cortex allowed for an accurate understanding of the dual target task across many locations anatomically in the brain rather than just in one part of the brain. Shanechi found that in working memory during these tasks, the brain cells are divided into two groups and targeted to two different processing pathways in the brain. One of these being solely dedicated to success in reaching the first target, and the other in reaching the second (independent from reaching the first target). Even though the targets in each trial were shuffled around, Schanechi's team found that the cells remained in these two distinct groups, and no new information necessarily interfered with existing information encoded into each of these groups. Her team could identify factors from these groups that would prompt monkeys to pick the first or second target and understand what was going to happen in the trial prior to the action by observing the brain signals.

With her results from this experiment, Shanechi's technology has the potential to help individuals become smarter and more dynamic in their actions. This is facilitated through this technology that predicts motor control prior to the execution. This could be a major enhancement to numerous individuals who wish to have more control over their movements. Understanding their body's natural response before it happens (through monitoring these brain signals) would provide these individuals more information about their movements.

Practical Applications

With more development of her project, Shanechi wants to tweak her algorithm to eventually provide a novel generation of technology that would tailor to patients with psychiatric disorders, including depression and anxiety.

Currently, those with psychiatric disorders have few forms of treatment, with the majority of options being medication. A more device-based form of treatment includes deep brain stimulation, machinery that needs to be manually adjusted at different time intervals, according to how long certain manic/depressive symptoms last. It also needs to be closely monitored and changed accordingly to the subject's mood, in attempts to control any extreme behavior.

If Shanechi utilizes her algorithm in this case, she could potentially sense thoughts from neuronal firings in real time and automatically adjust stimulation. There would be no need for manual adjustment based off of time and mood, which would significantly improve the treatment's effectiveness. Additionally, her team's device would gather data more efficiently, and help an individual act more independently while still being monitored by the device and have this evaluation constantly quantified through the data collected in real time. This would help move patients with various psychiatric disorders into healthier headspaces by jump starting their mood management strategies immediately.

Future Directions For the Team

Schanechi has made mind reading more of a reality than it used to seem.

While she has just laid the groundwork with this current research, she is continuing her work in systems to feed electrical signals to the brain and record how neurons react to these signals. She wishes to decode the full planned motor sequence prior to execution of the act, in aims to not only understand motor movement, but potentially reassess and perform a certain action more effectively. If she is successful in altering their response through these brain machine interface technologies, she would be able to read thoughts/movements and manipulate them to provide a different response.

Being able to predict execution of an action prior to the behavior itself could prove extremely helpful in disabled individuals and their treatment. In programming this machine to complete more complex tasks and in eventually moving on from primates to use human subjects, Schanechi hopes to find more from the effectiveness of being able to read thoughts.

REFERENCES

Temming, M. (2019). Maryam Shanechi designs machines to read minds. *ScienceNews*, available at: https://www.sciencenews.org/article/maryam-shanechi-sn-10-scientists-to-watch.