Medical Xpress

Brain measurements could lead to better devices to move injured or artificial limbs

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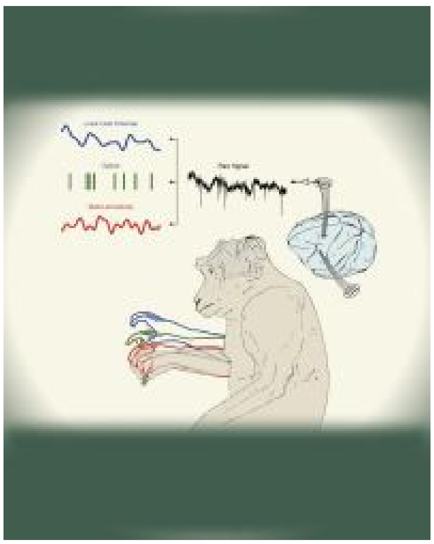

Neural activity in the premotor cortex carries information about reaching and grasping. Information can be obtained from local field potentials (top left, blue signal), spikes or individual neuronal action potentials (green), and multi-unit activity (red), measuring the activity of populations of neurons. The most accurate information is obtained by combining multi-unit activity from multiple electrodes, depicted by the red-colored shadow hand of the monkey. Credit: Sandrine Alon

Neuroscientists at the Hebrew University of Jerusalem have developed a novel approach for measuring and deciphering brain activity that holds out promise of providing improved movements of natural or artificial limbs by those who have been injured or paralyzed.

Neuroscientists have long been working towards achieving a better understanding of the relationship between brain activity and behavior, and especially between neural activity in the motor regions of the cortex and hand movements.

In addition to addressing basic scientific questions, this line of research carries important practical implications, since the identification of precise relationships would enable neuroscientists to assist in the construction of devices through which brain signals will activate muscles in a paralyzed limb or a prosthetic (robotic) arm.

In an article recently published in *The Journal of Neuroscience*, Hebrew University neurophysiologists Eran Stark and Prof. Moshe Abeles report on their new approach for measuring and deciphering brain activity, which avoids many of the drawbacks of current methods and which provides an accurate decoding of brain activity.

Currently, two methods are being used to measure brain activity in the context of neuro-prosthetic devices. The first method is based on the EEG (electroencephalogram) and is measured either over the scalp, directly from the cortical surface, or from the cortex itself. The second method is based on the activity of individual nerve cells within the cortex, and uses intra-cortical electrodes – which essentially are fine wires.

Each method has advantages but is also subject to considerable drawbacks. To decipher brain activity at a level of accuracy that is sufficient to activate a paralyzed limb or a robotic arm, a large number of parallel and preferably independent measurements must be taken from a relatively small area (in humans, about 4 cm2). Neither of the above two methods is particularly efficient in accomplishing that.

One of the particular drawbacks to the use of the EEG is that nearby electrodes record approximately the same EEG activity, so the gain from employing multiple measurements is limited. A second drawback is that the bulk of the changes recorded in the EEG brain wave occurs after movement and not prior to it, as is required for controlling a paralyzed limb or a robotic arm.

With regard to the fine-wire electrodes, it has been found that, over time, the brain responds to the implanted electrodes by forming glia cells in a process akin to scar formation, with the consequence that a large portion of the brain wave activity is masked.

The approach taken by the Hebrew University scientists entails measuring the activity of all the nerve cells that are located at an intermediate distance (100-200 micrometers) from a recording electrode. In this way, independent measurements can be obtained from many adjacent points. Minor damage to the brain tissue in close proximity to the measurement site scarcely affects the quality of the measurement. Moreover, the measurement remains reliable over a long duration.

In testing the new approach, monkeys were trained to make prehension movements, reaching and grasping various objects located at different positions. Prehension requires coordination between the direction of reach, performed mainly by the arm, and the type of grasp, performed mainly by the fingers. By measuring the activity of populations of nerve cells as outlined above, using no more than 16 electrodes, the upcoming reach direction and grasp type could be predicted at an accuracy of about 90% and, in some cases, at a near-perfect accuracy (above 99%). The prediction errors of the proposed method of measurement were two to three times lower than the errors of predictions based on the other methods of brain activity measurement.

The Hebrew University researchers believe that this new study constitutes a considerable step forward towards deciphering intentions to perform movements by persons who are paralyzed or are amputees, thus paving the way for creation of better instruments for converting brain activity into actual movements.

Source: The Hebrew University of Jerusalem