A better 'map' of the lights you see when you close your eyes can improve 'bionic eye' outcomes

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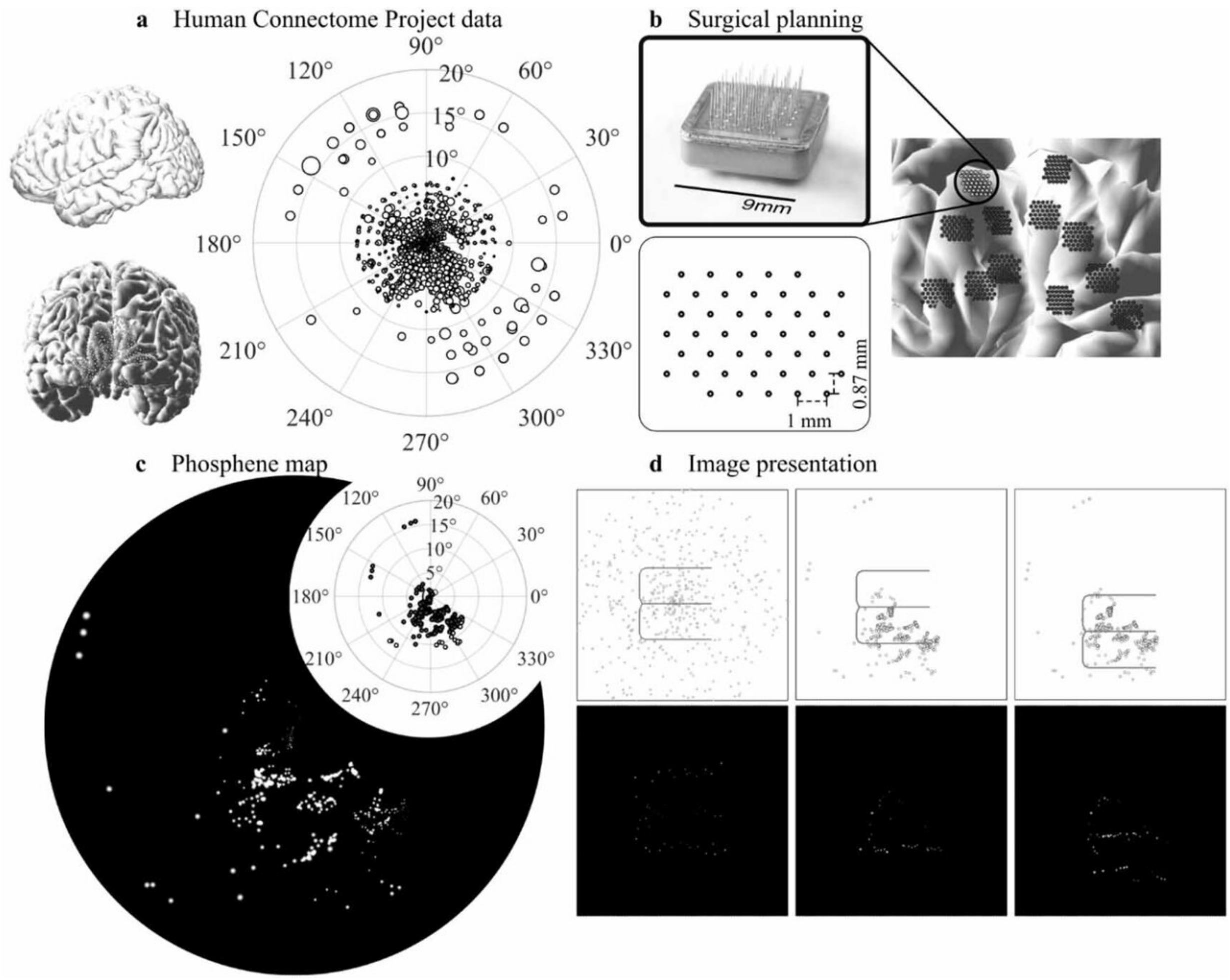

The simulation paradigm The simulation paradigm. (a) Retinotopic data of one subject from the Human Connectome Project. On the left are the lateral view and posterior view of the brain. On the right are the population receptive fields of V1 and V2 grayordinates. Each white dot on the brain and visual field represents the grayordinate and corresponding population receptive field. (b) Surgical planning by placing implants on the MRI scan of the subject's visual cortex. On the top left is the Monash Vision Group Gennaris implant, and on the bottom left is the layout of electrodes. On the right is the placement of implants on V1 and V2. (c) Derived phosphene map using the dataset (top right). The image shows the rendered images after adjusting the phosphene size. (d) Image presentation. On the left is the control condition, in the middle is a naïve method (retinotopic condition) where the visual stimulus is placed at the center of the phosphene map. On the right is a clustering method (retinotopic + clustering condition) where the visual stimulus is placed at a region where the phosphenes are denser. Credit: *Journal of Neural Engineering* (2023). DOI: 10.1088/1741-2552/aceca2

Researchers at Monash University have identified a new way of mapping 'phosphenes'—the visual perception of the bright flashes we see when no light is entering the eye—to improve the outcome of surgery for patients receiving a cortical visual prosthesis ('bionic eye').

Cortical visual prostheses are devices implanted onto the brain with the aim of restoring sight by directly stimulating the area responsible for vision, the visual cortex, bypassing damage to the retina of the eye or the optic nerve.

A typical prosthesis consists of an array of fine electrodes, each of which is designed to trigger a phosphene. Given the limited number of electrodes, understanding how electrodes can best be placed to generate useful perceived images becomes critical.

As part of this researchers from the Department of Electrical and Computer Systems Engineering at Monash University, led by Associate Professor Yan Tat Wong, are honing in on the ideal distribution of phosphenes.

"Phosphenes are likely to be distributed unevenly in an individual's visual field, and differences in the surface of the brain also affect how surgeons place implants, which together result in a phosphene map unique to each patient," Associate Professor Wong said.

Published in the *Journal of Neural Engineering*, "A novel simulation paradigm utilising MRI-derived phosphene maps for cortical prosthetic vision" presents a more realistic simulation for cortical prosthetic vision.

The study used a retinotopy dataset based on magnetic resonance imaging (MRI) scans, consulting with a neurosurgeon about realistic electrode implantation sites in different individuals, and applying a clustering algorithm to determine the most suitable regions to present stimuli.

Sighted participants recruited for the study were asked to test and verify the phosphene maps based on visual acuity and object recognition.

"We're proposing a new process that incorporates our simulation paradigm into surgical planning to help optimize the implantation of a cortical prosthesis," Associate Professor Wong said.

The process would begin with an MRI scan to plot the recipient's brain surface in the area of the visual cortex. Potential implant locations would then be identified, and the simulation developed in the Monash research would be used to plot phosphene maps.

"We can use the metrics we computed to find practical implant locations that are more likely to give us a usable phosphene map, and we can verify those options through psychophysics tests on sighted participants using a virtual reality headset," Associate Professor Wong said..

"We believe this is the first approach that realistically simulates the visual experience of cortical prosthetic vision."

More information: Haozhe Zac Wang et al, A novel simulation paradigm utilising MRI-derived phosphene maps for cortical prosthetic vision, *Journal of Neural Engineering* (2023). DOI: 10.1088/1741-2552/aceca2

Provided by Monash University