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Signals from the brain reveal what color a person is seeing

Researchers at the University of Tübingen succeed in predicting the color seen by an observer using the activity patterns measured in the visual cortex of other subjects.

Visual areas of the brain can reveal the colors a person is seeing while watching moving color rings, even if the chromatic responses of their brain have not previously been studied. This was the result of a study by Dr. Michael Bannert and Professor Andreas Bartels from the Centre for Integrative Neuroscience at the University of Tübingen. Using functional MRI scanning they recorded images from the brains of subjects who were observing visual stimuli, and identified different signals for red, green and yellow. The pattern of brain activity appeared similar in subjects who were not previously involved, meaning that the color they saw could be correctly predicted simply by comparison with images from the brains of other participants. The representation of colors in the brain is far more uniform across individuals than had been thought. The study has been published in the Journal of Neuroscience.

It was already possible to determine what color an individual is seeing in experiments using functional magnetic resonance imaging (fMRI) – but only for the same brain. "We wanted to know though how similar colors are encoded in different brains. In other words, can the colors that are seen also be deduced if we only have the neuronal color signals from the brains of other people?" says Michael Bannert. It is well known that the functional structure of different brains is roughly the same. "Some regions, for example, are more active when we see a face, a body or just color," explains the researcher. In their experiments with color rings, the researchers trained specific classification algorithms with fMRI data to distinguish the signals from the brains of a group of individuals systematically by color.

Graded experimental process

In the next step, the researchers worked with data from new subjects to determine which colors they were seeing using neuronal signals. To provide orientation in each brain, the researchers spatially mapped how it responded to stimulation at different locations of the visual field using fMRI measurements. "In order not to bias our results, we didn't use any colors at this stage, only black & white patterns," explains Andreas Bartels. "Just by using this mapping data in combination with the color information from the brains of others, we were able to determine reliably from the activity of a 'new' brain which colors that person was seeing at that point," says the researcher. "We were surprised that even the subtle differences between individual colors are so similar across brains in terms of the activity patterns they elicit during processing in certain visual areas. This was not previously known."

The spatial color coding in the brain is area-specific and organized consistently across individuals. Bartels and Bannert surmise that there must be a functional or evolutionary pressure for this uniform development, adding that this relationship still needs to be clarified. "The neurosciences are an especially renowned field of research in Tübingen, that consistently make important contributions to fundamental research into the human brain," says Professor Dr. Dr. h.c. (Dōshisha) Karla Pollmann, president of the University of Tübingen.

Publication:
Michael M. Bannert and Andreas Bartels: Large-scale color biases in the retinotopic functional architecture are region specific and shared across human brains. Journal of Neuroscience
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