Similar structures for face selectivity in human and monkey brains

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(Medical Xpress) -- Face recognition and the interpretation of facial expressions and gaze direction play a key role in guiding the social behavior of human beings, and new study results point to similar mechanisms in macaques. Until now, many scientists have assumed that the capability for face recognition in monkeys is significantly different from that in humans – and that different parts of the brain are involved. Using functional magnetic resonance imaging (fMRI), scientists at the Max Planck Institute for Biological Cybernetics in Tübingen have now discovered that the circuitry for face processing in the brain is remarkably similar in both macaques and humans. Consequently, macaque monkeys could be suitable model organisms for studying human disorders such as autism or prosopagnosia, so-called “face blindness.”

Very early in life children learn to recognize the faces of their parents and other human beings around them. In addition, humans must be able to process the cues from facial expressions and gaze direction in a matter of seconds. These complex tasks are performed by a number of brain areas, mainly in the superior temporal sulcus and the ventral temporal cortex. It is here that the fusiform face area (FFA) is located, the most important structure involved in face selectivity in humans.

In previous studies in macaques, only areas in the superior temporal sulcus had shown activity in processing facial information, and it was assumed that this discrepancy resulted from a species difference. “However, macaque monkeys live in groups of many individuals and have sophisticated social behavior. Vision is the main part of their communication, so I expected them to have sophisticated brain structures for face recognition as well", says Jozien Goense from the Max Planck Institute for Biological Cybernetics.

Together with her colleagues from the same Institute Shih-Pi Ku and Nikos Logothetis, Director of the Department of Physiology of Cognitive Processes, and Andreas Tolias, now in Houston with Baylor College of Medicine, the Michael E. DeBakey Veterans Affairs Medical Center and Rice University, Jozien Goense mapped the face-processing brain network in macaques. Functional magnetic resonance imaging (fMRI) reveals the activity of brain areas at a given time. The scientists made use of an optimized fMRI protocol that overcame the trouble with artifacts encountered in older studies, especially in the important ventral temporal lobe.

In the new experiments, the monkeys were shown pictures of unknown conspecifics displaying different facial expressions and gaze directions. The goal was to activate areas and neuronal structures that respond to identity and social cues. As a control, the responses to monkey faces were compared with reactions to pictures of fruit, houses and the abstract fractal patterns. The scientists found face-selective areas in the superior temporal sulcus, the prefrontal cortex and amygdala, which had been identified in previous studies. In addition, several patches in the ventral temporal lobe, the hippocampus, the entorhinal cortex and medial temporal lobe were shown to be active in the processing of facial information. The experiments were repeated in anesthetized macaques to eliminate the effects of motion and to test whether the activity depended on awake processing. The difference was minimal; the face-selective network was almost identical under anesthesia.

Jozien Goense sees her hypothesis confirmed that it was only technical limitations that led earlier scientists to assume that significantly fewer areas were active in face processing in the monkey brain than the human brain: “We know from our results that the network is larger than previously published. We have discovered several additional areas in the ventral temporal lobe which include a potential homologue of the fusiform face area in humans”, she says. Further studies still need to be done to test whether the similarities in the brain structures involved in face selectivity in humans and monkeys could help to investigate certain human illnesses. One example is prosopagnosia, which specifically affects the recognition of faces. The persons concerned are not able to memorize the faces of others and cannot even recognize their family members by vision alone, while the detailed differentiation of objects or even animals poses no problems.

More information: Shih-Pi Ku, Andreas S. Tolias, Nikos K. Logothetis and Jozien Goense, fMRI of the Face-Processing Network in the Ventral Temporal Lobe of Awake and Anesthetized Macaques, *Neuron* (2011), doi: 10.1016/j.neuron.2011.02.048

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