Brain scans show what makes us drink water and what makes us stop drinking

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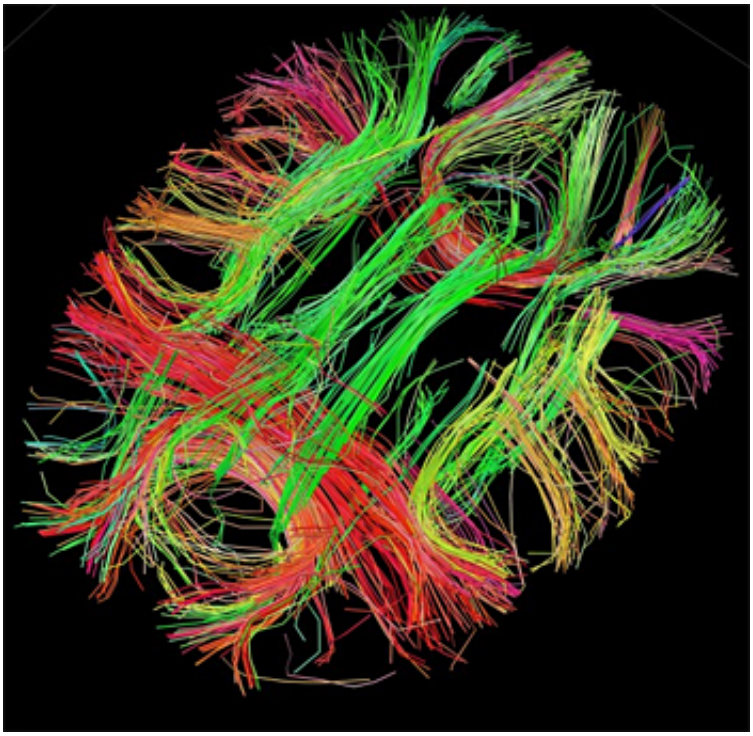

White matter fiber architecture of the brain. Credit: Human Connectome Project.

(Medical Xpress)—Drinking water when you're thirsty is a pleasurable experience. Continuing to drink when you're not, however, can be very unpleasant. To understand why your reaction to water drinking changes as your thirst level changes, Pascal Saker of the University of Melbourne and his colleagues performed fMRI scans on people as they drank water.

They found that regions of the brain associated with positive feelings became active when the subjects were thirsty, while regions associated with negative feelings and with controlling and coordinating movement became active after the subjects were satiated. The research appears in the *Proceedings of the National Academy of Sciences*.

A sense of thirst probably evolved in animals when they began living on land during the Ordovician period, about 400 million years ago. We need water to survive, and thirst provides us with the impulse to drink. However, drinking too much water can be as bad as drinking too little. Cells require a precise balance of water and other nutrients. Too much water can be deadly, leading to hyponatremia (low sodium levels) or cerebral edema (excess fluid in the brain.)

Fortunately, in normal conditions, we tend to drink only as much water as we need. The positive sensation we associate with drinking when thirsty disappears as soon as we are satiated. Then drinking produces a feeling of aversion.

To understand how the brain regulates the desire to drink water, Saker and his team had 20 people work up a sweat by exercising on a stationary bike for an hour. After the subjects had finished exercising, the team had them drink water and continue to drink, even after they were no longer thirsty. Over the course of the experiment, the researchers had the subjects report how they felt and performed fMRI scans to study activity in the subjects' brains.

When the subjects stopped exercising, they were dehydrated and felt thirsty. Drinking made them feel good. Brain scans revealed activation of regions associated with positive feelings in response to stimuli.

However, continuing to drink when they were no longer thirsty made the subjects feel bad. The more they drank, the worse they felt. Brain

regions associated with negative responses to stimuli and inhibition of swallowing became active, as did regions associated with motor control and coordination. Activation of motor control centers shows they were probably trying to force themselves to keep drinking even though they were experiencing a desire to stop.

The researchers think their findings could be used to help people with schizophrenia, who are prone to overdrinking.

More information: Regional brain responses associated with drinking water during thirst and after its satiation, Pascal Saker, *PNAS*, DOI: 10.1073/pnas.1403382111

Abstract
The instinct of thirst was a cardinal element in the successful colonization by vertebrates of the dry land of the planet, which began in the Ordovician period about 400 million y ago. It is a commonplace experience in humans that drinking water in response to thirst following fluid loss is a pleasant experience. However, continuing to drink water once thirst has been satiated becomes unpleasant and, eventually, quite aversive. Functional MRI experiments reported here show pleasantness of drinking is associated with activation in the anterior cingulate cortex (Brodmann area 32) and the orbitofrontal cortex. The unpleasantness and aversion of overdrinking is associated with activation in the midcingulate cortex, insula, amygdala, and periaqueductal gray. Drinking activations in the putamen and cerebellum also correlated with the unpleasantness of water, and the motor cortex showed increased activation during overdrinking compared with drinking during thirst. These activations in motor regions may possibly reflect volitional effort to conduct compliant drinking in the face of regulatory mechanisms inhibiting intake. The results suggestive of a specific inhibitory system in the control of drinking are unique.