

# Scientists find how neural activity spurs blood flow in the brain

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New research from Harvard University neuroscientists has pinpointed exactly how neural activity boosts blood flow to the brain. The finding has important implications for our understanding of common brain imaging techniques such as fMRI, which uses blood flow in the brain as a proxy for neural activity.

The research is described in the June 26 issue of the journal *Neuron*.

"When you see a brain image from fMRI studies, you are actually looking at changes in blood flow and oxygenation," says Venkatesh N. Murthy, professor of molecular and cellular biology in Harvard's Faculty of Arts and Sciences. "But because of the tight coupling between neural activity and blood flow, we are able to use the blood flow changes as a surrogate for brain activity. A better understanding of exactly how brain activity boosts blood flow should help us better read this process in reverse, which is what we do when interpreting fMRI images."

While it represents only about 5 percent of the human body's mass, the brain consumes 20 percent of the oxygen carried in its blood. Unlike muscle and other types of tissue, the brain has no internal energy stores, so all its metabolic needs must be met through the continuous flow of blood.

Murthy and colleagues studied mice and found that neurovascular coupling occurs through intermediary cells called astrocytes. By manipulating calcium levels, astrocytes can dilate or constrict blood vessels, depending on whether or not the cells are bound by neurotransmitters.

When a region of the brain becomes active, neurotransmitters begin to trickle out of that area's neural circuitry. The most common of these neurotransmitters in the mammalian brain, glutamate, is widely released at synapses and binds to astrocytes as well as to postsynaptic

receptors. Murthy's group found that after binding glutamate, astrocytes elevate their intracellular calcium levels, dilating blood vessels and increasing blood flow to that region of the nervous system.

Murthy and colleagues studied this process in the olfactory bulb, which processes odors.

"When a mouse encounters a scent, discrete loci in its olfactory bulb are activated, which in turn increases blood flow in those spots," Murthy says. "We measured all this using sophisticated optical microscopy, actually counting the number and rate of red blood cells passing through capillaries in the area. In addition to showing directly that astrocytes are involved in neurovascular coupling, we discovered that there are multiple molecular signaling pathways involved."

The new research by Murthy and colleagues lays the groundwork for further study of how this exquisite neurovascular coupling may go awry in neurodegenerative diseases, such as Alzheimer's disease, as well as in the normally aging brain. A growing body of evidence suggests that as people age -- and especially with the onset of neurodegenerative disease -- neurovascular coupling can be impaired. It's still unknown whether this impairment can add to the cognitive defects associated with both healthy and diseased aging.

Source: Harvard University

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