

Study reveals second pathway to feeling your heartbeat

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A new study suggests that the inner sense of our cardiovascular state, our "interoceptive awareness" of the heart pounding, relies on two independent pathways, contrary to what had been asserted by prominent researchers.

The University of Iowa study was published online this week in the journal [Nature Neuroscience](#) by researchers in the department of neurology in the Roy J. and Lucille A. Carver College of Medicine and the graduate programs in neuroscience and psychology.

The researchers found that, in addition to a pathway involving the insular cortex of the brain -- the target of most recent research on interoception -- an additional pathway contributing to feeling your own heartbeat exists. The second pathway goes from fibers in the skin to most likely the somatosensory cortex, a part of the brain involved in mapping the outside of the body and the sense of posture.

The UI team also confirmed the widely held belief by researchers that the insula and [anterior cingulate cortex](#) (ACC) regions of the brain are important, but not necessary, for a person to feel his or her own heartbeat. The insula helps with such higher-order functions as self-awareness, while the ACC is believed to regulate heart rate.

"What's shown in this study is there are probably two pathways that can participate in the conscious representation of these sensations," said David Rudrauf, Ph.D., assistant professor of neurology and radiology

and director of the laboratory of brain imaging and cognitive neuroscience. Rudrauf is lead author of the study along with Sahib Khalsa, M.D., Ph.D., who received medical and doctoral degrees from the UI and is currently working on his psychiatry residency at UCLA.

Daniel Tranel, Ph.D., a professor of neurology and psychology and director of the postdoctoral residency program in clinical neuropsychology, and Justin Feinstein, a graduate student in clinical neuropsychology, are co-authors on the study, titled "The pathways of interoceptive awareness."

The UI researchers studied an extremely rare neurological patient named "Roger" who has virtually complete bilateral insula and ACC damage, but who has the bilateral primary somatosensory cortex intact. They also studied 11 healthy age-matched male comparison participants.

Roger has been studied in the UI laboratory for 15 years. His brain damage occurred in 1980 following an episode of herpes simplex encephalitis. With Roger, Rudrauf and his colleagues wanted to see if the regions of the brain he's missing are really necessary to feel your own heartbeat.

The researchers injected the participants with a synthetic form of adrenaline to get their hearts to shoot up about 25 beats a minute. They then had the participants turn a dial to track their moment-to-moment experience of the intensity of their heartbeat sensations.

As it turned out, Roger felt his own heartbeat just like the healthy comparison participants in a dose-response fashion.

"It was a delayed reaction, but he was still feeling it," Feinstein said.

This development suggested that the insula and ACC were not necessary,

strictly speaking, for interoceptive awareness of heartbeat sensations.

The researchers suspected that Roger was feeling his heartbeat because his brain was using a different pathway, relying on the impact of the heartbeat on the chest wall and pulsations in blood vessels stretching the skin. So they applied a topical lidocaine anesthetic to the location on the skin where participants reported feeling the maximal heartbeat sensation.

They then repeated the injection procedure to increase each participant's heart rate. Roger again demonstrated heart rate increases identical to the healthy comparison participants. However, under anesthetic, he reported that he no longer felt his heartbeat. Conversely, the healthy comparison participants' ability to feel their heartbeats was unaffected by the anesthetic.

"There are two pathways. One conveys the heartbeat signal from the surface of the chest wall and blood vessels pulsating under the skin, to the somatosensory cortex, so whenever you feel your heart pounding it's stimulating that pathway," Feinstein said. "Roger is able to feel his heart beating because that area of his [brain](#) -- the somatosensory cortex -- is still there. When you get rid of that sensation by anesthetizing the skin, you need areas such as the insular [cortex](#) in order to feel the heart pulsing from deep within. That's what is missing in Roger and that's where the healthy person is able to feel it."

As emphasized by Rudrauf, interoceptive awareness, including the awareness of our cardiovascular states, is key in emotion, feeling and the sense of self. The pathways revealed by this study could be involved in everything from the pounding of the heart during a state of panic to the feeling of a "broken heart" during a state of grief.

Source: University of Iowa ([news](#) : [web](#))

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