

Vagus Nerve Stimulation Dramatically Reduces Inflammation



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Vagus nerve in yellow.

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Inflammatory responses play a central role in the development and persistence of many diseases and can lead to debilitating [chronic pain](#). In many cases, inflammation is your body's response to [stress](#). Therefore, reducing "fight-or-flight" responses in the nervous system and lowering biological markers for stress can also reduce inflammation.

Typically, doctors prescribe medications to combat inflammation. However, there's growing evidence that another way to combat inflammation is by engaging the vagus nerve and improving "vagal tone." This can be achieved through daily habits such as yoga and [meditation](#)—or in more extreme cases of inflammation, such as rheumatoid arthritis (RA)—by using an implanted device for vagus nerve stimulation (VNS).

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The vagus nerve is known as the "wandering nerve" because it has multiple branches that diverge from two thick stems rooted in the cerebellum and brainstem that wander to the lowest viscera of your abdomen touching your heart and most major organs along the way. Vagus means "wandering" in Latin. The words vagabond, vague, and vagrant are all derived from the same Latin root.

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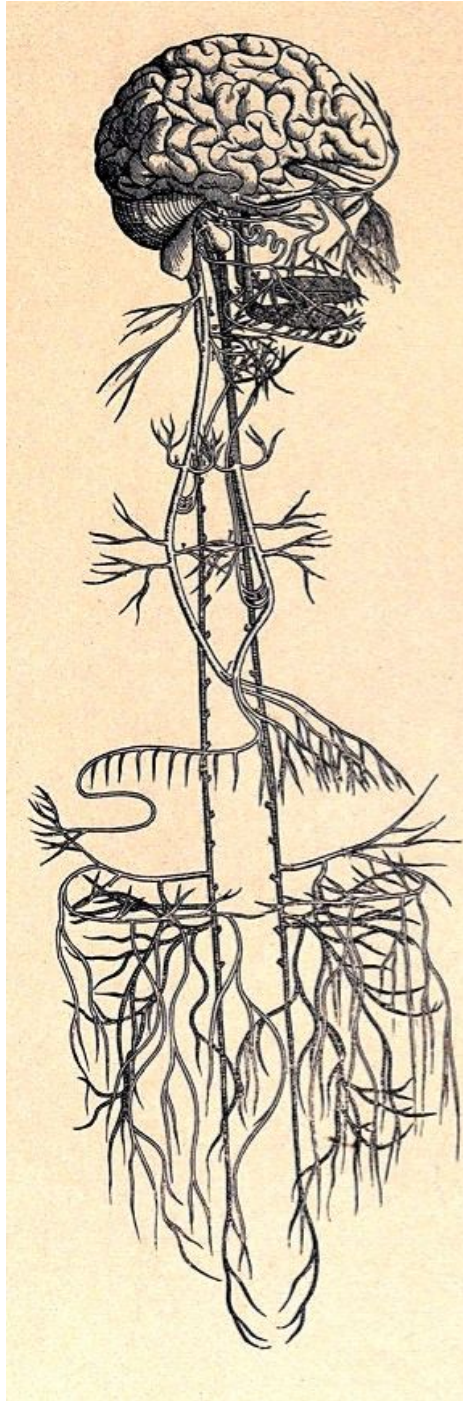
In 1921, a German physiologist named Otto Loewi discovered that stimulating the vagus nerve caused a reduction in heart rate by triggering the release of a substance he coined *Vagusstoff* (German for "Vagus Substance"). The "vagus substance" was later identified as acetylcholine and became the first neurotransmitter ever identified by scientists.

Vagusstoff (acetylcholine) is like a tranquilizer that you can self-administer simply by taking a few deep breaths with long exhales. Consciously tapping into the power of your vagus nerve can create a state of inner-calm while taming your inflammation reflex.

The vagus nerve is the prime component of the parasympathetic nervous system which regulates the "rest-and-digest" or "tend-and-befriend" responses. On the flip side, to maintain homeostasis, the sympathetic nervous system drives the "fight-or-flight" response.

[Healthy Vagal Tone Is Part of a Feedback Loop Linked to Positive Emotions](#)

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Early anatomical drawing of the vagus nerve.

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Healthy vagal tone is indicated by a slight increase of heart rate when you inhale, and a decrease of heart rate when you exhale. Deep diaphragmatic breathing—with a long, slow exhale—is key to stimulating the vagus nerve and slowing heart rate and blood pressure, especially in times of performance anxiety.

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A higher vagal tone index is linked to physical and psychological well-being. Conversely, a low vagal tone index is associated with inflammation, [depression](#), negative moods, [loneliness](#), heart attacks, and stroke.

A 2010 study, “[How Positive Emotions Build Physical Health: Perceived Positive Social Connections Account for the Upward Spiral Between Positive Emotions and Vagal Tone \(link is external\)](#),” was published in *Psychological Science*. For this research, Barbara Fredrickson and Bethany Kok of the University of North Carolina at Chapel Hill honed in on the vagus nerve and discovered that a high vagal tone index was part of a feedback loop between positive emotions, physical [health](#), and positive social connections.

Their research suggests that positive emotions, robust social connections, and physical health influence one another in a self-sustaining upward spiral dynamic and feedback loop that scientists are just beginning to understand.

For this experiment, Frederickson and Kok used a Loving-Kindness Meditation (LKM) technique to help participants become better at self-generating positive emotions. However, they also found that simply reflecting on positive social connections and working to improve close-knit human bonds also caused improvements in vagal tone.

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In 2014, I wrote a *Psychology Today* blog post, “[How Does the Vagus Nerve Convey Gut Instincts to the Brain?](#)” based on findings by researchers in Switzerland who identified how the vagus nerve conveys “[gut feelings](#)” of [anxiety](#) and [fear](#) to the brain. Clinical and experimental studies indicate that stress and depression are associated with the up-regulation of the immune system, including increased production of pro-inflammatory cytokines.

When administered to patients or laboratory animals, cytokines have been found to induce typical symptoms of depression. Therefore some cases of low mood, low energy, and lack of [motivation](#) may be due to elevated levels of cytokine proteins.

[Vagus Nerve Stimulation \(VNS\) Dramatically Reduces Arthritic Inflammation](#)



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Vagus Nerve Stimulation Dramatically Reduces Inflammation

Recently, an international [team](#) of researchers from Amsterdam and the United States conducted a clinical trial which demonstrates that stimulating the vagus nerve with a small implanted device significantly reduced inflammation and improved outcomes for patients with rheumatoid arthritis by inhibiting cytokine production.

RA is a chronic inflammatory disease that affects approximately 1.3 million people in the United States and costs tens of billions of dollars to treat each year, according to the researchers.

The neuroscientists and immunology experts involved in this study used state-of-the-art technology to map the [neural](#) circuitry that regulates inflammation. In one circuit—termed “the inflammatory reflex”—action potentials transmitted in the vagus nerve inhibit the production of pro-inflammatory cytokines.

The July 2016 study, "[Vagus Nerve Stimulation Inhibits Cytokine Production and Attenuates Disease Severity in Rheumatoid Arthritis \(link is external\)](#)," appears online in the *Proceedings of the National Academy of Sciences* (PNAS) and will be published in an upcoming print issue.

This is the first human study designed to reduce symptoms of rheumatoid arthritis by stimulating the vagus nerve with a small implanted device which triggered a chain reaction that reduced cytokine levels and inflammation. Although this study focused on rheumatoid arthritis, the trial's results may have implications for patients suffering from other inflammatory diseases, including Parkinson's, Crohn's, and [Alzheimer's](#).

In a statement, Paul-Peter Tak, the international principal investigator and lead author of the paper from the Division of Clinical Immunology & Rheumatology of the Academic Medical Center at the University of Amsterdam, said,

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"This is the first study to evaluate whether stimulating the inflammatory reflex directly with an implanted electronic device can treat RA in humans. We have previously shown that targeting the inflammatory reflex may reduce inflammation in animal models and in vitro models of RA . . . which might be relevant for other immune-mediated inflammatory diseases as well."

These findings suggest a new approach to fighting diseases that are currently treated with relatively expensive [drugs](#) that have a host of side effects. VNS gives healthcare providers a potentially more effective way to improve the lives of people suffering from chronic inflammatory diseases.

Conclusion: VNS Is a Potent Drug-Free Alternative for Treating Inflammation

In conclusion, co-author Kevin J. Tracey, president and CEO of the Feinstein Institute for Medical Research and the person who discovered the inflammatory reflex, said,

"This is a real breakthrough in our ability to help people suffering from inflammatory diseases. While we've previously studied animal models of inflammation, until now we had no proof that electrical stimulation of the vagus nerve can indeed inhibit cytokine production and reduce disease severity in humans. I believe this study will change the way we see modern medicine, helping us understand that our nerves can, with a little help, make the drugs that we need to help our body heal itself."

The emerging field of bioelectronic [integrative medicine](#) targets a variety of disorders traditionally treated with pharmaceuticals by using advanced neuromodulation devices. Stimulating the vagus nerve offers significant advantages to the use of drugs—such as lower cost and fewer side effects. Stay tuned for more on these exciting breakthroughs!

To read more on the vagus nerve, check out my *Psychology Today* blog posts,

Vagus Nerve Stimulation Dramatically Reduces Inflammation

- ["The Neurobiology of Grace Under Pressure"](#)
- ["How Does the Vagus Nerve Convey Gut Instincts to the Brain?"](#)
- ["Cortisol: Why "The Stress Hormone" Is Public Enemy No. 1"](#)
- ["The Neuroscience of Calming a Baby"](#)
- ["Mindfulness Meditation and the Vagus Nerve Share Many Powers"](#)
- ["Psychotherapy Can Dramatically Improve Your Gut-Brain Axis"](#)
- ["Don't Panic! Stress Is Contagious"](#)

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