# all in your head? impossible!

*part 1*

NOVEMBER 2014
ALIVE!

**WHEN SYMPTOMS** of disease and sickness are said to be all in one's head, there is an implication made that questions the legitimacy of physical ailment. When we hear this description we understand that something is thought of as reality, but is only imaginary. In the absence of underlying pathology, symptoms can be attributed to psychosomatic influences. This can at first glance seem invalidating to the sufferer. However, this relationship between the mind and body is the foundation for my belief that it is virtually impossible for anything to be all in your head.

Common symptoms of physical sickness include: diminished appetite, mental and physical fatigue, behavioral and psychological languishing, disinterest in pleasurable activities, fever, etc. These responses are not directly elicited from the sight of infection. It is the brain that triggers the symptoms of sickness. Steven Maier, PhD, and his colleagues posed a seemingly simple question that led to some interesting research. How does the brain know there is an infection in the first place?

The first armory on the scene of any infection is macrophages, white blood cells with an amazing variety of potential roles. They reside in every tissue of the body. Macrophages interpret cues they receive and respond in an attempt to protect the body. Activated macrophages secrete molecules called pro-inflammatory cytokines. Rather than discuss specific cytokines, let me introduce them to you as a large family of compounds whose surname is cytokine.

The term cytokine is derived from a combination of two Greek words: "cyto" meaning cell and "kinos" meaning movement. True to their name, cytokines get things going. Just like members of any large family, each cytokine has different roles and functions. Basically, cytokines are molecules that aid intercellular communication in immune responses and stimulate the movement of white blood cells toward sites of inflammation, infection, and trauma. Some regulate the body's response to disease and infection. They can behave as chemical switches that turn certain immune cell types on and off. Cytokines also mediate normal cellular processes in the body. It is interesting that when cytokines interact with brain cells the brain triggers the sickness response.

Maier and his colleagues used this piece of information to answer the question regarding how the brain perceives sickness in their research with sick animals. When cytokines were inactivated or when the receptors or docking sites in the brain that bind cytokines were blocked, the animals showed no sign of sickness after infection. Their brains did not perceive that infection was raging since it could not detect the presence of cytokines. Guess what happens if the brain is uninformed that there is an emergency? La de da, it goes happily on its way. Conversely, when cytokines were administered to healthy animals' brains, all the signs of infection were manifested even though no infection existed. In other words, even though there was no pathology below the neck, and the cytokines were literally all in the head, the animals felt sick.

How did the brain know the body was sick? Through the communication and presence of members of the cytokine family the brain knew to elicit the sickness response.

The next question that resulted from these findings was, how do these

cytokines that are produced locally at the site of infection, get to the brain? One might think they travel through the blood, but Maier and his colleagues found this not to be the case.

## HOW DOES THE BRAIN KNOW THERE IS AN INFECTION IN THE FIRST PLACE?

Rather than cytokines travelling through blood vessels, like following a road to the final destination, a more direct route is opted for that eliminates having to try and get through the formidable blood-brain barrier. Cytokines take the nearest off-ramp for the quickest route and switch from the gently flowing bloodstream to the nervous system, the vagus nerve autobahn.

The vagus nerve is the longest cranial nerve extending from the brain to the abdomen. It has the widest distribution in the body innervating the throat, esophagus, heart, lungs, stomach, spleen, pancreas, liver, kidneys and small and large intestine. There is a problem, however, to this picture of cytokines taking an off-ramp and hopping onto the nervous system. Nerves play with a completely different currency than blood. They do not transport goods as we think of the blood doing. Chemicals are converted into electrical messages. How does the body translate a blood-borne signal into a neural signal?

Sitting along the vagus nerve are pockets of neurotransmitters, which have on them receptors/docking sites for cytokine family members, as in the brain.

"So, the way this all works is really clever," explains Maier. "Your macrophage chews on a bacteria," it releases a cytokine into the neighboring space, the cytokine binds to neuron receptors that send a message "to activate the vagus nerve, which then sends an electrical signal to the brain. This signal triggers the brain to make" the very same cytokines that were down below. One could say perhaps that it is recreating a sample of what is taking place in other parts of the body so the brain knows what to do about it. The brain then sets off the sickness response and sends signals back to the immune system, further activating immune cells.

"If I cut your vagus," said Maier, who has done such in rats, "your brain doesn't know you're sick."[1]

The immune response manufactures chemical messages that are translated into electrical signals that are reconverted to a chemical message on the way up and vice versa on the way down. In other words, that cytokine message from the site of infection came through loud and clear in the brain.

Ellen White was aware of such a highway of communication between the brain and the organs below. Referring to children who ate poor diets, she commented on the fact that it resulted in more than gastrointestinal tract suffering. She said, "The excitement is **communicated to the brain through the nerves**, and the result is that the animal passions are roused and control the moral powers."[2] The 21st century scientists in the field of psychoneuroimmunology, who came to understand this mode of communication through their research, might marvel at her comment.

Psychoneuroimmunology is the study of the interaction between psychological processes, the nervous system, and the immune system. In past decades it was unheard of for these concepts to be studied together not to mention being combined in the same word. Textbooks on immunology would not mention the central nervous system, brain, or mood. However, important advances have been made through research expanding our understanding of how immune-related events can influence the central nervous system processes and can alter cognition, mood, and behavior, and vice versa.

Mental stress just happens to tap into this very same vagus nerve circuit that we just talked about, starting in the brain rather than by an immune system response. When animals were stressed through social isolation or by giving them an electrical shock, massive increases of cytokine levels in the brain were seen. Both stress and infection produce the same effect in the brain. The stress produces the exact behavioral changes of the sickness response as seen when infection rages. Maier's observation is, "These animals are physically sick after stress. You see everything you see with infection."[3]

[1] Beth Azar, "A New Take On Psychoneuroimmunology," *American Psychological Association*, Dec. 2001, Vol 32, No. 11, http://www.apa.org/monitor/dec01/anewtake.aspx.

[2] Ellen White, *Testimonies to the Church*, vol. 4, p. 141.

[3] Beth Azar, "A New Take On Psychoneuroimmunology," *American Psychological Association*, Dec. 2001, Vol 32, No. 11, http://www.apa.org/monitor/dec01/anewtake.aspx.


Risë has been writing on various health subjects for over 20 years. She has inspired many through her research and down-to-earth writing and speaking style. She believes that healthy living is intimately tied to happiness and wholeness.