Science of The Heart: Exploring the Role of the Heart in Human Performance

An Overview of Research Conducted by the Institute of HeartMath

Introduction

For centuries, the heart has been considered the source of emotion, courage and wisdom. At the Institute of HeartMath (IHM) Research Center, we are exploring the physiological mechanisms by which the heart communicates with the brain, thereby influencing information processing, perceptions, emotions and health. We are asking questions such as: Why do people experience the feeling or sensation of love and other positive emotional states in the area of the heart and what are the physiological ramifications of these emotions? How do stress and different emotional states affect the autonomic nervous system, the hormonal and immune systems, the heart and brain? Over the years we have experimented with different psychological and physiological measures, but it was consistently heart rate variability, or heart rhythms, that stood out as the most dynamic and reflective of inner emotional states and stress. It became clear that negative emotions lead to increased disorder in the heart's rhythms and in the autonomic nervous system, thereby adversely affecting the rest of the body. In contrast, positive emotions create increased harmony and coherence in heart rhythms and improve balance in the nervous system. The health implications are easy to understand: Disharmony in the nervous system leads to inefficiency and increased stress on the heart and other organs while harmonious rhythms are more efficient and less stressful to the body's systems.

More intriguing are the dramatic positive changes that occur when techniques are applied that increase coherence in rhythmic patterns of heart rate variability. These include shifts in perception and the ability to reduce stress and deal more effectively with difficult situations. We observed that the heart was acting as though it had a mind of its own and was profoundly influencing the way we perceive and respond to the world. In essence, it appeared that the heart was affecting intelligence and awareness.

The answers to many of our original questions now provide a scientific basis to explain how and why the heart affects mental clarity, creativity, emotional balance and personal effectiveness. Our research and that of others indicate that the heart is far more than a simple pump. The heart is, in fact, a highly complex, self-organized information processing center with its own functional "brain" that communicates with and influences the cranial brain via the nervous system, hormonal system and other pathways. These influences profoundly affect brain function and most of the body's major organs, and ultimately determine the quality of life.

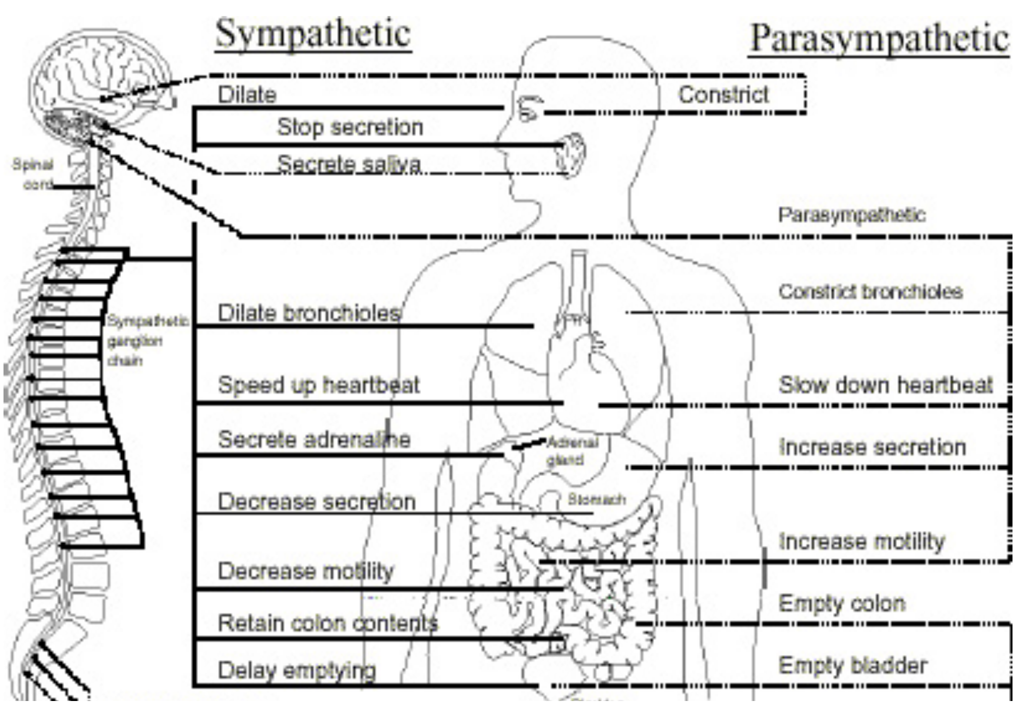

Figure 1.
Innervation of the major organs by the autonomic nervous system (ANS). Parasympathetic fibers pass through the cranium and sacrum; sympathetic fibers are associated with the thoracic and lumbar vertebrae. Proper functioning of the ANS is critical for the maintenance of health, while a number of health problems are associated with ANS dysfunction or imbalance. Emotions greatly affect the activity of the ANS and the balance between the two branches. For example, anger causes increased sympathetic activity and reduced parasympathetic. Constriction of the arteries resulting from excessive sympathetic stimulation can contribute to hypertension and heart attacks.

Neurocardiology: The Brain in the Heart

While the Laceys were doing their research in psychophysiology, a small group of cardiovascular researchers joined with a similar group of neurophysiologists to explore areas of mutual interest. This represented the beginning of the new discipline of neurocardiology, which has since provided critically important insights into the nervous system within the heart and how the brain and heart communicate with each other via the nervous system.

After extensive research, one of the early pioneers in neurocardiology, Dr. J. Andrew Armour, introduced the concept of a functional "heart brain" in 1991. His work revealed that the heart has a complex intrinsic nervous system that is sufficiently sophisticated to qualify as a "little brain" in its own right. The heart's brain is an intricate network of several types of neurons, neurotransmitters, proteins and support cells like those found in the brain proper. Its elaborate circuitry enables it to act independently of the cranial brain – to learn, remember, and even feel and sense. The recent book Neurocardiology, edited by Dr. Armour and Dr. Jeffrey Ardell, provides a comprehensive overview of the function of the heart's intrinsic nervous system and the role of central and peripheral autonomic neurons in the regulation of cardiac function. The nervous system pathways between the heart and brain are shown in Figure 2.

The heart's nervous system contains around 40,000 neurons, called sensory neurites, which detect circulating hormones and neurochemicals and sense heart rate and pressure information. Hormonal, chemical, rate and pressure information is translated into neurological impulses by the heart's nervous system and sent from the heart to the brain through several afferent (flowing to the brain) pathways. It is also through these nerve pathways that pain signals and other feeling sensations are sent to the brain. These afferent nerve pathways enter the brain in an area called the medulla, located in the brain stem. The signals have a regulatory role over many of the autonomic nervous system signals that flow out of the brain to the heart, blood vessels and other glands and organs. However, they also cascade up into the higher centers of the brain, where they may influence perception, decision making and other cognitive processes.

Dr. Armour describes the brain and nervous system as a distributed parallel processing system consisting of separate but interacting groups of neuronal processing centers distributed throughout the body. The heart has its own intrinsic nervous system that operates and processes information independently of the brain or nervous system. This is what allows a heart transplant to work: Normally, the heart communicates with the brain via nerve fibers running through the vagus nerve and the spinal column. In a heart transplant, these nerve connections do not reconnect for an extended period of time, if at all; however, the transplanted heart is able to function in its new host through the capacity of its intact, intrinsic nervous system

The Heart Brain

The intrinsic cardiac nervous system, or heart brain, is made up of complex ganglia, containing afferent (receiving) local circuit (interneurons) and efferent (transmitting) sympathetic and parasympathetic neurons. Multifunctional sensory neurites, which are distributed throughout the heart, are sensitive to many types of sensory input originating from within the heart itself. The intrinsic cardiac ganglia integrate messages from the brain and other processing centers throughout the body with information received from the cardiac sensory neurites. Once information has been processed by the heart's intrinsic neurons, the appropriate signals are sent to the sinoatrial and atrioventricular nodes as well as the muscles in the heart. Thus, under normal physiological conditions, the heart's intrinsic nervous system plays an important role in much of the routine control of cardiac function, independent of the central nervous system. Dr. Armour and his colleagues have shown that the heart's intrinsic nervous system is vital for the maintenance of cardiovascular stability and efficiency, and that without it, the heart cannot operate properly.

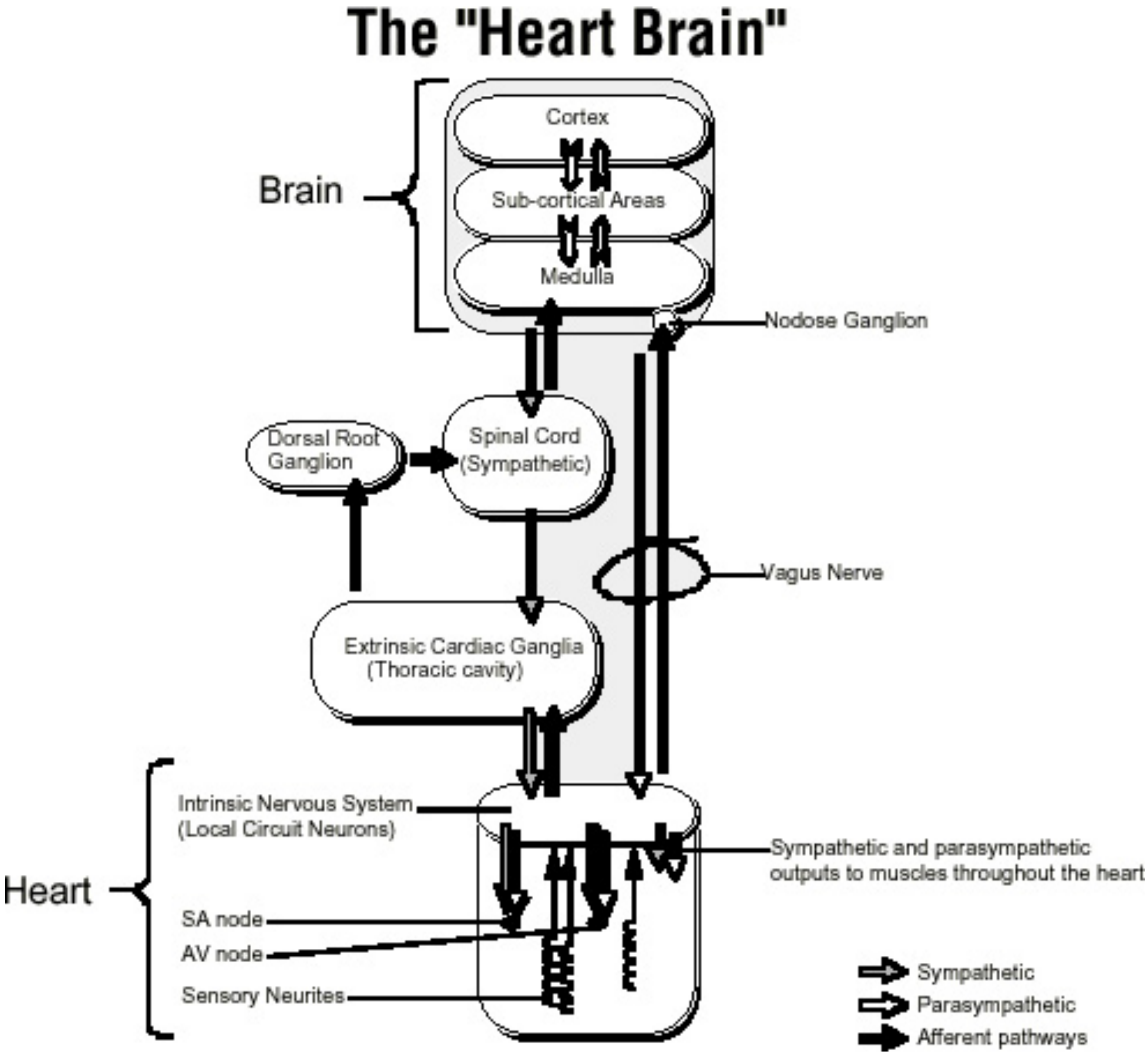

Figure 2.

The neural communication pathways between the heart and the brain. The heart's intrinsic nervous system consists of ganglia, which contain local circuit neurons of several types, and sensory neurites, which are distributed throughout the heart. The intrinsic ganglia process and integrate inflowing information from the extrinsic nervous system and from the sensory neurites within the heart. The extrinsic cardiac ganglia, located in the thoracic cavity, have direct connections to organs such as the lungs and esophagus and are also indirectly connected via the spinal cord to many other organs, including the skin and arteries. The "afferent" (flowing to the brain) parasympathetic information travels from the heart to the brain through the vagus nerve to the medulla, after passing through the nodose ganglion. The sympathetic afferent nerves first connect to the extrinsic cardiac ganglia (also a processing center), then to the dorsal root ganglion and the spinal cord. Once afferent signals reach the medulla, they travel to the subcortical areas (thalamus, amygdala, etc.) and then to the cortical areas.

To access the complete eBook, please visit:

http://www.heartmath.org/research/science-of-the-heart/introduction.html