Functional Magnetic Resonance Imaging and Spectroscopy of Brain Activation During Heart Rhythm Coherence

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Deciphering the relationships between emotional states and physiological processes is critical to broadening our understanding of consciousness. The purpose of this study was to explore the neurophysiological correlates of specific states of consciousness associated with the experience of sustained positive emotions.

Research conducted at the Institute of HeartMath has demonstrated an important link between emotions and changes in the patterns of both efferent (descending) and afferent (ascending) autonomic activity, which are associated with changes in the heart's rhythmic activity. These findings support a model of emotion in which heart-brain interactions play an important role in emotional perception and experience.

In previous studies it was found that sustained positive emotions, such as appreciation, are associated with a distinct mode of physiological function, which can be characterized and quantified using electrophysiological measures. We have introduced the term psychophysiological coherence to describe this mode. Correlates of psychophysiological coherence include a smooth, sine wave-like pattern in the heart rate variability waveform (heart rhythm coherence), a shift in autonomic balance toward increased parasympathetic activity, entrainment between diverse physiological oscillatory systems, increased heart-brain synchronization, and improved cognitive performance.

In order to further characterize the relationship between this distinct state of consciousness and physiological processes, we applied neuroimaging tools to measure patterns of brain activation during this state. Recent technological developments have dramatically increased our capacity to examine the structure and function of the human brain. These "neuroimaging technologies," e.g., functional magnetic resonance imaging (fMRI) and functional magnetic resonance spectroscopy (fMRS), have the potential to reveal some of nature's most closely held and significant secrets. Both fMRI and fMRS are techniques that measure physiological parameters of brain activation. These brain imaging techniques are referred to as functional (rather than structural) because participants perform specific tasks while they are in the magnet; as a result, analyses of the imaging permit conclusions about activation of the functioning brain rather than neuroanatomy of the resting brain.

We have performed preliminary experiments measuring functional brain activity while subjects maintained a state of psychophysiological coherence. Two subjects who were proficient at sustaining this state of consciousness were scanned at the University of Washington Neuroimaging Research Center. The subjects were scanned using both fMRI and fMRS while they were asked to intentionally experience positive or negative emotions (appreciation versus anxiety). Heart rate variability was also simultaneously measured during the scans.

Results of heart rhythm pattern analysis revealed high heart rhythm coherence during intentionally generated states of appreciation (confirming that subjects had entered the psychophysiological coherence mode) and increased disorder in heart rhythm patterns during self-induced anxiety. The fMRI scans showed significant increases in activation in the frontal, temporal, and parietal-occipital regions of the brain during appreciation-driven states of

psychophysiological coherence, as compared with anxiety. Additionally, the fMRS scans demonstrated chemical changes in the brain that correlated with states of appreciation and heart rhythm coherence. By demonstrating distinct changes in brain physiology associated with the psychophysiological coherence mode, the results of these studies enhance our understanding of the physiological correlates of positive emotional states.