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The heart rate and respiration-heart and respiration relationship. Biofeedback investigation method

There are many articles about respiratory sinus arrhythmia (RSA) and the links between heart rhythm and respiration. However, there has been need for further investigation into the underlying mechanics of these dependencies.

We have investigated the underlying mechanics of the relationship between heart rhythm and respiration through the use of biofeedback. Biofeedback techniques were used for imposing testing perturbances into the examined system.

Nine healthy male volunteers (ages 25-40 years) participated in this study. The primary measure for this study was respiratory curve and heart rate. Each subject sat in a comfortable chair in front of a monitor. The testing sinusoid and respiratory curve (biofeedback signal) were displayed. Subjects were informed about displayed curves and instructed to breathe in such a way that the respiration curve and testing curve would coincide. Each subject underwent 4-6 sessions. During each session, subjects were presented with 9 randomly ordered testing sinusoids with periods of 1, 2, 4, 7, 10, 13, 18 and 30 seconds. Each sinusoid was displayed for approximately 2-3 minutes. Values of magnitude and phase transfer functions between heart rhythm and respiratory curves were calculated for each testing period.

It was found that transfer functions for the subjects didn't change significantly during the sessions. Although these functions varied between individuals, certain commonalties were found. The magnitude function had a clearly visible maximum. Phase function had positive values on low frequencies. When subjects increased respiratory frequency, Phase function values went down to negative values. On the frequency of the magnitude function's maximum, the values of the phase function approached zero. The respiratory frequency, which corresponded to the maximum of the magnitude function, and the maximum's amplitude were different for each subject.

This experimental data does not show that the level of the relationship between respiration and heart rate depends on respiration frequency (rate). This level is expected to be constant for the entire tested frequency range and is defined by n.vagus activity. The clearly defined maximum of the amplitude function shows again the resonance characteristic of the human cardiovascular system. The respiration in the resonance frequency 'swings' high amplitude oscillations of the heart rate. The resonance amplitude is defined by a close loop resonance characteristic rather than by respiration intensity or the level of the heart rate-respiration relationship.

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Communications should be addressed to:
Evgeny Vaschillo
HPDRC, 11200 SW Eighty St., ECS 243
Miami, FL 33199