Hello all and welcome to the November ***COHERENCE Newsletter***. This month the topic is "COHERENCE - The Big Picture".

In physics, "coherence" is a complex measure of wave phenomena. Specifically, its a measure of the correlation between all of the physical properties of waves, e.g., amplitude, phase, and frequency.

If two perfectly "coherent" waves collide, waves that are exact in every respect, they will negate each other perfectly, this "stationary interference" being proof positive of their exactness or "coherence". Another way to think of it is if we take two perfectly coherent waves, invert one, and add them, the result is exactly "zero".

In the body, as in nature, coherence is a characteristic of wave action, where we may be concerned with the correlation between wave activity demonstrated by different biological processes, for example respiration and circulation, or how any one process demonstrates coherence over time, i.e. how multiple consecutive waves demonstrate consistency.

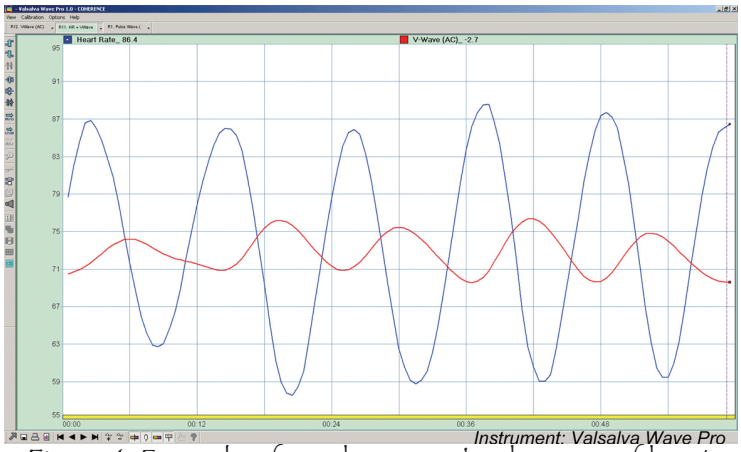

Figure 1: Example of synchrony and coherence of heart rate (blue) and breathing induced Valsalva Wave (red)

In the latter case, coherence is a broad measure of rhythmicity (multiple consecutive waves cannot exist without a degree of rhythmicity). The measurement of "heart coherence" is an example of this type of sequential analysis.

Wherever the human organism demonstrates rhythmic motion, there is wave phenomena. And where there is wave phenomena, the potential exists for those waves to exhibit rhythm and coherence, or its opposite – arrhythmia and incoherence – on a spectrum.

Figure 2: Child on a swing.
A demonstration of resonance

A pendulum is a simplest example or, or maybe there's an example of a dynamic pendulum that we're more familiar with, a child on a swing, in which case the child and the swing are part of the pendulum system.

For any child and any swing, there is a point of maximal efficiency, the point at which the swing travels highest to and fro with minimal sustained effort applied. This it the resonant condition at which the swing and the swinger are working in harmony yielding maximal height, i.e. "amplitude", with minimal incremental effort. A child can find this rhythm within seconds.

If, however, the effort applied becomes arrhythmic, the action of the swing becomes chaotic, its height diminishes, and it eventually comes to a stop. It is the application of appropriate rhythmic effort that keeps the swinger swinging joyfully with height.

Physical systems demonstrate wave activity and resonance. Being physical systems, biological systems demonstrate the same. We should care because wave action in the body is related to efficiency and ultimately to "life".

When the body is in a state of rest or semi-activity, i.e. when the skeleton is still, there are two fundamental bio-mechanical processes that carry on, both of these processes producing wave phenomena. The first one is the beat of the heart. The second is respiration, powered by the diaphragm. If either of these wave processes cease, our minutes are numbered.

The heart beat produces a high pressure (nominally 100mmHg average) pulsatile blood wave that advances into the aorta on the arterial side, a like amount of blood being drawn through the right heart, advancing into the low pressure (nominally 20mmHg) zone of the lungs on the venous side.

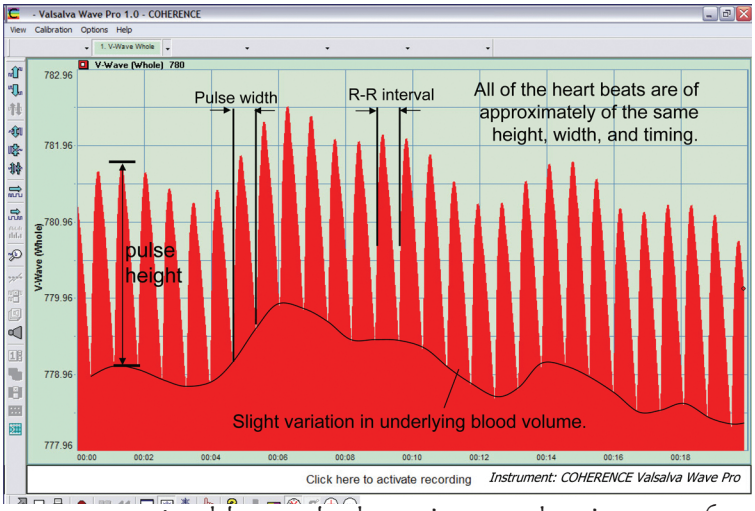

Figure 3: Highly regular heart beat in the absense of deeper rhythmic respiration (observe similarity of pulses)

Interestingly, in the absence of respiratory influence, the heart beat itself tends to be very rhythmic and coherent, demonstrating little beat to beat variation in amplitude, phase, or frequency. Coherence of the heart beat can be attributed to the biomechanical resonance of the heart and vascular system (acknowledging the role of the autonomic nervous system).

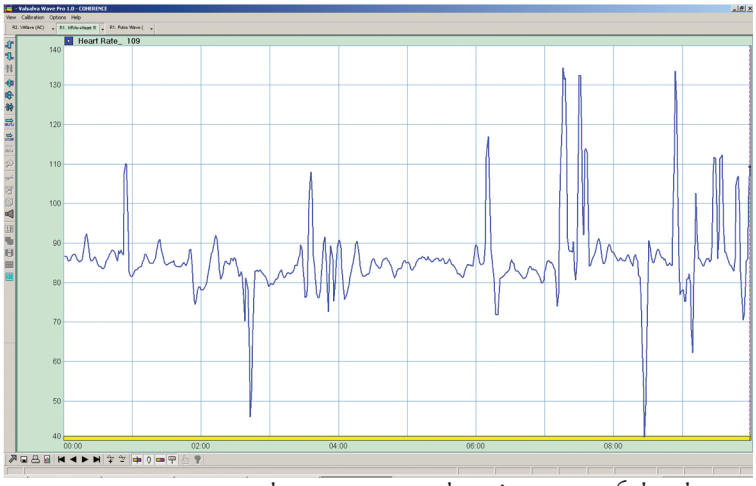

Figure 4: Spurious heart rate in the absence of rhythmic respiration (contrast this to the heart rate of Figure 1)

If we isolate the heart, we can think of this beat-beat coherence as a measure of "cardiac rhythmia", the tendency of the heart beat to be consistent in the absence of other stimuli, principally ANS activity. As the heart is amongst other things "a pump", rhythmicity and regularity are indicative of proper operation, an incoherent and irregular heart beat in the absence of external stimuli is indicative of heart defect.

The beat of the heart then, is one source of wave action in the body that may demonstrate coherence, or not, where "coherence" is desirable because it demonstrates integrity.

In actuality, the steady-state heart beat imagined above is perturbed by all matter of autonomic activity, ANS activity reflecting the state of the body and to some degree the mind. These perturbations, primarily reflected as spurious variation in instantaneous heart rate are particularly visible in the absence of respiration. (See Figure 4).

The second major source of wave action is the diaphragm, which, through its modulation of internal pressures in thoracic and abdominal cavities, creates air waves in conducting airways, blood waves in the circulation, and "waves of locomotion" in the gut.

Via the elegant arrangement of the body, the autonomic nervous system joins in this wave action, facilitating "super-synchrony" and "macro-coherence" that is, synchrony between movement of the diaphragm, gas exchange, blood flow, autonomic emphasis, enteric emphasis, etc. This macro-coherence expressly involves the heart, the lungs, the vascular system, and the gut, all of which begin to synchronize with the amplitude, phase, and frequency of diaphragm action.

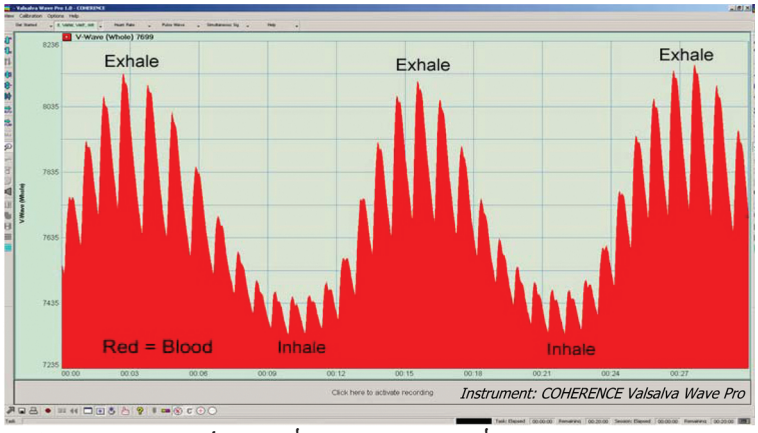

Figure 5: Cardio-pulmonary-circulatory resonance demonstrating dramatic changes in blood volume, pulse height, pulse width, and pulse rate

Generally, small diaphragm movement results in small synchronizing effect – large movement, in large effect. In between, there is a frequency and depth where synchronization is maximal, and the waves produced are maximally coherent and free of distortion. This is "the frequency and depth of cardio-pulmonary-circulatory resonance.

This author asserts that the body behaves this way because it is arranged to take advantage of work performed by the diaphragm – a large strong muscle in the center of the body. When the diaphragm is working, biological imperatives are met via increased efficiency, allowing other organs to do more yet work less.

Spurious variations in heart rate that may exist prior to employing "coherent" respiration like those of Figure 4, begin to disappear as the heart rate begins synchronizing with respiration and especially as heart rate variability increases into the 10+ beat range. It isn't clear if coherent respiration "covers up" these anomalies in heart rate or whether it eliminates them. If it eliminates them, incoherent, insufficient respiration could in fact be their cause.

Thank for your interest and consideration,

Stephen Elliott - COHERENCE

Stephen's research colleague is Dee Edmonson, R.N., BCIAC-EEG (www.neurologics.us).

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