Hello all,

Welcome to the December ***COHERENCE Newsletter***. I hope you enjoyed last month's special feature, ***From Sudan - A Story of Coherent Breathing***, by guest contributor Ellen Ratner, White House Correspondent and Washington Bureau Chief, Talk Radio. Thanks again Ellen, for sharing your important story with us. If you missed it you can always find it under "newsletters" at coherence.com. This last month of the year's topic is ***Valsalva Wave/Heart Rate Synchrony - A New Measure of Resonance***, which waxes a bit technical. For this I apologize.

Before we get started, Dee Edmonson and I will be presenting the half day workshop, ***The Arterio-Venous Wave, The Changing Landscape of Heart Rate Variability Biofeedback*** at the upcoming meeting of The Association for Applied Psychologists and Biofeedback professionals in San Diego, March 24-27. We'd love to see you there!

Dear reader,

This being the year's last COHERENCE Newsletter, I want to take a moment and thank you all for your kind interest and enthusiasm. May Coherent Breathing benefit you in every endeavor!

Happy holidays and best wishes for 2010.

Steve

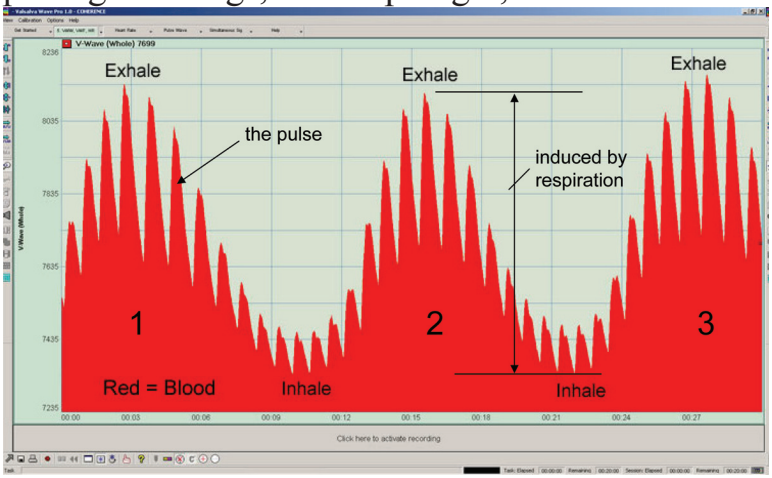
Also, the new book, ***Wuji Qi Gong And The Secret Of Immortality,*** written with colleague Meng Sheng Lin, is poised for publication in January. Its a practical and philosophical discussion of a millenniums old Taoist health practice that I've had the good fortune to study for the last 15 years. As discussed in the book, we believe it to have been practiced as far back as the dawn of civilization. Bold though it sounds, it may be an essential root of all Eastern yogas. To find out more keep an on eye on: www.wujiqigong.net.

Valsalva Wave/Heart Rate Synchrony – A New Measure of Resonance

"Resonance" is the tendency of any physical system to oscillate. The frequency at which it oscillates is that at which it is optimally efficient. The pendulum of a clock is a simplest example. The pendulum swings back and forth at its resonant frequency which is determined in large part by its mass and its length. The physical system we are interested in discussing is *the human cardiopulmonary system* consisting of the lungs, the left heart, the arterial tree, the capillary bed, the venous tree, the right heart, and coming full circle, the lungs. This is the primary course that the blood takes as it circulates through the body.

Unlike the clock pendulum, the cardiopulmonary system involves fluid mechanics. Nevertheless, it is a physical system that exhibits the tendency to oscillate at a resonant frequency. And like the pendulum, the oscillation occurs at the mechanical moment of optimal efficiency. Here optimal efficiency translates to maximal blood flow with minimal energy expended.

There are 4 primary forces that move the blood in the body. They are: 1) the thoracic pump comprising the lungs, the diaphragm, and the thoracic cavity, 2) the heart, 3) the arterial tree, and 4) gravity. At resonance, these factors come together to work in perfect synergy and synchrony which can be observed in the capillary blood flow to produce a wave that looks like this. We've named this phenomenon, the "Whole Valsalva Wave", *whole* because it offers a complete view of wave action of the blood. *Valsalva Wave* is the name we've given the complex *a*rterial and *v*enous wave induced by resonant respiration.



Synchrony of Respiration and Pulse Waves (Ear Lobe)

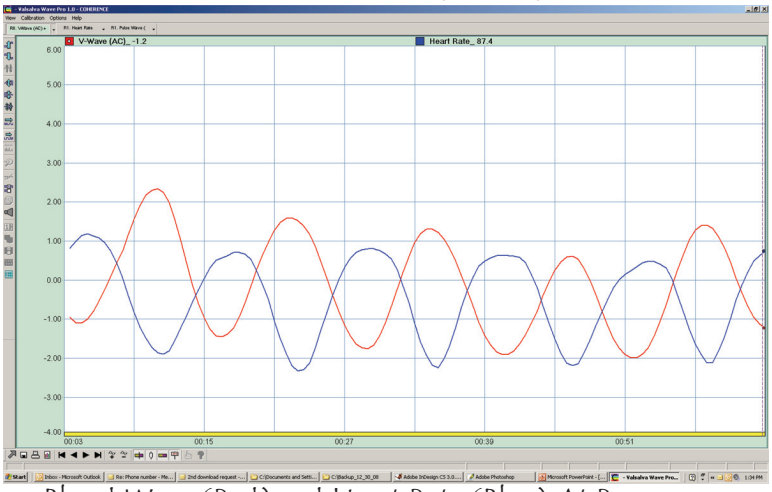
The figure presents the blood volume in the ear lobe during 2+ cycles of Coherent Breathing. I've labeled the cycles 1, 2, and 3. The large slow wave is induced by respiration. The faster wave, the heartbeat or pulse, appears to be riding on top according to a very specific pattern - as the large slow wave rises, pulses grow larger and the time between them longer. As the large wave falls, pulses become smaller and the time between them shorter. This is in keeping with the phenomenon of respiratory sinus arrhythmia (RSA) which says that the heart rate has a tendency to decrease during exhalation and increase during inhalation.

If we count the pulses from the peak of the first large wave to the peak of the next, there are 15. Count them and see....From this, we determine that there are 15 heart beats per cycle of respiration. As the rate of breathing is ~5 cycles per minute, the average heart beat rate is ~75 beats per minute, but we'll come back to this a bit later. For now, I want you to notice the *synchrony* between the respiratory wave and the pulse wave.

I'm sure you'll agree that they are *very* synchronous. They are in fact in lock step or "phase locked" together, which is why waves 1, 2, and 3 appear almost identical. This *coherence* is a characteristic of resonance. In physics, the term *coherence* is defined as "all properties of the correlation between physical quantities of a wave" (Wikipedia), the basic physical quantities being phase and amplitude, which we can think of as the wave's X and Y dimensions. Because, at resonance the actions of the thoracic pump, the heart, and the arterial tree, are synchronized, coherence is a characteristic of resonance.

If we "extract" the blood wave and the heart rate wave from the signal and plot them as line graphs on the same X axis we can see their relationship much more clearly. This next graph demonstrates the blood wave (red) and heart rate (blue) for 60 seconds of Coherent Breathing. Immediately, we notice their inverse relationship which approximates 180 degrees. Heart rate variability research-

ers Paul Lehrer and company foretold this relationship in their 2002 article, Heart Rate Variability Biofeedback As A Method For Assessing Baroreflex Function: A Preliminary Study Of Resonance In The Cardiovascular System, published in *Applied Psychophysiology and Biofeedback*, Volume 27, Number 1, where they theorized that heart rate variability and blood pressure cycles are 180 degrees out of phase at resonance. This point had a very large influence on my own work which we discussed in *The New Science of Breath*.



Blood Wave (Red) and Heart Rate (Blue) At Resonance

With the aid of Valsalva Wave Pro, we can now observe the simultaneous action of the blood volume wave and heart rate and see than when we breathe at resonance, their alignment does in fact approach 180 degrees. (Because blood pressure follows blood volume, this is consistent with conclusions of Lehrer, et al.) How variable and how stable the variability is around the frequency of resonance is not yet clear and represents work in progress. We can also see that both waves exhibit a high degree of coherence, i.e., consistency of amplitude, phase, and frequency.

I'm very excited about this capability because is sheds a good deal of light on the subjects of both *cardiopulmonary resonance* and *coherence*. Where resonance is concerned, I believe that is very supportive of the theory of resonance that we put forward in *The New Science of Breath* and discussed in more depth in *Coherent Breathing - The Definitive Method*, which if correct yields a broad new understanding of the relationships between respiration and circulation.

Regarding *coherence,* we are very used to "heart rate variability coherence", with little regard for resonance. We can have the former without the latter. But we cannot have sustained resonance without coherence, as it is the synchrony of cardiopulmonary functions, not to mention autonomic functions, that come together to produce resonance. This "lock step" synchrony results in coherence of respiration, coherence of blood flow, and coherence of the heart rate. It is this super-synchrony that is also observable across multiple biometrics, e.g. blood volume, heart rate, EEG, GSR, and EMG, when breathing "coherently".

There is only one way to achieve this *super-synchrony*...breathing at the frequency of resonance with commensurate depth, and relaxing!

See you in 2010,

Stephen Elliott, COHERENCE