Swan & Stone

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*Hello all,*


Figure 1: Time Domain View Of Resonance.

Welcome to ***Swan & Stone***, Volume 1, Issue 3: ***RESONANCE***. I hope you enjoyed Issue 2 wherein we briefly explored the response of the HRV cycle to periods of synchronous "Coherent Breathing" followed by extended exhalation and similarly, by extended inhalation. Please refer to issue 2 for background. The experiments, while certainly not definitive yielded interesting and maybe even surprising insights. This is one of the great values of biofeedback instrumentation. It allows one a glimpse into physical matters that are otherwise unseen. *Resonance* is a "physical" matter because what we're talking about is the frequency at which the cardio-pulmonary-circulatory system naturally oscillates. In ***The New Science Of Breath*** I referred to this as "the fundamental quiescent rhythm" of the body/mind. Knowing what one's resonant frequency is and learning to breathe at this rate is desirable because it is the "moment" of optimality in which many body systems align/participate. This is true because it represents the point at which the bodily flow of blood and bioelectricity are highest and internal impedances to that flow are lowest, in other words the cardio-pulmonary-circulatory-energetic system is working at peak effectiveness and efficiency. The swing of a pendulum is a near-perfect analogy.

I have asserted that it also represents the optimal division of labor between the diaphragm, heart, and the arterial tree in facilitating blood flow, relieving the heart of carrying the full burden of circulation, particularly that of venous return, which I argue is principally the responsibility of the diaphragm. Lastly, it is the "moment" in which arterial blood flow and venous blood flow are equal, which in the great scheme of things is a requirement that the autonomic nervous system must manage on an ongoing basis. The reason that the circulation is called "the circulation" is that blood flows in a circle. Resonant breathing helps facilitate this, venous flow being emphasized during inhalation and arterial flow during exhalation, capillary circulation throughout the body being washed by a wave.

Regarding resonant breathing, certainly there is a qualitative feel to it, especially once trained, but without having a quantitative view, it is very difficult to know for sure that one's breathing is in fact resonant. Hence I have argued consistently that one cannot know that they are breathing at their own frequency of resonance without instrumentation, or at least without their resonant frequency having been assessed with an instrument. Even with instrumentation, until the advent of Valsalva Wave Pro, assessing resonance has been a laborious matter. This is because its assessment has been limited largely to the analysis of the heart rate variability cycle in the frequency domain where a breather breathes at various rates and the rate that produces the highest spectral power peak is their resonant rate. This limitation has existed for decades because we had no "time domain" measure of resonance with which a breather could interact in real time to realize their resonant rate and its prominent frequency.

Valsalva Wave Pro overcomes this limitation by incorporating the detection, feedback, and correlation of *both* heart rate and breathing induced blood movement (the detection and feedback of blood being based on COHERENCE US patent #7922664), this wholistic blood wave phenomenon being what we have called "the Valsalva Wave", their real time phase relationship being an expression of resonance

in the time domain. Hence, a breather can interact with the instrument so as to bring about the phase relationship we see in Figure 1, a near 180 degree alignment, record that session and then post process the Valsalva Wave (or heart rate) signals to find the prominent frequency of breathing that produced it. One can then create a pacing device at that exact frequency and practice with it to engram that pattern, in much that same way that we have practiced with RESPIRE-1. While there are some variables like time of day, digestive status, body orientation, etc., the method is highly repeatable and accurate. We can see that one might assess their resonant frequency at different times and body orientations and create a unique pacing rhythm for each. Figure 2 above is the frequency domain analysis of the Valsalva Wave time domain signal of Figure 1 as recorded over a period of 6 minutes or so. Where the X axis of Figure 1 is time, the X axis of Figure 2 is frequency. In this example, the precise frequency where spectral power peaks is .0976 Hertz, dividing it into 1, a period of 10.24 seconds. Divide this by 2 and we have equal periods of 5.12 seconds for inhalation and exhalation.

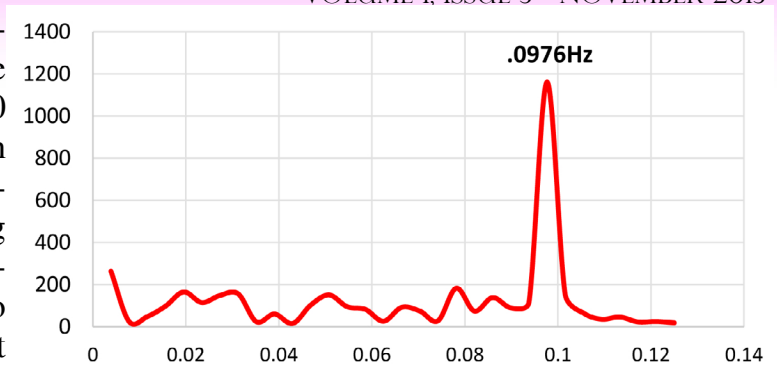

Figure 2: Frequency Domain View Of Resonant Valsalva Wave

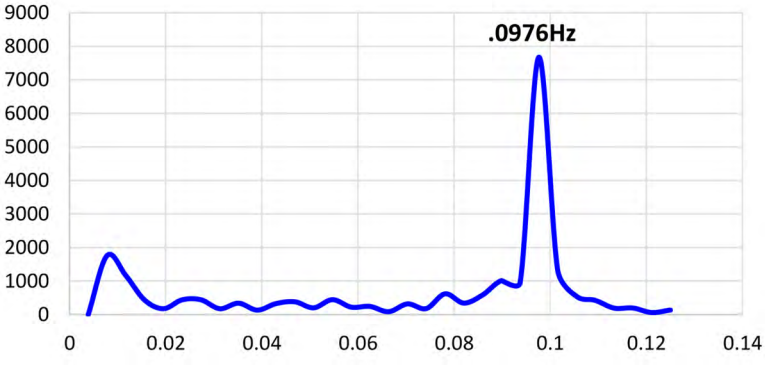

Figure 3: Frequency Domain View Of Resonant HRV Cycle

Using the instrument, we can prove this by creating a pacing device at this frequency, breathing with it while monitoring with Valsalva Wave Pro and watching it in real time reproduce resonance in the time domain view (e.g. Figure 1). Figure 3 is the frequency domain view of the corresponding heart rate. We can see that the precise resonant frequency is identical to that of the Valsalva Wave. This is because the two phenomena are phase locked during the assessment, hence the "Coherence" curve (correlation coefficient of Valsalva Wave and the heart rate that it produces) approaches -1 during the entire period. As a standard I prefer the Valsalva Wave because it is a record of breathing during the period and it is a physical wave. The heart rate variability cycle isn't a real physical phenomenon, it is a mathematical abstraction, a graph, of the heartbeat (which is a real physical phenomenon) rate. In either case, when the "Coherence Curve" of Figure 1 remains close to -1 during the period of recording, their spectral peaks are identical, i.e. the frequencies of their power peaks are the same. Here we can see that the "Coherence Curve" of Valsalva Wave Pro is in fact an indicator of resonance. COHERENCE Valsalva Wave Pro and BreatheHeart both support this capability. I am presently writing a manual that fully explains the session protocol, post processing, etc., that allows a breather or practitioner to perform this measurement for themselves or for a client, a service that I have also started to provide for my clientele. I've also begun to tailor RESPIRE-1 to support custom breathing frequencies. This has been my intent from the beginning and is the reason why you see this graphic on the disc. Thank you for your interest.


Stephen Elliott, President, COHERENCE