Hello all,

Welcome to the November COHERENCE Newsletter. I hope everyone had a peaceful Thanksgiving and a few days of rest, relaxation, and good company. I've waited until now to let this newsletter fly so as not to get caught in the wave of Thanksgiving advertising. Thank you for your patience.

This month's letter, ***Coherence And Exercise***, explores the fascinating relationship between breathing, blood flow (Valsalva Wave), and heart rate *before, during, and after exercise*. This work represents a COHERENCE first, as it is the first time an analysis of this type has been performed or presented - *anywhere*, at least to our knowledge.

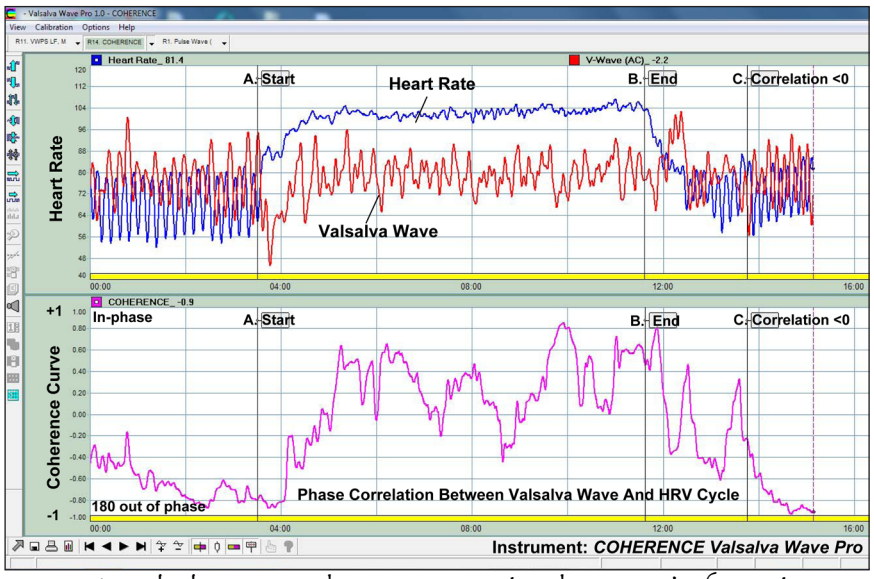

Figure 1: Valsalva Wave, heart rate, and coherence before, during, and after exercise (observed at ear lobe).
Please click here or on the graphic to zoom.

In fact, simultaneous observation of blood flow and heart rate during exercise was one of the first things we did once Valsalva Wave Pro was up and running (a few years ago now), but its the Coherence Curve innovation that's really exciting. Why? For one, it allows us to observe and understand what I postulate to be a fundamental biological shift in circulatory impetus that occurs as the body shifts from rest to exercise and back again.

Figure 1 presents ~16 minutes of simultaneous monitoring of heart rate and Valsalva Wave at the ear lobe during ~3.5 minutes of restful Coherent Breathing, followed by ~9 minutes of moderate exercise and concluded by another few minutes of restful rhythmic breathing. Exercise involved riding a stationary bicycle at a moderate pace and work load of ~60 watts. The upper panel depicts heart rate (blue) and Valsalva Wave (red). For the first few minutes we see characteristic 180 degree synchrony between the two, heart rate falling as the V-Wave rises and heart rate rising as the V-Wave falls. The purple graph in the lower panel, the "Coherence Curve", a measure of phase correlation between the Valsalva Wave and the HRV cycle, approaches -1.

For the first few minutes heart rate averages ~68 beats/minute and HRV is ~25 beats. As exercise begins (click here or on Figure 1 to open a larger web-view), heart rate immediately accelerates, plateauing at ~102 beats/minute. HRV diminishes by an order of magnitude and Valsalva Wave magnitude diminishes by about half, as breathing remains at a comfortable though slightly faster pace.

When we are at rest (and breathing coherently), the heart works in concert with breathing (and its Valsalva Wave) to facilitate circulation. Specifically, the heart speeds up as we inhale, ushering blood through the vena cava and right heart into the lungs. The heart slows down as we exhale, an equal volume of blood exiting the lungs via the left heart, filling the arterial tree. This speeding up

and slowing down with inhalation and exhalation is known as respiratory sinus arhythmmia (RSA) or what I prefer to call "breathing induced heart rate variability". The important thing to note is that when at rest, the Valsalva Wave (the blood wave induced by Coherent Breathing) and heart rate work in balanced opposition. I have theorized that this is part of the elegant design by which homeostasis and optimality of circulation, gas exchange, and energy production are maintained when we are in a state of rest or semi-activity.

The startling thing is this (though not in retrospect)...when we begin to exercise, instead of working in opposition, the Valsalva Wave and heart rate rapidly begin to work in unison, "reinforcing" as opposed to "counter-balancing" each other. Click here for close-up of the shift as exercise begins. The "Coherence Curve" tells the story where we see it shift rapidly from the territory of -1 toward +1, indicating an in-phase (vs. out of phase) relationship. This makes sense given the imperative to deliver blood to working muscles.

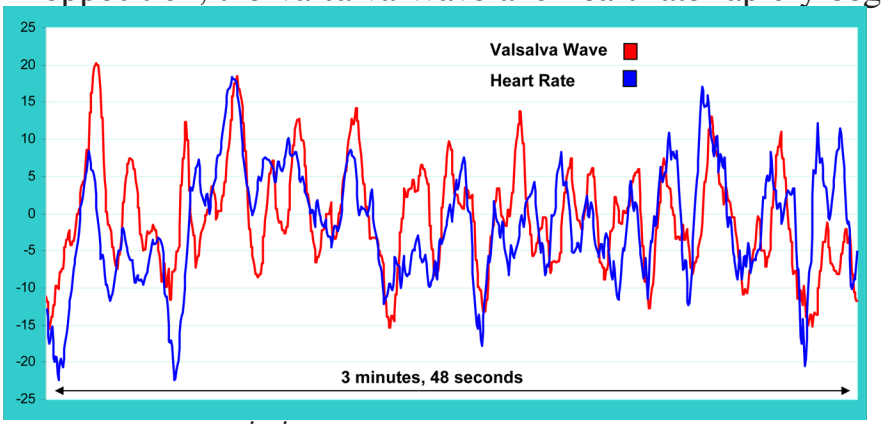

Figure 2: Valsalva Wave & Heart Rate During Exercise , Magnified And Overlaid On Zero Axis, To Make Clear Their Supportive Relationship. Click to zoom.

Because the HRV cycle promptly shrinks by an order magnitude (click here to view heart rate and Valsalva Wave variability for the duration of the experiment), this is difficult to observe without the magnification provided by Figure 2, which for purposes of clarity, focuses on about 4 minutes of the exercise period. Here we see a surprising degree of alignment between the heart rate and the Valsalva Wave which begin to resemble each other.

I consider this an exciting finding, one that bridges the gap between our understanding of breathing while we are at rest or semi-active vs. when we are actively engaged in exercise. While this study merely scratches the surface of the topic, the results make sense. One would fully expect the relationship between breathing, blood flow, and heart rate to vary as exercise demands on the body change - "an elegant dynamic coordination" if you will.

Next month, Dr. Bob Ward of Sports Science Network and previous performance coach of the Dallas Cowboys and I will discuss the significance of these findings relative to sports performance.

Thank you for your interest and consideration,

Stephen Elliott - COHERENCE

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