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Hello all,

Welcome to ***Blood Pressure Vs. Heart Rate Variability***, Swan & Stone, Volume 2, Issue 10. This article refers to a study undertaken by Dee Edmonson, RN, Fellow BCIAC-EEG, and Stephen Elliott, President, COHERNCE in the 2007-2009 timeframe. It was originally presented at the ISNR Annual Meeting in the fall of 2009. I think it is particularly useful to add context to Volume 2, Issue 9, ***Hawthorne and HRV***, our last issue by Taylor Elliott.

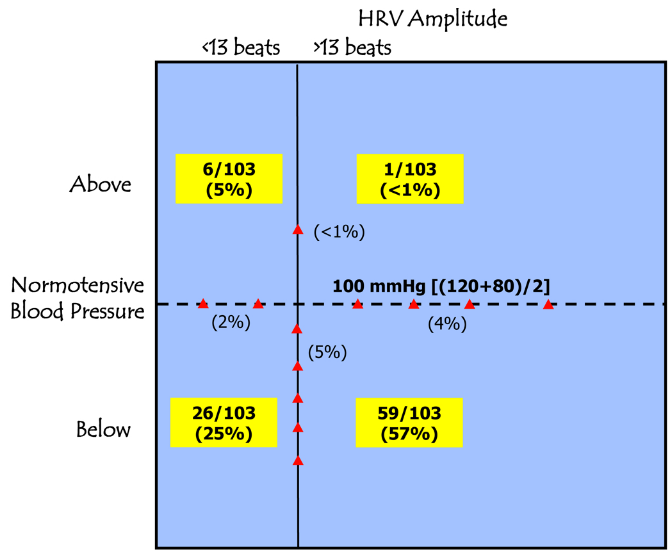

Figure 1: HRV (Amplitude) Vs. Blood Pressure

The research goals of this study were to determine the correlation between HRV amplitude and blood pressure and to determine how *average blood pressure* ([120mmHg + 80mmHg] / 2 = 100mmHg) changes with 8-12 minutes of Coherent breathing with HRV biofeedback. We had a total of 103 measurement instances during the study period. At the beginning of the study, 23/103 instances demonstrated average blood pressure >100mmHg. Note that this is a study of *breathing induced* HRV, not variation in heart rate for other reasons, acknowledging that other autonomic factors are in play. Figure 1 jumps right to the conclusion, demonstrating that at the completion of the study we found only one subject with *average blood pressure* greater than 100mmHg with an HRV of 13 beats or more. That subject's HRV was precisely 13 beats, leaving the interior of the upper right hand quadrant of Figure 1without any instances. Putting it another way, we had no subjects at the end of the study with average blood pressure >100mmHg with HRV *over* 13 beats. Why would this be so?

Coherent (resonant) breathing results in the phenomenon of the respiratory arterial pressure wave, what we have since referred to as "The Valsalva Wave" because it isn't limited to the arterial system and therefore limiting its name to "arterial pressure wave" doesn't describe it wholistically. In fact it is both arterial and venous, pressure and flow issuing in the arterial tree via the left heart during exhalation and returning to the lungs via the right heart during inhalation. As a reader of ***Swan & Stone***, you have seen my recent emphasis on the proper concept of the circulatory system as "a circle" where flow must ultimately be equal, though temporal. If it isn't equal there is imbalance in arterial and venous trees, a common symptom of this imbalance being elevated arterial pressure. If we were to measure venous blood at the same time, we would find that its flow is diminished. The common cause for this condition is inadequate use of the diaphragm, specifically inadequate inhalation, which has the biological function and purpose of venous return. If the diaphragm does not move downward with sufficiency, then a negative pressure fails to develop in the chest to which venous blood is compelled to return (under very low pressure approximating atmospheric pressure). When this occurs, arterial blood backs up and the outcome is elevated arterial pressure. *A simple fact.*

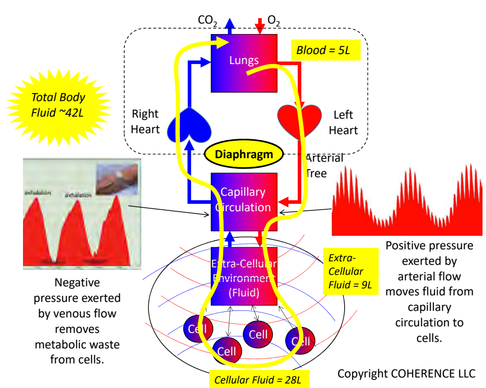

Figure 2: Circulatory Physiology

Breathing induced Heart Rate Variability (HRV) is indicative of diaphragm motion. Diaphragm motion sets up the Valsalva Wave in the circulation to which the autonomic nervous system responds, thereby increasing and decreasing heart rate so as to maintain circulatory equilibrium. Refining the conclusions, we found zero instances of average blood pressure above 100mmHg when HRV was greater than 13 beats. (The single instance where the subject did demonstrate average blood pressure above 100mmHg had an HRV of 13 beats, and an average blood pressure of 103mmHg.)

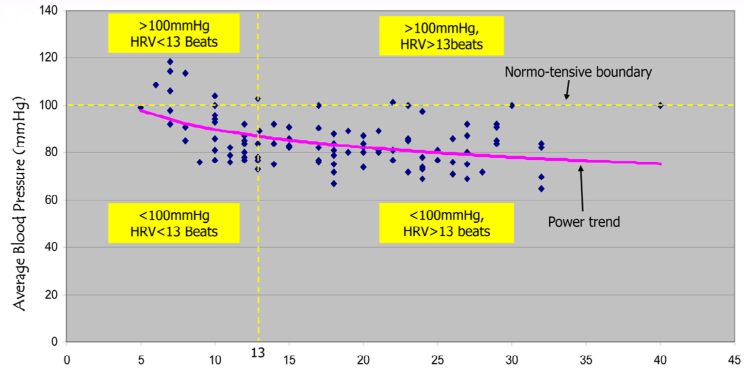

Figure 3: Average Blood Pressure Vs. HRV Post Session

The study consisted of 103 instances of data collected from 42 clients after each engaged in 8-12 minutes of Coherent Breathing with HRV biofeedback. Because the goal of this study was simply to understand the real time relationship between blood pressure and HRV, both of which are considered variables, each assessment involving the 42 clients can be considered unique. 23/103 or 22% demonstrated average blood pressures >100mmHg at the beginning of the study period. 6/103 demonstrated pressure in excess of 100mmHg at the end of the study period. Their HRV remained below 13 beats. 97 instances demonstrated a reduction in average blood pressure. The average decrease in average blood pressure across this group was 8.7mmHg.

The power trend line of Figure 3 curves gently upward as we move to the left, demonstrating nonlinearity in the relationship. In fact, if trends are segmented at 13 beats there is a very dramatic difference in the correlation between blood pressure and HRV to the right and left of 13 beats. To the right of 13 beats the correlation between HRV and lower blood pressure is strong, i.e. higher HRV relates strongly to lower average blood pressure. Whereas, to the left of 13 beats the correlation is weak; average blood pressure is generally higher and HRV is exerting less effect on blood pressure, pressures below HRV of 13 beats being more random.

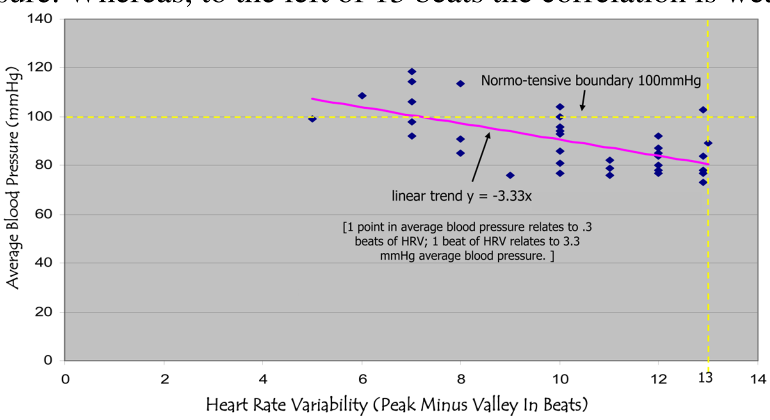

Figure 4: A Linear Trend When HRV Is <13 Beats

The linear trend line of Figure 4 demonstrates the strength of the effect <13 beats where we see that 1mmHg in average blood pressure relates to .3 beats of HRV; conversely, 1 beat of HRV relates to 3.3 mmHg average blood pressure. Please zoom in to see the graphic more clearly.

The large difference in correlation below vs. above 13 beats suggests that the physiological relationship between HRV and blood pressure above 13 beats is strong and in opposition, i.e. higher HRV correlates strongly with lower blood pressure. To the left of 13 beats, we see the strength of the relationship diminish. Here we are talking about "breathing induced HRV" which is a function of diaphragm motion and range.

In the end, we can call the correlation between HRV and blood pressure a correlation between diaphragm motion and blood pressure where *diminished diaphragm motion relates to higher blood pressure* and *increased diaphragm motion results in lower blood pressure*. "Blood pressure" (arterial pressure) is a metric we've grown used to "out of context". The fact is that elevated blood pressure means that blood is not flowing freely in a circle – as it should. Blood not flowing freely in a circle results in higher arterial pressure and diminished flow of all fluids throughout the body. It has negative implications on every organ and every cell in the body, especially the brain because it is held highest and therefore the most dependent on proper flow.

Thank you for your interest.

Stephen Elliott, President, COHERENCE LLC