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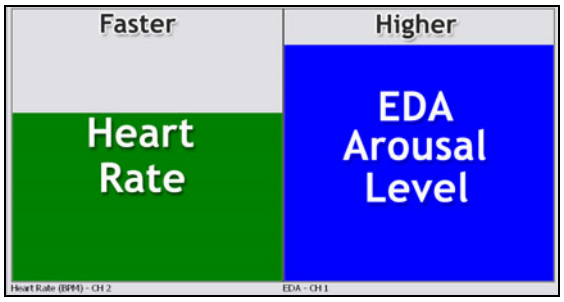

I. INTRODUCTION

Recently, there has been a renewed interest in mind-body interactions. There are many processes in the body in which you exert voluntary control. For example, if you want a glass of water, you move your body and go through the motions to take out a glass, fill it with water, and drink. You are consciously "aware" of the motions that are under your "voluntary" control. However, once you start to swallow the drink of water, you are not usually "aware" of the regulatory processes which follow automatically (e.g., you secrete saliva, rhythmical constrictions in the esophagus move the water down to the stomach, the stomach starts churning, etc).

These processes are regulated by the **autonomic nervous system** and do not require conscious control by the cerebral cortex. Muscle movement to obtain a drink of water involves some voluntary controls (wherein your brain and body interact in a "loop" between sensory reinforcement of movement and the brain) but there is usually no loop of feedback between consciousness and the involuntary actions regulated by the autonomic nervous system, e.g., actions of the gastrointestinal tract.

The autonomic nervous system has two regulatory divisions, which can affect the same organs or tissues but exert contrasting effects:

- **sympathetic division** — short-term response to acute stress, "fight-or-flight" response
- **parasympathetic division** — daily routine maintenance of homeostasis

For example, both systems are constantly regulating heart rate, but when the parasympathetic system dominates, the heart rate is lower than when the sympathetic nervous system dominates.

Essentially, **biofeedback** completes the loop between autonomic functions and conscious awareness. Biofeedback training is a learning process whereby people exert conscious control over physiological processes controlled by the autonomic nervous system. Biofeedback instruments unobtrusively monitor physiological functions (e.g., heart rate) and provide feedback in real time. The equipment provides feedback using a signal that changes with the monitored variable. The person can then use the signal to enhance the desired response.

With biofeedback training, people have been able to regulate many processes: lower heart rate; lower blood pressure, control headaches, and manage responses to stressful situations. For example, biofeedback training has been shown to be effective for controlling hypertension or high blood pressure.

One training method consists of a "hand warming" response — that is, the biofeedback signal is associated with the temperature of the hands. What does "hand warming" have to do with high blood pressure? Well, blood pressure is a result of cardiac output (volume output of the heart per minute) and peripheral resistance. Peripheral resistance is inversely proportional to the amount of blood flow to the periphery. Because blood is warmed in the body, when blood flow to the skin increases, the skin is warmer. Therefore, warmer hands signify increased blood flow that occurred when peripheral resistance and blood pressure decreased.

Biofeedback training has also been used to teach stress management techniques. In physiological terms, relaxation using biofeedback training teaches people to activate specific controls of the parasympathetic part of the autonomic nervous system, e.g., to lower heart rate. At the same time, biofeedback can be used to decrease activity of the sympathetic nervous system.

The **Electrodermal activity (EDA)** is one variable traditionally associated with sympathetic nervous system activity. The EDA is affected by sweat gland activity and skin responses on the palmar surface of the hand. Unlike the heart, the sweat glands are only activated by sympathetic activity. If the sympathetic branch of the autonomic nervous system is highly aroused, then sweat gland activity increases and consequently, so does EDA. Because of this association, the EDA is traditionally used as an index of sympathetic activity. When a person is relaxed, then the EDA should be low. Note that Electrodermal activity (EDA) has replaced galvanic skin response (GSR) as the collective term used to describe changes in the skin's ability to conduct electricity.

The BIOPAC EDA transducer works by placing one electrode at ground (0 Volts) and the other at a constant 0.5 Volts DC. The internal circuit measures the amount of current required to maintain .5 Volts across the two electrodes. These two electrodes are connected to two different fingers, so there will be an effective resistance (R) placed across the electrodes. The current measured (I = E/R) is proportional to the conductance (1/R) because the voltage (E) is constant. Normal human EDA ranges from 1 to 20 microsiemens, so the maximum current flow would be approximately 10 micro amps.

In this lesson, the biofeedback signal will be plotted on the screen as a thermometer style bar chart that will rise and fall with changes in heart rate and EDA, allowing the Subject to become conscious of his/her heart rate and arousal (EDA). The Subject will try to change the reading(s) without physical movements and should be able to see that heart rate and level of arousal are independent.