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Biopac Student Lab® Lesson 9

ELECTRODERMAL ACTIVITY & POLYGRAPH

Introduction

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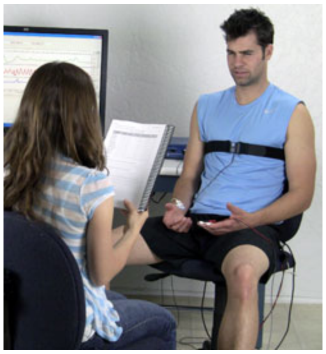

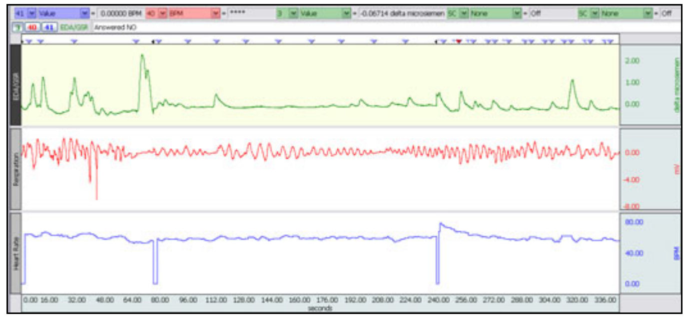

I. INTRODUCTION

Electricity flows through an electrical circuit because of a difference in electrical pressure between the beginning and the end of a circuit. Electrical pressure or **electromotive force** (E) is measured in volts (V). The flow of electricity, called **current** (I,) is measured in **amperes** (A) or amps for short. As electricity flows through the circuit, resistance to flow occurs. Electrical **resistance** (R) is measured in ohms (Ω).

In a simple circuit of direct electrical current, the relationship between the electromotive force causing the electrical current, the resistance to flow of electricity and the resultant magnitude of the current is described by Ohm's Law.

Ohm's Law: I (Amps) = E (Volts) / R (Ohms)

If two of the three variables are known, the unknown third variable can be calculated.

> ***For example***, if voltage and resistance values for a simple circuit are known, the above formula can be used to calculate the value for current; if the values for current and resistance are known, then the formula for computing voltage is E = IR.

Ohm's Law implies that if a constant current is applied across a resistance, changes in the resistance will produce a voltage change directly proportional to the resistance change.

> ***For example***, if a constant current of 1.0 ampere is applied across a resistance of 2.0 ohms, the measured voltage would be 2.0 volts (I = E/R, 1.0 ampere = 2.0 volts/2.0 ohms). If the resistance dropped to 0.5 ohm, the voltage would also fall to 0.5 volt (I = E/R, 1.0 amperes = 0.5 volt/0.5 ohm).

In this lesson, you will apply principles of Ohm's Law and record changes in the electrical resistance of the skin.

The human skin displays several forms of bioelectric phenomena, especially in areas of the extremities such as the fingers, palms of the hands, and soles of the feet.

- **Galvanic skin resistance (GSR)** — When a feeble electric current is steadily applied between two electrodes placed about an inch apart, the recorded electrical resistance between them, referred to as the galvanic skin resistance (GSR,) varies in accordance with the emotional state of the subject.
- **Galvanic skin potential (GSP)** — Similarly, if the electrodes are connected to a suitable voltage amplifier, but without any externally applied current, the voltage measured between them, referred to as the galvanic skin potential (GSP,) varies with the emotional state of the subject.

The combined changes in the GSR and GSP related to the emotion of the subject constitute the **galvanic skin response (GSR).**

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 preferred measure of EDA is conductance (inverse of resistance) in units of microsiemens. Conductance is preferred over resistance because the skin does not act as a single resistor, but rather a series of many resistors in parallel. The normal human EDA range is from 1 to 20 microsiemens.

The physiological basis of EDA is a change in autonomic tone, largely *sympathetic*, occurring in the skin and subcutaneous tissue in response to a change in the affective state of the subject. Changes in peripheral autonomic tone alter sweating and cutaneous blood flow, which in turn change EDA.

> ***For example***, if a painful stimulus such as a pinprick is applied to the skin in an area distant to the electrode, the stimulus will reflexively elicit a general phasic sympathetic discharge to sweat glands, increasing secretion. The increase in sweat, although generally small, lowers the electrical resistance of the skin because sweat contains water and electrolytes, both of which increase electrical conductivity of the skin.

As in the case of somatic sensory stimuli (e.g., pain, pressure, touch,) changes in emotion elicit changes in peripheral autonomic tone and hence the EDA. A common example is the vasodilation of cutaneous blood vessels of the face (blushing) and increased sweating that often occurs in the emotional state of embarrassment.

Special sensory stimuli (vision, hearing, equilibrium, taste, smell) also affect a person's emotional state, as any aficionado of classical music or hard rock can attest. Interestingly, although highly subjective, the perception of color may elicit changes in autonomic tone, which in turn, affect the subject's mood and behavior. Warm colors such as red, orange, and yellow evoke emotions of warmth and comfort in some persons, feelings of anger and hostility in others. The phrase "seeing red" refers to an angry person. Cool colors such as green, pink, and blue evoke feelings ranging from enviousness ("green with envy",) tranquility, and sadness or indifference ("feeling blue").

The influence of color on the affective state was well known to ancient Egyptians, Chinese, and other cultures who used colors to promote healing. The therapy, called **chromotherapy**, is still used today in holistic medical practice. It must be noted that most clinicians are skeptical of color therapy. The effects of color therapy vary from person to person and tend to be short-lived or temporary. In this lesson we will explore the short-term influence of color on the affective state of the subject as revealed by changes in EDA.

The detection and recording of the EDA is often combined with the detection and recording of other autonomic-dependent psychophysiological variables such as heart rate, respiratory rate, and blood pressure. The device that detects and records these variables is called a **polygraph**. Although many people think polygraph is synonymous with lie detector, the literal meaning is "many measures" (*poly* - many, *graph* – write).

This lesson is a polygraph in the true sense of the word since it uses three types of measures: (a) EDA, (b) respiration, and (c) heart rate.

One of the underlying principles involved in using the polygraph as a lie detector is that autonomic nervous system control of heart rate, respiratory rate, blood pressure and flow, and sweating cannot consciously be altered. Another principle is that changes in emotion associated with intentional falsification of answers to carefully selected and worded questions involuntarily and subconsciously alters autonomic output in such a way as to cause recognizable changes in recorded physiological variables.In the experiments that follow, you will record respiration, EDA, and heart rate under various experimental procedures so as to gain a better understanding of polygraphy, its applications, and its limitations.

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. For this lesson we are only interested in changes in EDA over short periods of time (after a question is asked, etc.) To help in interpreting the data, the software applies a .05 Hz High Pass filter to allow the baseline to always settle to 0. For this reason the units for EDA are "**delta microseimens**" to indicate that it is measuring <u>changes</u> in EDA.

> ***It is important to keep in mind*** that although the recording procedures and measures used are similar to those that might be used in a real polygraph recording, this is not a "lie detector test." All you will do here is record the subject's physiological responses to certain questions. Some types of physiological responses are typically associated with "lying," although even under the best conditions about one-third of innocent people "fail" lie detector tests. The best you can hope for here is to get a better understanding of how these types of procedures work.