Experiment HP-2: The Galvanic Skin Response (GSR) and Emotion

What is a GSR?

The Galvanic Skin Response (GSR) is one of several electrodermal responses (EDRs). EDRs are changes in the electrical properties of a person's skin caused by an interaction between environmental events and the individual's psychological state. Human skin is a good conductor of electricity and when a weak electrical current is delivered to the skin, changes in the skin's conduction of that signal can be measured. The variable that is measured is either skin resistance or its reciprocal, skin conductance. According to Ohm's Law, skin resistance (R) equals the voltage (V) applied between two electrodes on the skin divided by the current passed through the skin (I). The law can be expressed as $R=V/I$.

A GSR amplifier, like the one that will be used in this experiment, applies a constant voltage to the skin through electrodes. The voltage is so small that it cannot be felt or perceived by the individual. However, the current that flows through the skin, as the voltage is applied, can be detected and displayed. Because the constant voltage applied to the skin is known and the current flow can be measured, the skin's conductance can be determined by the GSR amplifier. The output of the GSR amplifier is the skin's conductance expressed in units called microSiemens (μS).

Two types of skin conductance are characterized, tonic and phasic. Tonic skin conductance is the baseline level of skin conductance, in the absence of any particular discrete environmental event, and is generally referred to as Skin Conductance Level (SCL). Each person has a different SCL and values are subject to the type of unit being used to measure it. Tonic skin conductance levels vary over time in individuals depending on his or her psychological state and autonomic nervous system regulation.

Phasic skin conductance is the type that changes when events take place. Discrete environmental stimuli (sights, sounds, smells, etc.) will evoke time related changes in skin conductance. These are generally referred to as Skin Conductance Responses (SCRs). SCRs are increases in the conductance of the skin which may last 10-20 seconds followed by a return to a tonic or new baseline level of skin conductance (SCL). They generally occur within the first 10 seconds of when the event has occurred, but it can take as long a 20 seconds to show any response. These phasic changes are often simply called GSRs. Individuals will show spontaneous GSRs, that are not event related, to varying degrees. The typical frequency of spontaneous GSRs is between one and three per minute. Some persons are highly reactive with considerable spontaneous generation of GSRs, and others have a relatively steady tonic level of skin conductance without spontaneous GSRs. Some of these individual differences are discussed in another section of this experiment.

The parameters of event-related GSRs that can be quantified are: amplitude, in microSiemens; and latency, rise time, and half-recovery time, in seconds. These parameters can be determined from a recording like the one shown in Figure HP-2-B1.

The amplitude of an event-related GSR is the difference between the tonic skin conductance level, at the time the response was evoked, and the skin conductance at the peak of the response. Latency is the time between the stimulus and the onset of the event-related GSR; latency values should be about three seconds or less. Rise time is the time between the onset of the event-related GSR and the peak of the response; typical values for rise time are one to three seconds. Half-recovery time is the time between the peak of the response and the point after the peak when the conductance returns to an amplitude that is one-half the amplitude of the peak; typical values for half-recovery time are two to ten seconds.

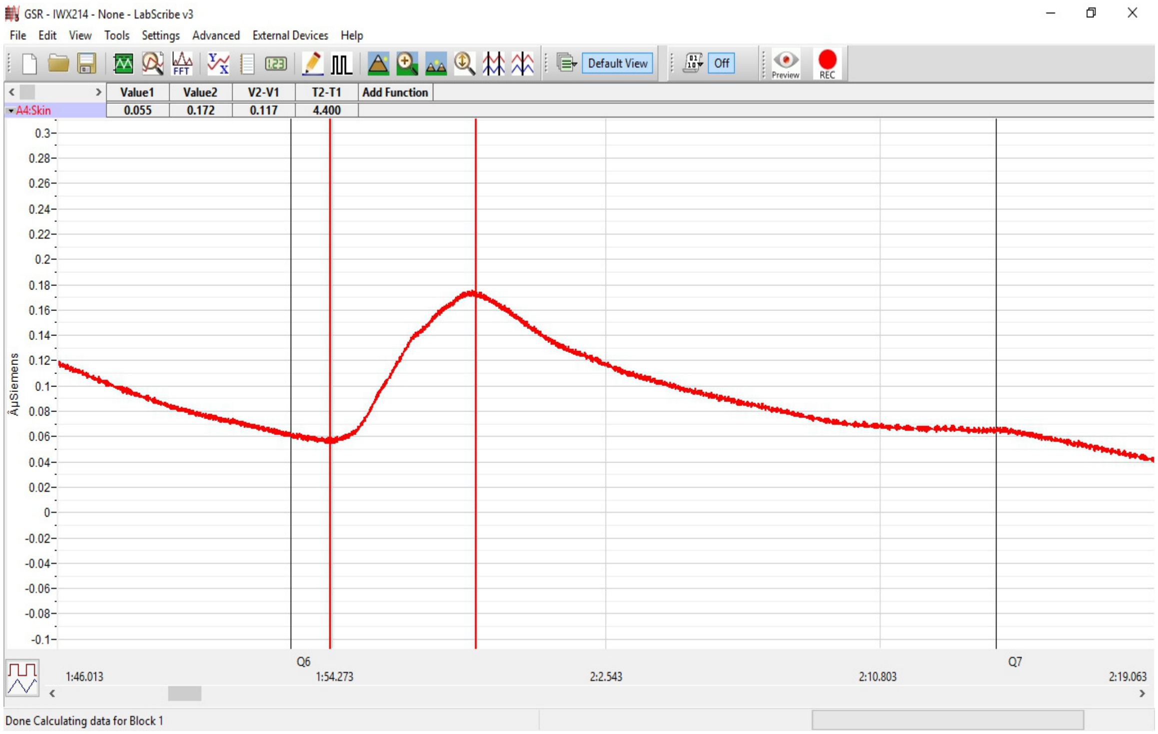

Figure HP-2-B1: A typical GSR in response to an emotional question, displayed in the Analysis window.

In the sample presented in Figure HP-2-B1, the subject was asked a standard neutral question: “Do you own a bike?”

The Electrodermal System

The skin is a three-layered (epidermis, dermis, subdermis) adaptive organ which aids in the maintenance of the body’s water balance and core temperature. These functions are carried out by blood vessels and eccrine sweat glands. The blood vessels constrict and dilate to deliver blood flow to the surface of the body for heat conservation or loss. The eccrine sweat glands function to cool the body by depositing moisture on the skin surface through ducts (in the dermis) and sweat pores (in the epidermis). The glands, which are located in the subdermis over most of the body, are about ten times more dense on the palmar surface of the hands and soles of the feet.

The most widely accepted model of skin conductance is the sweat circuit model proposed by Edelberg (1972). According to this model, phasic changes in skin conductance occur when the sweat ducts in the epidermis fill, and skin conductance recovers to tonic levels when the moisture is deposited on the skin or reabsorbed by the sweat glands.

In Edelberg’s model, the sweat ducts act as variable resistors; their resistance lowers (conductance increases) as they fill with sweat. The amplitude of the change in conductance depends on the amount of sweat delivered to the ducts and on the number of sweat glands which are activated.

Sweat gland activation is a simple physiological survival mechanism, which is of interest in psychology because it is a neural response. This activation is controlled by the brain via the sympathetic division of the autonomic nervous system. Human sweat glands receive primarily signals from sympathetic cholinergic fibers that use the neurotransmitter acetylcholine. This is an anomaly because most sympathetic fibers utilize norepinephrine. Edleberg (1972) described three descending pathways for regulatory control over the sweat glands:

- the premotor cortex descending through the pyramidal tracts;
- the hypothalamus and limbic system;
- the reticular formation.

Individual Differences in Electrodermal Activity

In the 1950s, Lacey and Lacey first described individual response patterns that have become commonly accepted as relatively reliable personality trait characteristics. Individuals, who show a high frequency of spontaneous skin responses and habituate slowly to repeated presentations of simple stimuli, are termed electrodermal labiles. In contrast, individuals, who produce few spontaneous skin responses and habituate rapidly to simple stimuli, are termed electrodermal stabiles. Additionally, these traits have been correlated with a number of psychophysiological variables (Schell, Dawson, & Filion, 1988). Persons typed as electrodermally labile are generally better at vigilance tasks and show a lower vigilance decrement over time than electrodermally stable persons. Some researchers believe that electrodermal lability/stability represents a fundamental difference in the information processing characteristics of individuals (Schell, et al., 1988).

Psychosocial Events and Skin Conductance

Electrodermal activity correlates positively with the novelty, intensity, emotional content, and significance of the stimulus. In each of these contexts, an orienting response (OR) is activated in the central nervous system. The orienting response is the neural equivalent to: "Hey, pay attention to this; it might be important for your survival!" Both tonic and phasic skin conductance are influenced by psychosocial contexts.

It has been shown that tonic skin conductance levels rise in anticipation of performing a variety of tasks and during the performance of these tasks. Common tasks that have been used in experiments to demonstrate this phenomenon include: mental arithmetic, vigilance/attention tasks, and social tasks (like, discussing a social issue with others).

Phasic skin conductance responses have been studied in a variety of contexts. The field of social psychophysiology utilizes skin responses as indicators of social empathy, embarrassment, and social attitudes. Electrodermal activity is considered a highly sensitive indicator of the social significance of an event. The most common use of electrodermal activity has been in the detection of deception, the so-called "lie detection test."

The Polygraph, or Lie Detection Test

The test used to detect the truthfulness of an individual's statements is often referred to as a polygraph. A polygraph is actually a multi-function chart recorder that measures GSR, heart rate, blood pressure, and respiration rate. These four responses are sensitive to stimulus novelty, intensity, emotionality, and significance. The device is operated by a person known as a polygrapher, who is trained and licensed to administer and interpret the test with the art and science of the discipline.

Polygraphers use a variety of tools to detect deception, including highly standardized questioning procedures. The use of polygraphs to detect lying in individuals accused of crimes is highly controversial, in part because the identification of false positives occurs in about 10 to 15% of test cases. A false positives occurs when the polygrapher has determined that the person is being deceptive when, in fact, he or she has not. A much rarer occurrence is a false negative. A false negative occurs when the test indicates the person is telling the truth, but he or she is actually guilty. For this reason, polygraph tests are often used in support of a person's truthfulness, but not as evidence of guilt.

In this experiment, you will use measurements of skin conductance to analyze psychophysiological responses. You will:

- measure the tonic level of skin conductance, the frequency of spontaneous conductance responses, and the habituation of the skin conductance response;
- observe and measure the GSR as an orienting response to being asked neutral content questions;
- observe and measure the GSR to questions with emotional content.