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The Biofeedback Stress Test

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ABSTRACT

Stress can be defined as an arousal reaction to some outside stimulus (Girdano & Everly, 1986), or as the nonspecific response of the body to any demand made upon it (Selye, 1974; Organ & Bateman, 1986). The identifiable symptoms of the stress reaction are heightened arousal of both psychological and physiological processes. Research into stress began with the general adaptation syndrome (G.A.S.) in 1936, which provided the foundation for the relationship between the physiology and pathology of stress (Selye, 1974).

To comprehend the physiology of stress, it is necessary to acquire an understanding of the autonomic nervous system (ANS) that controls basic, elementary body processes such as hormone balance, metabolism, body fluid regulation, vascular (blood vessel) activity, and reproduction. The hypothalamus, a small collection of nerve cells at the base of the brain, provides the link between the nervous system and the endocrine system, and regulates the activities of the ANS. Hypothalamus stimulation prepares the body for possible action by increasing the discharge of hormones, increasing the availability of energy, preparing the cardiovascular system by shifting blood flow to essential organs, and tensing the muscles. The impulses that originate from the ANS are carried throughout the body through two systems, the sympathetic and parasympathetic. The sympathetic system stimulates the adrenal glands causing them to secrete epinephrine (adrenaline) which, in turn, increases the activity of the organs that are needed for the fight or flight response, while inhibiting the organs that are not needed. The parasympathetic system also increases the activity of some organs, while inhibiting the action of others, but contrary to the action of the sympathetic system. It slows the action of the heart while expanding the blood vessels (Girdano & Everly, 1986).

When the brain receives a stimulus (or stressor), a message is sent to the pituitary, which in turn, secretes the hormone adrenocorticotrophic hormone (ACTH), into the bloodstream. ACTH circulates to the adrenal cortex causing secretion of the hormones glucocorticoids (primarily cortisol) and the mineralcorticoids (primarily aldosterone) affecting the body's metabolism by increasing energy, either for the stress response or for recovery from a long period of overactivity. Cortisol also increases the metabolic process of the liver that causes it to form more glucose. This assures the body of an adequate supply of an energy source during the accelerated period of activity. Aldosterone is used to prepare the body for increased muscular activity. These hormones are then sent to the different organs of the body that subsequently change to meet the demands (Girdano & Everly, 1986).

The hormones enter the bloodstream and trigger a succession of changes in the body chemistry - in the level of fatty acids in the blood and in the blood's clotting chemistry, while at the same time altering the digestive processes (Organ & Bateman, 1986). The messages are sent to the organs of the body, which changes to meet the demands. Some of the symptoms cause the pulse to quicken, the pupils to dilate, the lungs to take in more oxygen to fuel muscles, muscle tension to increase blood pressure to rise, and respirations to increase.

Long-term stress is negative to an individual. It consists of increasingly higher levels of prolonged and uninterrupted periods of stress where the body cannot return to its homeostatic state. The results of long-term stress are a higher pulse rate and increased blood pressure, both of which are known to lead to heart disease. Other illnesses, which can be generated by stress, include gastric or duodenal ulcers (the stress ulcers), and various types of mental illnesses (Selye, 1974). To correct the problem of excessive stress, one must be aware of its causes and symptoms. If an individual can sense that stress is influencing his or her performance, then that individual can take steps to reduce the stress (Schultz, 1992).

Biofeedback devices have been used for muscle tension monitoring brain waves, and monitoring body temperature. The interpretation of a person's skin temperature has become a useful technique in biofeedback system refers to control over vasoconstriction (constriction of the blood vessels) and vasodilation (dilation of the blood vessels) (Girdano & Everly, 1986). Information about the activity of the arteries was found by measuring the temperature of the skin's surface.

The biofeedback technique is based on the fundamental learning principle that an individual can learn to perform a particular response when given information about the consequences of that response (feedback), and then make the appropriate compensatory behavioral adjustments.

The ability to interpret a person's skin temperature has become a useful technique in biofeedback stress studies (Roberts, Kewman & MacDonald, 1973). The reaction of microencapsulated cholesteric liquid crystals (MCLC) to various skin temperatures can be used to readily identify the homeostatic (state of arousal) condition being experienced by an individual. One MCLC product, the Biodot, is temperature sensitive and changes color in accordance with the user's skin temperature, since skin temperature is purported to reflect a particular mood change in an individual (Schultz, Schultz & Williams, 1986). In order to understand the theory associated with Biodot functions, it is important to understand the operants that regulate the skin's temperature. The autonomic nervous system (ANS) which controls the activity of our internal organs, glands, heart, lungs, and all the smooth muscles of the body, is made up of two opposing networks: the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS). The SNS is activated in times of stress. Under duress, the body automatically undergoes vasoconstriction causing an increasing an increase in the amount of blood flowing to vital organs. Simultaneously, blood moves away from the extremities causing the temperature in these areas to decrease (Gatchel & Price, 1979), resulting in a color change in the Biodot (Schultz, 1986, 1987, 1988, 1990; Jenson, 1993). The PNS functions at slow metabolic rates or, at times, at rest. In this state, the blood flow is regulated throughout the body in a constant manner, causing the temperature of the skin to be higher than in times of stress (Gatchel & Price, 1979).

Biofeedback is also defined as a process of developing an additional feedback loop upon the already present homeostatic adaptive control system (Gaarder, 1981). In some cases, individuals may have a defective, undeveloped, or non-existing internal control system and, therefore, use biofeedback to compensate for the condition. Since biofeedback can be applied to help regulate the ANS and control ultimate stress related problems, knowledge of how one will perform in a stress related situation will enable that individual to take preventive action, if needed, to maximize their performance level.

Biodots, developed by Biodots International, Inc., contain a spectrum of color capabilities. Each color variance corresponds to a predetermined skin temperature. The Biodot is a small flat device, approximately one-quarter inch in diameter, with a small amount of adhesive on the back enabling it to adhere to the skin without temperature interference. Biodots are effective biofeedback devices due to the small size, quick reaction time, and ease of interpretation. According to data provided by the manufacturer, the ideal location to place the Biodot is on the back of the hand, between the thumb and index finger. For individuals with poor blood circulation, the Biodot should be placed on the upper and innermost portion of their forearm in order to more accurately reflect changes in the skin's temperature. For accuracy and consistency in reading the Biodot, placement directly on the veins, arteries, or bones is not recommended (Biodot International, 2001).

Five previous studies utilized Biodots as a method of assessing skin temperature to measure stress levels. A 1986 study (Schultz, Schultz, & Williams) investigated the differences in stress levels for business students taking written examinations and giving oral presentations. A second study by Schultz, Schultz, and Becker (1987) determined whether a student's stress level, prior to an examination, could predict final test scores. A third study by Schultz, Leptrone, and Schultz (1988) measured stress levels created by various types of examinations. The fourth study by Jenson, Schultz and Schultz (1993) evaluated stress variations occurring during evaluations. The fifth study by Schultz, Schultz and Riley (1990) studied the affects on performance resulting in variations in stress levels.

According to Barrios, the inventor of the stress control card, it is extremely important for an individual to detect stressful situations in order to avoid subsequent stress-related problems, for example high blood pressure. As an alternative to the Biodot, the stress control card has successfully reduced many stress related problems because of its ability to detect temperature changes indicative of stress (Mullich, 1984).

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AUTHOR NOTE

The background information for this study was taken from articles and presentations by Schultz and Jenson. The information was used in order to validate the use of the "Biodot" as a biofeedback device. The information establishes the credibility of the Biofeedback Stress Test, which is the focus of this paper.

BIOFEEDBACK STRESS EVALUATION

The purpose of this exercise is to allow an individual to evaluate his or her stress levels in various situations. The exercise utilizes the Biodot, a small, flat dense, approximately one-quarter inch in diameter, with a small amount of adhesive on the back, which enables it to adhere to the skin without temperature interference. The Biodot is composed of microencapsulated cholesteric liquid crystals, which react to various skin temperatures, by indicating changes in color. Studies have shown that skin temperatures can be used to identify the homeostatic condition being experienced by an individual.

When an individual is experiencing stress, the blood moves away from the extremities causing the temperature in these areas to decrease, causing the color of the Biodot to change. For this reason, the manufacturer of the Biodot has stated that it should be placed on the back of the hand, between the thumb and index fingers. For individuals with poor circulation, it should be placed on the upper and innermost portion of the forearm. For consistency purposes, do not place the Biodot on veins, arteries, or bones.

The following table indicates the color of the Biodot when it is reflecting the corresponding temperature and physiological state.

Color	Temperature	Physiological State
Black	87	Very Tense
Amber	89.6	Tense
Yellow	90.6	Unsettled
Green	91.6	Involved
Turquoise	92.6	Relaxed
Blue	93.6	Calm
Violet	94.6	Very Relaxed

1. Select as what you would perceive as a “normal” 24-hour day.
2. Place the Biodot on the back of your hand between the thumb and index finger (or on the upper and innermost section of the forearm if you have poor circulation).
3. Record the color reflected in the center of the dot every time it changes on the attached form in the column marked “Biodot Color”.
4. Utilizing the values in the following table, calculate and record the change in value on the attached form in the column marked “Value Change”. For example, if the color change is from Green to Blue, the value to record would be “2”. If the change was from Turquoise to Amber, record a “3”.
5. Total the number of changes and the amount of value changes.

Black	1
Amber	2
Yellow	3
Green	4
Turquoise	5
Blue	6
Violet	7

6. Divide the number of Biodot color changes into the total amount of value changes. This value equates to the Value Change Index.
7. Assign the values from the table to the colors in the Biodot Color Column. Add the values and calculate the mean. This value equals to the Mean Color Index.
8. Use the attached matrix to plot your level of stress.
9. Repeat this exercise on other times to ascertain if the level of stress fluctuates or remains constant.

BIODOT COLOR CHART

Biodot Color	Value Change

Total # of Changes _____
Mean Color Index _____

Total of Value Changes_____
Value Change Index _____

MEAN COLOR INDEX