

Classification of Stress and Non Stress Groups Based on Physiological Parameters

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ABSTRACT: With the deteriorating condition of mental health in the country, it has become increasingly important to monitor the mental health of an individual. Mental ailments like anxiety and depression are mostly caused due to high levels of stress. Acute stress can be easily measured in a consistent and timely way than chronic stress. Anything that requires a mental, physical adjustment or a response is termed as stress. Changes in stress level can be detected by monitoring the changes in physiological parameters of the body such as blood pressure, electro dermal activity and heart rate. In this work, it has been found out that high levels of stress are best correlated with mean arterial pressure – a feature of blood pressure and it is also observed that there is a significant difference between the changes in physiological features of stress and non stress groups.

Index Terms: Electro Dermal Activity, Heart Rate, Blood Pressure, Stress, DASS 21

I. Introduction

With an aim to improve the quality of mental health in India, the government in October 2015 announced a new policy to provide universal mental health services. It is the first policy in India that will focus on needs of the poor, on creating awareness of mental health disorders and removing any of kind of stigmas attached to it and on preventing suicide. It is very unfortunate to note that India has the highest number of suicides in the world. According to the World Health Organization, in 2012, 258,000 of 804,000 (i.e 32%) suicides recorded worldwide were in India.[1] Indian youths between the age of 15 and 29 years kill themselves at a rate of 35.5 deaths per 100,000 – the highest in the world – and suicide has surpassed maternal mortality as the leading cause of death of young Indian women.

For every 343,000 Indians, currently there is only one psychiatrist. It is too few to reduce the shameful suicide rate. Other mental problems that are faced by the society are depression, acute economic insecurity, anxiety among youths over educational success, and distress among young women

caught in a bind between the opportunities of a changing India and pressure from traditionally minded families to marry.

Mental ailments like anxiety and depression are mostly caused due to high levels of stress. Acute stress can be easily measured in a consistent and timely way than chronic stress. Anything that requires a mental, physical adjustment or a response is termed as stress. Stress is encountered in our day- to-day life. Any activity that is done always creates some form of stress. [2]

Different kinds of stress:

- 1) Acute stress which is short-term stress and does not cause extensive damage. It is easy to detect and treatable.
- 2) Episodic acute stress, which makes people anxious.
- 3) Chronic stress, which is long-term stress capable of extensive damage and difficult to be detected.

II. Effect of stress on human body

Stress produces many physiological changes in our body. In stressful situations, the endocrine system of the human body prepares itself for response by secretion of catecholamine hormones, such as adrenaline

or noradrenaline, which facilitates immediate physical muscular reactions. These include acceleration in heart rate, respiration rate, increased blood flow, constrictions of blood vessels, liberation of nutrients (mainly fat and glucose), dilation of pupil and change in brain activity. Prolonged conditions of stress can lead to medical conditions like anxiety, depression, heart problems, controlled diabetes and effect of normal functioning of endocrine system. Stress management will thus play a crucial role in prevention of other chronic ailments.

III. Physiological changes produced by stress in human body

Stress produces many physiological changes in our body. In stressful situations, the endocrine system of the human body prepares itself for response by secretion of catecholamine hormones, such as adrenaline or noradrenaline, which facilitates immediate physical muscular reactions.

Following are some of the physiological parameters that have been studied subject to experimental conditions:

Heart rate variability (HRV): Heart rate variability can be used to indicate the activity of sympathetic and parasympathetic systems. The high frequency (HF) component reflects parasympathetic activity, and the low frequency (LF) component mainly reflects sympathetic activity.[3] HRV refers to the oscillation of the interval between consecutive heartbeats. When subjects are under stress, HRV is suppressed and when they are relaxed, HRV emerges as shown in Fig. 3. Similarly, HRV decreases with mental effort, but if the mental effort needed for a task increases beyond the capacity of working memory, HRV will increase [4].

Respiratory system: Respiration can be measured as the rate or volume at which an individual exchanges air in their lungs. Rate

of respiration (RespRate) and depth of breath (RespAmp) are the most common measures of respiration. Emotional arousal increases respiration rate while rest and relaxation decreases respiration rate [5]. Although respiration rate generally decreases with relaxation, startle events and tense situations may result in momentary respiration cessation.

The cardiovascular and respiratory systems are functionally related to each other. [6] Zhang et al investigated the effect of mental task on the synchronization between cardiovascular and respiratory systems and found that Mental arithmetic task significantly increased the breath rate, the heart rate

Electro dermal activity: EDA is a measure of the conductivity of the skin. There are specific sweat glands (eccrine glands) that cause this conductivity to change and result in the EDA. Located in the palms of the hands and soles of the feet, these sweat glands respond to psychological stimulation rather than simply to temperature changes in the body.

In this study we have used EDA, HR and BP to monitor stress.

Blood Pressure: Blood pressure (BP) is the pressure exerted by circulating blood upon the walls of blood vessels. When used without further specification, "blood pressure" usually refers to the arterial pressure in the systemic circulation. It is usually measured at a person's upper arm. Blood pressure is usually expressed in terms of the systolic (maximum) pressure over diastolic (minimum) pressure and is measured in millimeters of mercury (mm Hg).

The modern professional approach to "lie detection" is based on the utilization of a number of physiological measures obtained simultaneously. Standardization of practice has led to the employment of a limited number of Polygraph instruments which

usually include the following channels: (a) blood pressure and pulse rate, (b) respiration, and (c) galvanic skin response (GSR). Kugelmass and Lieblach in 1966 attempted to study experimental lie detection under different levels of stress using police cadets. Analysis of the physiological data indicated that while some degree of stress was created, the experimental examinations were less stressful than those encountered during police interrogation. [7]

IV. Methods to monitor stress

It can be monitored by following methods:

- Psychological Method: Interviews and questionnaires.
- Behavioral Method: To observe changes in the manner in which a person does his daily activities.
- Physical Method: To study the changes in physiological features of the body.

In this study we have used psychological method and physical method to monitor stress under experimental conditions.

V. DASS 21

In this method we have used Dass 21 scale. It is a 21 item self report questionnaire designed to measure the severity of Depression, Anxiety and stress. To fill the questionnaire, each question has 4 options:

Table 1: Options to answer DASS 21

Option	Description
0	Did not apply to me at all
1	Applied to me to some degree or some of the time
2	Applied to me to a considerable degree or a good part of time
3	Applied to me very much or most of the time

The significance of the DASS is to assess the severity of Depression, Anxiety and Stress

level in an individual. It also allows means to measure the response of patients to a treatment. The DASS and Diagnosis Although the DASS may contribute to the diagnosis of Anxiety or Depression, it is not designed as a diagnostic tool. Indeed, a number of symptoms typical of Depression such as sleep, appetite and sexual disturbances, are not covered by the DASS and will need to be assessed independently. The DASS is not meant to replace a comprehensive clinical interview.

TABLE1: DASS-21 scores according to severity [8]

	Depression	Anxiety	Stress
Normal	0-4	0-3	0-7
Mild	5-6	4-5	8-9
Moderate	7-10	6-7	10-12
Severe	11-13	8-9	13-16
Extremely Severe	14+	10+	17+

VI. Procedure:

60 volunteers were chosen for the test. The test was divided into 3 parts. Before the test, electro dermal activity, heart rate and blood pressure was noted for each subject in rest condition. This was named as the baseline reading, in the absence of any stimuli. The first test given was 30 questions having simple mathematical calculations. The subjects had to solve the questions without the use of calculator in 10 minutes. This was mental ability test. The next test was stroop test. EDA and HR readings were taken during the stroop test. In psychology, the Stroop effect is a demonstration of interference in the reaction time of a task. When the name of a color (e.g., "blue", "green", or "red") is printed in a color not denoted by the name (e.g., the word "red" printed in blue ink instead of red ink), naming the color of the word takes longer and is more prone to errors than when the color of the ink matches the name of the color. The effect is named after John Ridley

Stroop, who first published the effect in English in 1935.

After the stroop test, the subjects had to fill the DASS 21 questionnaire.

VII. Analysis of the data:

Statistical analysis has been used to study the relation between stress level obtained from DASS 21 questionnaire and blood pressure readings. There are four features of blood pressure – systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse pressure (PP), mean arterial pressure (MAP)[9]. Pulse pressure is simply the difference between SBP and DBP. MAP is sum of one third of PP and DBP. Statistical features were also obtained for EDA and HR signals. The sample was divided into two groups – with stress and without stress on the basis on DASS 21 scale.

VIII. Results and Discussion

Stress and emotions in daily life affects the performance of individual. It also affects health of an individual. A number of physiological markers are widely used for stress assessment, including: electro dermal activity, several features of heart rate patterns, blood pressure and respiration activity. So continuous monitoring the state of an individual is often necessary for the understanding and timely managing the ill effects of stress.

On the basis of DASS 21 questionnaire, the volunteers were divided into two groups – with no stress and with stress. Physiological parameters for both the groups were studied at rest period and after task. It was observed that heart rate for the group with stress showed significant change after the task whereas the group categorized as without stress did not show significant change in heart rate after the task. However peak-to-peak values of EDA showed significant change after the tasks for both the groups. It has also been found out that high levels of stress are best correlated with MAP ($p < 0.05$ i.e $|p| = 0.008$).

Thus to monitor stress it is important to continuously obtain physiological signals from the body and analyze the signals for features that can best describe the level of stress. Physiological method to monitor stress is considered to be a better approach over behavioral and psychological methods as it can continuously measure the changes in the body and report the level of stress so as to enable a timely action. For this the electro dermal activity and heart rate are simple, useful and reproducible techniques, which helps assess the internal state of individual during mental and emotional changes.

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