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PSYCHOPHYSIOLOGICAL MASUREMENTS IN EDUCATION

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Abstract: Studying response of human autonomous nervous system is known to be useful to evaluate the emotional state, mental load and other psychological characteristics of man. In education, psychophysiological measurements can be used for studying children psychology in order to evaluate effectiveness of teaching methods, pupil's relaxation, readiness to learn, comfort etc. A more relaxed child within a modern holistic teaching approach learns more and more effectively and is more motivated.

In this paper three experiments using a portable measuring system on elementary school pupils are described and evaluation of measuring anxiety (psychological effect, caused by awareness of being measured and resulting in changes of physiological signals) discussed.

Keywords: psychophysiology, portable devices, education, school, measuring anxiety, error.

1. INTRODUCTION

Research on the autonomic nervous system enables study of response to the emotional state, mental load and other psychological characteristics of man. Physiological parameters such as cardiovascular activity, respiration frequency, skin temperature, electrodermal activity or skin microcirculation are correlated with the activity of autonomic nervous system, which depends on the psychological state of the observed person.

The impact of psychological or mental stress on human physiological parameters is described in several studies. Previously published studies report on the impact of mental stress on the various psychophysiological parameters such as the change in heart rate, blood pressure, electrical conductivity of the skin and skin temperature. Studies have shown that in laboratory conditions, mental/emotional strain can produce a significant response of the sympathetic nervous system. For example, 10% increase in blood pressure and heart rate during mental stress tasks was reported. Other reported effects were changes in skin conductance and skin temperature [1, 2, 3, 4, 5, 6, 7, 8, 9].

Of special interest are studies that are conducted outside the controlled laboratory conditions in real-life conditions, such as studies of the psychological burden of athletes, the burden on air traffic controllers, the psychology of road users, rehabilitation, etc. [10, 11, 12, 13, 14, 15].

In education, relaxation and calming down enables larger readiness for new knowledge and increases self-confidence, resulting in larger tolerance in classrooms. Psychophysical relaxation triggers biochemical processes in brains. Endorphins are excreted, resulting in improved well-being and increased motivation and ability to accept new information (knowledge) [16, 17, 18].

In this paper we describe three experiments using a multiparameter portable device for measurement of skin temperature and conductance. Device features excellent ergonomics of the monitor casing, thus being fairly non-intrusive for persons to wear. This is also the reason that the device can be used in various studies in which we want to minimize the psychological impact on the physiology (eg studying measuring anxiety, alertness, difficulty, burden of expectations, etc) [19, 20].

2 PSYCHOPHYSIOLOGICAL PARAMETERS

2.1 Skin conductance

Skin conductance (SC, also PGR - psychogalvanic reflex, EDA - electrodermal activity or GSR - Galvanic skin response) is one of the most commonly used methods for observing the activity of human skin and a measure of change in electrical properties of the skin in the form of increased sweat activity. It is used in clinical psychopathology, dermatology, neurology evaluation for diagnosis and therapy. Developments in the clinical setting are on the detection of cystic fibrosis, the classifications of depression in schizophrenia, forecasting, identifying the differences between healthy and psychotic patients, early detection of diabetic neuropathy, chronic treatment of hyperhidrosis, epilepsy ... [21, 22].

In general, psychological excitement of the observed person induces increase of sweat glands activity and thus the skin conductance. The measuring problematics includes measuring site, electrical contact between the electrode and skin, sensitivity to motion artefacts, etc.

2.2 Skin temperature

A series of studies, which dealt with the change in physiological parameters due to psychological state, reported that skin temperature was linearly dependent on the core body temperature [9, 23, 24]. It was found that, unlike the long-term thermoregulatory changes in skin blood circulation due to cooling (vasoconstriction) and heat (vasodiletation), changes in blood flow due to the psychological stimulus are of short duration. In a warm person who has a typical temperature of the fingers (33 ± 2) °C, for example, a sympathetic stimulus causes vasoconstriction in the skin, i.e. the arousal causes lowering of the skin temperature.

Temperature is usually measured on fingers of the hand by means of fast resistance thermometer or thermocouple. Apart temperature, heat flux, a from-temperature-derived physical quantity, is a novel parameter still in research stage with large measuring uncertainty, but could be used also for psychophysiological measurements.

3 MESUREMENTS IN CLASSROOM

In laboratory conditions, psychophysiology experiments are conducted in controlled environmental and experimental conditions, consequently not being equivalent to real life events in everyday life. Portable multisensory devices are capable of measuring in real time under real conditions outside the laboratory. But real-life measurements are more susceptible to external influences and more buried in a complex psychology. Measurements in classrooms are representatives of a real-life psychophysiological measurement.

Ergonomics, low energy consumption, large memory capacities and small physical size of modern portable devices enable minimising the impact on the psychological state of the observed person due to measurements, i.e. the measuring anxiety is minimized. Measuring anxiety (MA) is defined as a state of psychological tension of the observed person being a measurand. Due to measurement anxiety the measuring result could be affected also when observing pupils.

Measuring anxiety has been studied in a number of studies [25, 26, 27]. In general, there are three types of experiments dealing with MA: a) determining MA while the observed person is not aware of being measured (e.g. heart rate measurements from the computer mouse), b) determining MA, while the observed person is aware of being measured (e.g. measurements of skin conductance while driving a vehicle [9]) and c) determining MA, while the observed person is aware of being measured, but mentally is not interested/concerned about it (any more) and/or has got used to it (e.g. ambulatory measurements like 24h ECG measurements [28, 29]).

Practical determination of influence of MA is measurement of psychophysiological parameters, such as heart rate, blood pressure, heart rate variability, skin temperature and conductance, respiratory frequency, occurring as a result of observed person's awareness of being involved in measurement as a measurand. Changes can in principle be caused by physical parameters (e.g. when measuring blood pressure, an occlusive cuff can have an effect of cardiovascular system in form of mechanical changes in fluid dynamic), psychological parameters (e.g. stress, anxiety, fear of consequences, etc), represent natural physiological variability of the arterial blood pressure or is simply mixture of all.

Logging psychophysiological parameters in classrooms is important way of additional information of how the pupils feel during lessons, their readiness to participate, relaxation and willingness to work and learn. Apart some psychological measures in form of questionnaires or interviews, these psychophysiological parameters may represent valuable additional information to the teacher.

In our experiment we used a multiparameter portable device for measurement of body movement and psychophysiological parameters SenseWear PRO3 by BodyMedia Inc. This upper-arm device is capable of measuring skin and near-body temperature, heat flux, body movement and skin conductance.

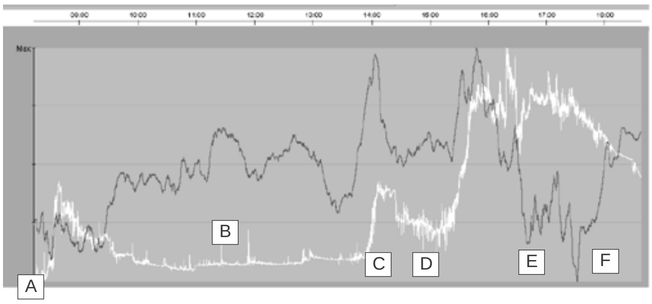

Figure 1. Upper arm skin temperature (black signal) and skin conductance (white) of a typical school day of a second grade elementary school pupil. A – lessons start, B – lessons, C – school lunch, D – afternoon lessons, E – soccer practice, F – visiting theatre.

A school day of a second-grade elementary school pupil (7 years old) is shown in figure 1. Skin temperature and skin conductance was logged during a day. In figure 1 it can be observed an increased psychological activity at the start of morning lessons, leaving for lunch and physical activity while playing soccer and calming down at the end of the day while watching a school play in the theatre. Changes in temperature and skin conductance are of different sign, which corresponds to [15a].

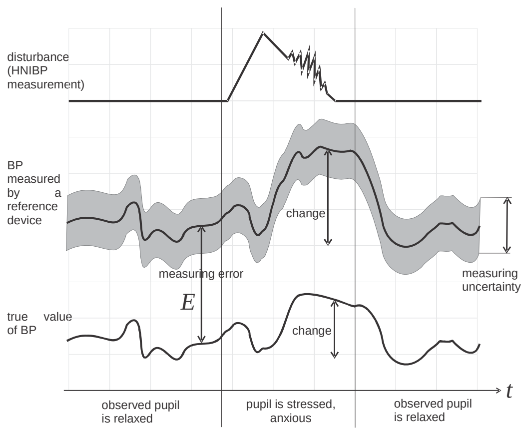

Figure 2. Measuring anxiety determination during self-measurement of blood pressure (BP) by a ninth grade elementary school pupil. As a disturbance a measurement using a home non-invasive blood pressure device (HNIBP) was used.

Figure 3 shows similar experiment, but not in relatively controlled environment of a classroom, but outside school, on a school field trip to an amusement park. Skin conductivity of a third-grade elementary school pupil during the day is shown in figure 3.

The last example is described in figure 2 and is dealing with measuring errors due to measurement anxiety. Figure 4 presents changes of arterial blood pressure of a ninth grade elementary school pupil during a HNIBP self-measurement. Such an experiment enables more detailed study of measuring anxiety by eliminating mechanical and fluid dynamics influences, determination of level of psychological stress of the observed person, etc.

Measurements of blood pressure using a HNIBP is known to be affected by measuring anxiety, hence the importance of ambulatory 24h devices [28]. Ambulatory measurements are performed in regular time intervals (e.g. every 30 min during the day and 60 min during night). Using ABPM has proven to decrease white coat hypertension effect, since it lessens the measurement anxiety [29].

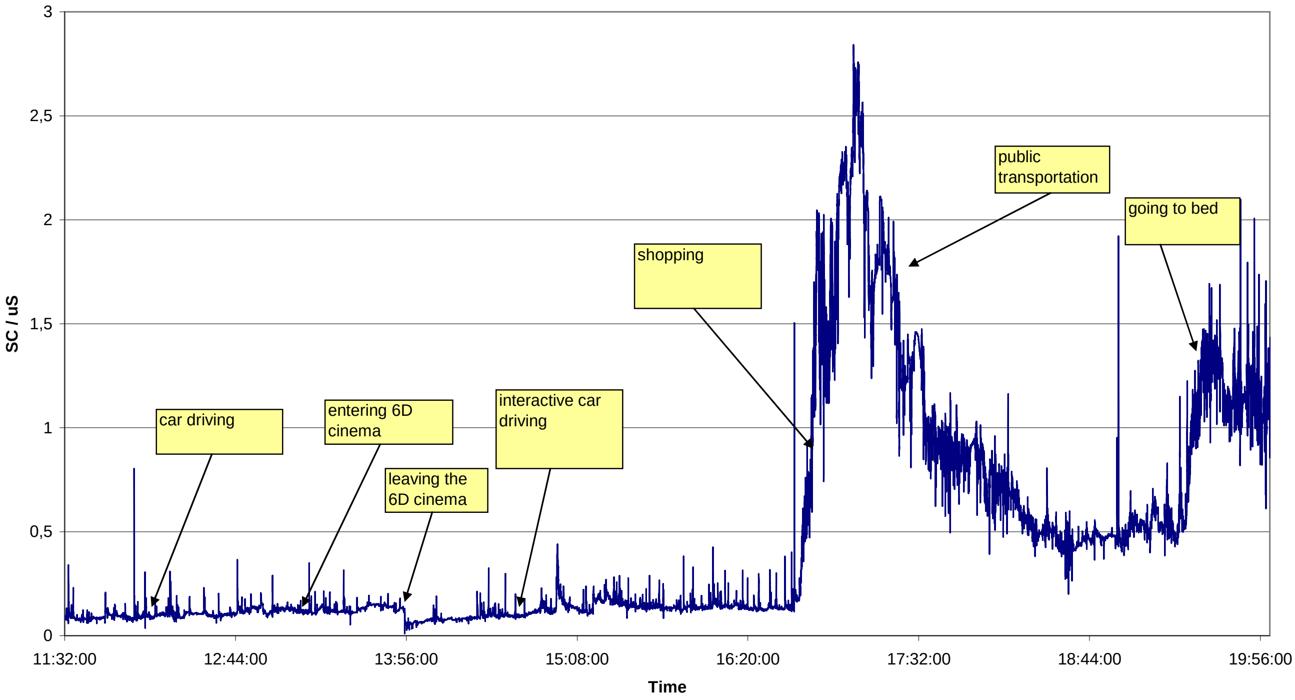

Figure 3. Skin conductance measurement of a third-grade elementary school pupil on a school field trip. At 16:45 large activation due to excitement while shopping and returning home with crowded public transport can be observed.

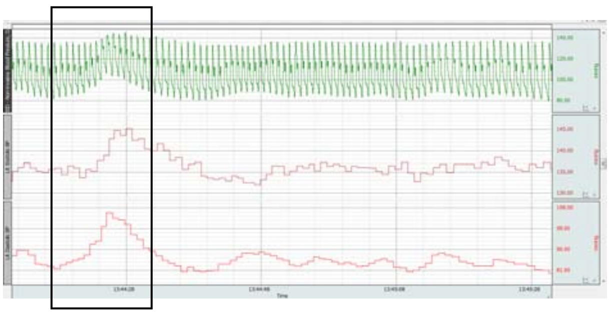

Figure 4. Influence of disturbance (i.e. measurement using a HNIBP) on physiological parameter (i.e. arterial blood pressure) of a relaxed pupil (from above – child continuous arterial pressure, systolic and diastolic blood pressure). Black rectangular indicates the length of disturbance. Time delay of physiological change is observable.

4 CONCLUSION

This paper describes the usage of portable multisensor device in education. The device, capable of measuring and logging numerous physiological parameters, is used in order to determine the psychological state of an observed person. In this paper three examples of employment of psychophysiology in the field of education are shown. Importance of measuring anxiety effect is stressed and its determination discussed.

Psychophysiological measurements can represent valuable additional knowledge when assessing the level of relaxation of pupils and determining effectiveness of different teaching approach.

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