

ELECTRODERMAL ACTIVITY AND STRESS ASSESSMENT

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ABSTRACT

Stress, as a kind of emotion, is inevitable in everyday life. In psychosomatic medicine stress represents a powerful link in the pathophysiological chain of disorder. Having evidence about the power of stress on the body, the interest in medicine was how to measure it in appropriate, fast way and with minimal cost. Electrodermal activity seems to be available for this purpose.

The galvanic skin response (GSR) is an objective, transient indication of autonomic nervous system arousal in response to a stimulus. It refers to changes in sweat gland activity that are reflective of the intensity of our emotional arousal.

In this article we discuss physiological specifics of skin conductance/resistance and how it is measured in practice. The most used application of GSR is in biofeedback methodology. Biofeedback assessment and training exactly uses skin reaction to different stimuli and aims to gain voluntary control over this autonomic response. The aim of this article is to show effectiveness of this method in paediatric practice.

Keywords: electrodermal activity, stress, biofeedback, paediatrics

INTRODUCTION

Every day we speak about stress: in family, at work, in school setting, at university, during car traveling, even in situations which are estimated as happy and amazing (wedding, anniversary) etc. We can agree that in the contemporary life's style stress is unavoidable event. The phenomenon of stress is especially present in all medical disciplines, in students, doctors, nurses, but especially in patients. In this context, research on stress was our long-term professional interest.

By definition, stress is a physical, chemical, or emotional factor that causes bodily or mental tension and may be a factor in disease pathogenesis. In psychosomatic medicine stress represents a powerful link in the pathophysiological chain of disorder. However, stress is predominantly a kind of emotion. The study of human emotions is important in medicine and represents a fascinating and cross-disciplinary field of research. In the past 20 years, the interest on human emotions has been extended, from the realm of psychology, to other disciplines such

us neuroscience, product and experience design, and computer science. Despite different theories of emotions have been proposed over the years, there seems to be the common understanding that emotional states are characterized by physiological and cognitive responses to clearly identifiable stimuli. As such, whether we investigate emotions to understand the human mind or to teach an automated system how to be more “humane”, emotion investigation is, in the great majority of cases, based on: (a) delivering emotional stimulation and (b) measuring cognitive and physiological reactions.

Having enough proofs about the power of stress on the body, the interest in medicine was how to measure it in appropriate, fast way and with minimal cost. Electrodermal activity seems to be available for this purpose.

In this article we describe what is currently understood to underlie the electrodermal response (EDR) to stress, and our own experience with EDR application in paediatric practice.

The galvanic skin response (GSR) was one of the earliest tools used in psychological research, as a method of measuring the electrical resistance of the skin. Experimentally, it was confirmed that in response to a stressor, GSR nonspecific increases and basal resistance decreases. GSR is sensitive to immediate emotional arousal as well as to the changes of general mood or to different stress stimuli.

Interest in the conductance between skin electrodes arises because of the involvement of the sweat glands in this measurement. Since sweat gland activity is controlled by sympathetic nerve activity, this measurement has been considered as an ideal way to monitor the activity of the autonomic nervous system.

The main function of the skin is to protect the body from the environmental influences. One aspect of this is to prevent the loss of water by the body. However, at the same time, the evaporation of water is important for regulating body temperature. The activity of sweat glands is regulated by autonomic nervous system (sympathetic branch) and it is without conscious control. In this context, measurement of the output of the sweat glands based on EDR provides a simple gauge of the level and extent of sympathetic activity. It is well established that the electrodermal response is associated with sweat gland activity.

There are two major measures of the electrodermal response. The first, involving the measurement of resistance or conductance between two

electrodes placed in the palmar region, was originally suggested by Féré (1888) and pioneered by Tarchanoff (1889) and referred as exosomatic because the current is measured from the outside. The second type, which is less commonly used, is called endosomatic, since the source of voltage is internal.

The number of sweat glands varies across the human body, but is the highest in hand and foot regions (200–600 sweat glands per cm²), where the GSR signal is typically collected from. The resistance and conductance measurements are reciprocals. Our measurement of sweat gland activity is toward skin resistance and expressed in micro ohms (mΩ). However, the electronics associated with measurement of EDR is fairly simple. For exosomatic conditions either a constant current or a constant voltage source is used. The placement of the electrodes is shown on Figure 1. The applications of EDR lie in the area of psychophysiology and relate to studies in which a quantitative measure of sympathetic activity is desired.

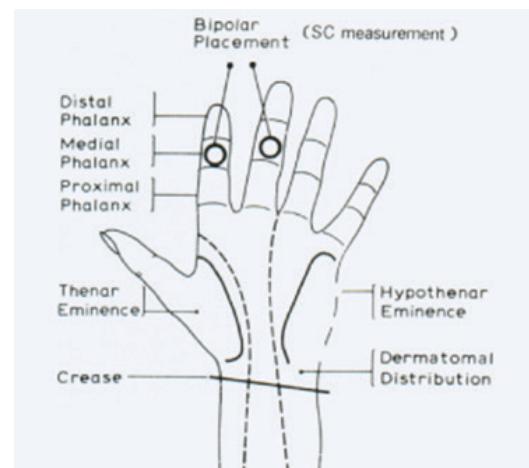


Fig. 1. *Electrodes sites on the palm for measurement of skin resistance and skin potentials*

The activity of the skin is named differently, such as “Skin Conductance”, “Galvanic Skin Response” (GSR) or “Electrodermal activity” (EDA). Anyway, Skin Conductance is the currently the most used term. It is based in the primitive ‘fight or flight’ response, whereby the body prepares itself for the exertion needed to deal with a perceived threat by increasing sweat activity to cool itself. At low levels, this happens all the time, as the mind experiences thoughts and emotion.

Today, many different modalities for measuring skin conductance/resistance exist. Most modern GSR electrodes have an Ag/AgCl (silver-chloride) contact point with the skin. Ag/AgCl electrodes are used as they are cheap, robust, safe for

human contact, and of course are able to accurately transmit the signal from the ionic activity. Figure 2 shows the placement of electrodes in practice.



Fig 2. *Placement of the electrodes in practice*

Figure 3 shows the increasing pathway of resistance (measured in $m\Omega$), due to relaxation.

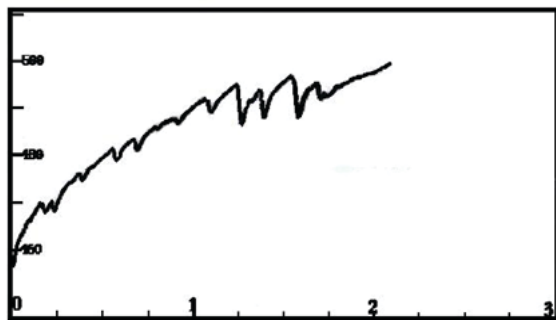


Fig. 3. *Increase of skin resistance due to overcoming stress*

In more details, Figure 4 shows phases in skin conductance (in micro Siemens) obtained due to some stimulus.

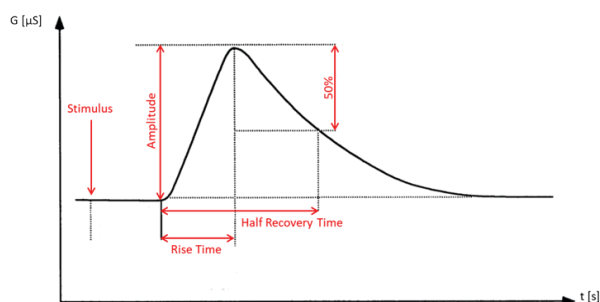


Fig. 4. *Phases in skin conductance response due to stimulus (stress)*

The skin conductance response is an objective, transient indication of autonomic nervous system arousal in response to a stimulus. It is a common measure of emotional arousal in the laboratory. The galvanic skin response refers to changes in the sweat gland activity that are reflective of the intensity of our emotional state, otherwise known as emotional arousal. Our level of emotional arousal changes in response to our environment i.e. if something is scary, threatening, joyful, or otherwise emotionally relevant, then the subsequent change in the emotional response that we experience also increases eccrine sweat gland activity. Research has shown how this is linked to the emotional arousal. It was shown that both positive (happy or joyful) and negative (threatening or saddening) stimuli can result in an increase in arousal – and in an increase in skin conductance. The GSR signal is therefore not representative of the type of emotion, but the intensity of it. While sweat secretion plays a major role for thermoregulation and sensory discrimination, changes in skin conductance are also triggered robustly by emotional stimulation: the higher the arousal, the higher the skin conductance (Venables P., 1980; Boucsein W., 1992).

The applications of EDR lie in the area of psychophysiology and relate to studies in which a quantitative measure of sympathetic activity is desired. Fowles (1986) states:

”The stimuli that elicit these [EDA] responses are so ubiquitous that it has proved difficult to offer a conceptualization of the features common to these stimuli. There is no doubt, however, that the response often occurs to stimuli that depend for their efficacy on their physiological significance as opposed to their physical intensity”.

It was confirmed in many studies that EDA is a sensitive psychophysiological index of changes in autonomic sympathetic arousal that are integrated with emotional and cognitive states (Fowles D, 1974; 1981; 1986). Until recently there was little direct knowledge of brain mechanisms governing generation and control of EDA in humans. However, studies of patients with discrete brain lesions and, more recently, functional imaging techniques have clarified the contribution of brain regions implicated in emotion, attention, and cognition to peripheral EDA responses (Bechara A. et al. 1997; 1998; 2000; 2004; Damasio A, 1995). Moreover, such studies enable an understanding of mechanisms by which states of bodily arousal, indexed by EDA, influence cognition and bias motivational behaviour.

One of the first examinations of a physiological response through skin reaction was during deci-

sion making. Bechara and colleagues (1997) studied patients with orbitofrontal cortex (OFC) damage, especially in patients with ventromedial prefrontal cortex (vmPFC) damage during they performed gambling task. To explain the obtained results, Bechara, Damasio and their colleagues proposed the widely influential “Somatic Marker Hypothesis” (Damasio, 1996). This hypothesis suggests that the anticipatory arousal response is a bodily signal of the value of the choice and that this bodily signal serves to steer participants away from “risky” choices. This important study remains one of the first to link emotional responses and brain systems to behavioural decision patterns, and it has played a central role in both the history of the study of decision making and the history of the study of emotion.

In a newest study of Moretto et. al (2010) electrodermal activity was used to show that the emotional physiological responses are associated with activation of vmPFC and influence the moral decision. The studies measuring skin conductance thus indicate that an autonomic measure of arousal correlates with different components of the decision task, and that different brain regions linked to arousal (vmPFC, insula, amygdala) may mediate this relationship.

Although emotional stress typically increases sympathetic tone, there are some exceptions. Despite marked anxiety, distress and functional impairment, dissociation between the anxiety levels appears to dysregulate sympathetic nerve activity in depersonalization disorder (DPD) (Owens A, 2017; Lee W, 2012; Sierra M, 2011; Michal M, 2013; Mooren N, 2014; Davis S, 2010). Depersonalization disorder (DPD) is defined by derealization (surroundings feel unreal), emotional numbing, feelings of disembodiment and memory recall deficits. DPD is a defensive response engaged during perceived overwhelming threat (Lee et al., 2012) and has a lifetime prevalence of 74% for mild episodes and 1%–2% for chronic DPD (Sierra and David, 2011). Peritraumatic dissociation shares some symptoms with depersonalization—emotional numbing, derealization, self-observation, and dysmorphia—and occurs during extreme inescapable threat (Mooren and Van Minnen, 2014).

The amygdala plays a crucial role in evaluating the emotional significance of stimuli and in transforming the results of this evaluation into appropriate autonomic responses. Lesion and stimulation studies suggest involvement of the amygdala in the generation of the skin conductance response (SCR), which is an indirect measure of autonomic activity that

has been associated with both emotion and attention (Davis and Whalen 2001). Additionally, functional imaging studies have shown a correlation between BOLD (blood oxygen level dependent) signal in the amygdala and SCR amplitude and occurrence under conditions of emotional image presentation (Hoffman et al. 2007; Liberzon et al. 2000; Williams et al. 2001). Yet, damage to the amygdala can eliminate production of SCRs to a wide variety of unconditioned, non-emotionally stimuli (Asahina et al. 2003).

Still, the contribution of the amygdala to the modulation of various types of EDA remains unclear. It is possible that the amygdala is involved with EDA production/generation regardless of the source of arousal. Research showed that the amygdala is only one of many structures involved with emotion, attention, and autonomic regulation. The medial and orbital prefrontal cortices, the anterior insula, the anterior cingulate cortex, and periaqueductal grey have overlapping roles in the evaluation of emotional stimuli and in the initiation of autonomic responses, including SCRs (Critchley 2002).

Although low EDA in depressed patients was first described in 1890 (Vigouroux A.), interest in this physiological variable as a marker of depressive disorders occurred mainly between the late 1970s and the 1990s. Electrodermal hypoactivity seems to be a reliable feature of depression and a valid marker of suicidal risk. It has been suggested that differences in EDA may be specific to suicidality rather than depression. Nevertheless, the potential utility of EDA in diagnosis, prevention, and treatment planning for depression and suicidal behavior, should be thoroughly studied (Sarchiapone M, 2018).

GSR is familiar to many as the signal used in “lie detectors,” since GSR amplitude reacts sensitively to emotional provocation, salient thoughts, and attentional demand. Correspondingly, this effect exemplifies the direct coupling between sympathetic sweat gland innervation, measured by GSR, and brain states of affective and cognitive arousal.

Even EDA has a history in psychophysiological (including emotional or cognitive stress) research since 1879, it was not until recent years that researchers began using EDA for pathophysiological applications like the assessment of fatigue, pain, sleepiness, exercise recovery, diagnosis of epilepsy, neuropathies, depression, and so forth. The advent of new devices and applications for EDA has increased the development of novel signal processing techniques, creating a growing pool of measures derived mathematically from the EDA. For many years, simply computing the

mean of EDA values over a period was used to assess arousal. Much later, researchers found that EDA contains information not only in the slow changes (tonic component) that the mean value represents, but also in the rapid or phasic changes of the signal. The techniques that have ensued have intended to provide a more sophisticated analysis of EDA, beyond the traditional tonic/phasic decomposition of the signal.

Finally, biofeedback training (as a relatively new methodology) exactly uses skin reaction to different stimuli and aims to gain voluntary control over this autonomic response (Schwartz, 2008; Culbert T, 1996). Aim of this article is to show effectiveness of this method in paediatric practice.

METHODOLOGY

We introduced biofeedback methodology in practice at the Paediatric University Clinic in Skopje in 1996. The following technologies were used: Relax plus-Ultramind, London; Inner Tunner Professional- Ultramind, London; Biograph ProComp. Thought Technology, LTD., Canada. The last one contains several biofeedback modalities related to changes in skin, muscle activities, peripheral temperature, breathing as well as brain waves changes.

By definition, peripheral biofeedback training focuses on learning self-regulation over autonomic nervous system. The peripheral biofeedback we used is based on measuring skin resistance, expressed in Ohm's. The placement of electrodes is on the hand fingers and the obtained signal is transferred to the PC where graphical representation of the obtained results is available to both (doctor and patient). For obtaining better interest and collaboration with children, the changes of electrodermal activity are transformed in different games which are enrolled on the screen. The game goes in accordance with the obtained resistance and stop if the client is unsuccessful to relax.

For all biofeedback procedures the patients were sitting in a comfortable chair, in a quiet room, along with the doctor. The instruction was: be calm, breathe deeply and try to think about pleasant situations or persons. After the assessment, 15 training sessions are applied.

The samples trained with biofeedback are different in a number of patients, and are randomly selected. The results are compared with healthy control, matched by age. All results are statistically calculated using Statistica-10 package.

RESULTS

The first evaluated group comprises patients with chronic diseases: a) adolescents with cystic fibrosis (N = 40, mean age = 17.5 years); b) adolescents with bronchial asthma (N = 35, mean age = 19.5 years); c) children with epilepsy (N = 45, mean age 13.5 years) and d) children with diabetes mellitus (N = 30, mean age = 12.5 years).

The results obtained with EDR biofeedback for the group of cystic fibrosis are displayed on Figure 5. As we mentioned before, electro dermal resistance is measured in $\mu\Omega$. Figure 5 shows the first and last session group's results.



Fig. 5. EDR biofeedback in CF adolescents

Calculated Student t-test (first session $M=23.9\pm4.41$; last session $M=57.16\pm4.21$; $N=40$) is highly significant ($t\text{-test}=-49.96$ $p=0.0000$).

For the group of asthmatic adolescents, results obtained for EDR biofeedback is presented in Figure 6.

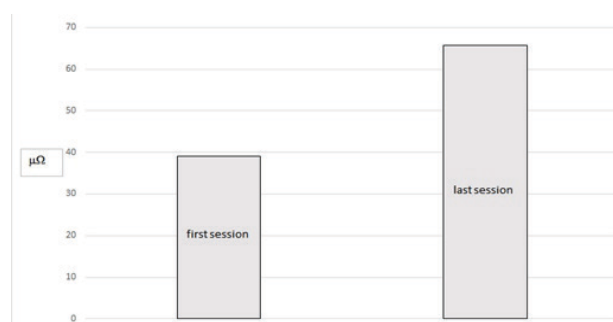


Fig. 6. EDR biofeedback in adolescents with asthma

Calculated Student t-test (first session $M=39.15\pm5$; last session $M=65.67\pm3.23$; $N=35$) is highly significant ($T\text{-test}=-48.57$ $p=0.0000$).

Applied EDR biofeedback for epileptic children showed results presented in Figure 7.

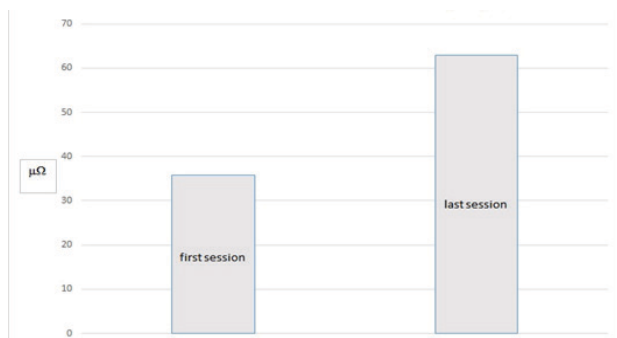


Fig. 7. EDR biofeedback in epileptic children

Student t-test (first session $M=35.73 \pm 3.45$; last session $M=62.92 \pm 2.7$; $N=45$) was also highly significant ($t\text{-test} = -67.55$ $p=0.0000$)

For the group of diabetic children, results are presented in Figure 8.



Fig. 8. EDR in diabetic children

Calculated Student t-test (first session $M=33.92 \pm 4.26$; last session $M=59.42 \pm 2.7$; $N=30$) is highly significant ($t\text{-test} = -51.73$ $p=0.0000$).

The second trained sample comprises 80 students, aged 16-18 years, 94% girls, 6% boys; 81% were Macedonian and 19% Albanian. The biofeedback training was performed for better school achievement. Figure 9 shows changes in electrodermal resistance in the first and last training session. In addition, we applied psychometric tests such as: Trial Making Test Form A (TMT- A) and Form B (TMT-B) and Short-Term Memory Span Tests i.e. Verbal Span Assessment (WMS-R) Numbering - forward and backward, for measuring changes in cognitive performance.



Fig. 9. Changes of electrodermal resistance

The results of the psychometric tests are not statistically significant. In other words, even at obtaining relaxation this technique is not specific for obtaining better cognitive achievement.

It is well known that eating disorders present a serious problem and great challenge for treatment in female adolescent population. We treated 76 obese girls (mean age 12.75 ± 1.75 years), as well as a group of 27 anorectic girls (mean age 14.25 ± 2.99 years). All patients were tested for anxiety level with General Anxiety Scale (GASC) and the obtained results are shown in Table 1. As expected, anorectic patients showed higher anxiety level.

Table 1. Results for General Anxiety Scale

Patients	Mean	SD	Maximum scores
Anorectic	32.8	2.6	35
Adipose	25.7	4.6	35

Graphical comparison of the obtained biofeedback results for both groups is presented in Figure 10. It is obvious that in anorectic patients we obtained better results.

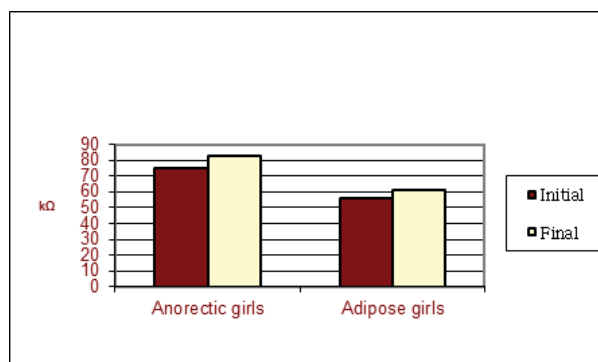


Fig. 10. EDR biofeedback in anorectic and adipose girls

In Figure 11 we present the obtained results with peripheral biofeedback in patients with posttraumatic stress disorder (N=10, mean age 12.2 ± 2.56). It is very clear that that group presents very good results obtaining significant raise in skin resistance as learned stress control.

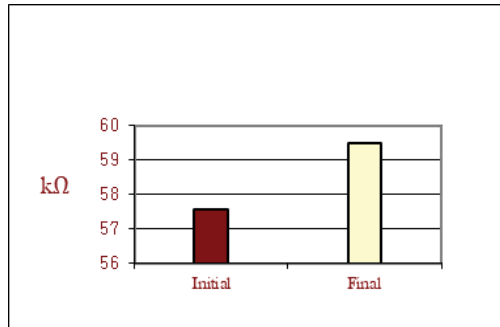


Fig. 11. EDR biofeedback in PTSD

Finally, we present some results of biofeedback assessment in a group of children exposed to lead. It is known that lead is potential toxic metal leading to hematological, nephrological and CNS lesions, especially in very young children. The city of Veles, has a geographical position, atmospheric specifics, urban and industrial concentration and wrong location of the Lead and Zinc Smelter, opposite to the wind rose, which altogether predispose to continuous air pollution with lead agents.

We evaluated a sample of 31 school children, living near to the smelter, both sexes (22 boys,

9 girls), mean age 12.8 years. Our aim was to evaluate intelligence, using Raven matrices and Bender-gestalt test, as well as to apply multimodal biofeedback assessment using Biograph/ProComp+ Thought technology, Canada and comparing them with the blood lead level and academic achievement.

The obtained results were as follows:

Mean blood lead level are over normal (i.e. $>10 \mu\text{g/dl}$); (M = $16.51 \pm 6.74 \mu\text{g/dl}$; min 8.1, max. $32.9 \mu\text{g/dl}$.) For boys - $18.71 (\pm 6.51)$; for girls - $11.12 (\pm 3.67) \mu\text{g/dl}$.

IQ = $104.35 (\pm 10.15)$; Gestalt-Bender (bad 3/31; medium 19/31; excellent 9/31) and Academic marks (a = 16/31; b = 9/31; c = 5/31, d = 1/31).

There is statistical significance between the differences of the mean values and the standard deviations between groups based on academic marks and blood lead level (t-test $2.72 p < 0.05$).

The results obtained for electrodermal conductivity (resistance) of all 31 children presented as baseline and during Stroop test performance are presented in Figure 12. The Stroop Color and Word Test (SCWT) is a neuropsychological test extensively used to assess the ability to inhibit cognitive interference that occurs when the processing of a specific stimulus feature impedes the simultaneous processing of a second stimulus attribute, well-known as the Stroop Effect.

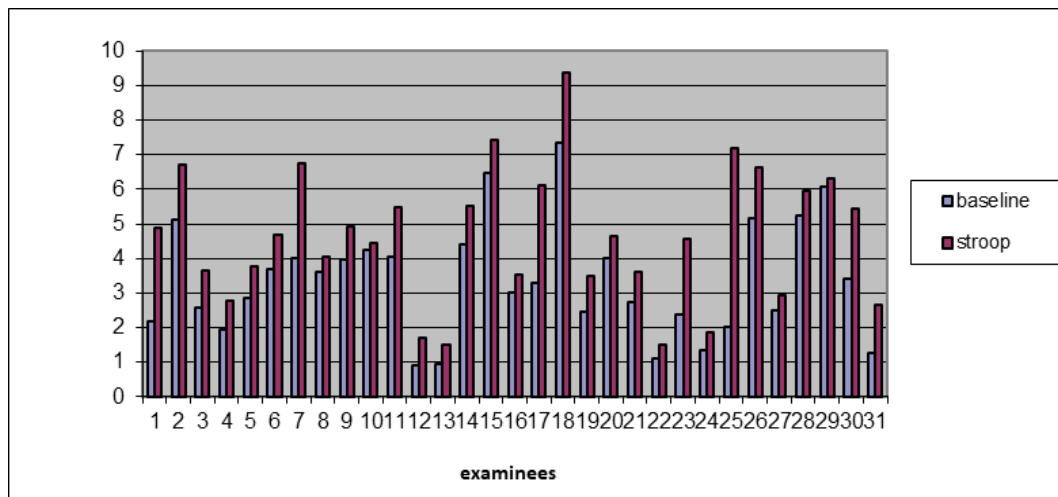


Fig. 12. Electrodermal conductivity (in micro Siemens) baseline and during Stroop test

It is clear that the performance of the Stroop test provokes higher skin conductance due to the higher stimulation of sympathetic system.

In general, we used peripheral biofeedback method as a non-pharmacological, cheap and easy

to apply technique for many different groups of paediatric patients. Table 2 summarises the majority of the obtained results. As it can be concluded, all groups of patients' peripheral biofeedback showed positive results.

Table 2. Results obtained with EDR biofeedback

Disorder	Number of patients	Mean age (years)	<i>t</i> -test	Significance
Somatoform problems	243	10.31 (\pm 2.75)	10.05	$p < 0.01$
Anxious/phobic reactions	30	10.12 (\pm 3.44)	9.93	$p < 0.01$
Encopresis	9	8.44 (\pm 1.24)	9.39	$p < 0.01$
Enuresis	26	10.07 (\pm 3.27)	9.31	$p < 0.01$
Ticks	27	10.81 (\pm 3.69)	7.83	$p < 0.01$
Stuttering	10	9.2 (\pm 3.58)	6.79	$p < 0.01$
Headache (tension type)	59	12.5 (\pm 1.24)	6.19	$p < 0.01$
ADHD	25	9.0 (\pm 1.54)	5.07	$p < 0.01$
Obsessive-compulsive behavior	4	10.5 (\pm 2.38)	4.76	$p < 0.05$
Anorexia/bulimia	103	13.05 (\pm 2.37)	3.87	$p < 0.01$
Nightmares	8	8.0(\pm 1.85)	0.87	$p < 0.01$

DISCUSSION

Electrodermal response (EDR) is a complex reaction with a number of control centres in the CNS. Three systems related to arousal, emotion and locomotion are responsible for the control of the electrodermal activity (Boucsein 1992). The reticular formation controls EDR related to states of arousal, the limbic structures (hypothalamus, cingulated gyres and hippocampus) are involved in the EDR activity related to the emotional responses and thermoregulation, while the motor cortex and parts of the basal ganglia are involved in locomotion. In particular, skin potential and skin conductance used as parameters in EDR biofeedback are related to both sympathetic and parasympathetic arousal (Mangina & Beuzeron-Mangina, 1996).

Treatment by EDR biofeedback is generally based on training patients in strategies for lowering arousal and maintaining a healthful Sympathetic/Parasympathetic tone. Consequently, EDR biofeedback modality is the first choice for introvert persons, where high inner arousal is a typical finding and biofeedback training is supposed to lower sympathetic arousal. Changes in electrodermal activity can be reliably detected within one second of stimulus presentation, often following a single event. It is important to know that electrodermal conductance precede any other signals related to neuroimaging such Positron Emission Tomography (PET), Blood oxygen level-dependent functional magnetic resonance (BOLD),

Single photon emission computed tomography (SPECT) etc. which are used in practice. In other words, the changes of the electrodermal activity can be registered before the changes obtained by the other neuroimaging techniques.

The biopsychosocial framework, that recognizes the importance of the mind-body interrelationship for the developing human being became relevant for the contemporary paediatric health-care. Simultaneously, biofeedback has arisen as a modern computer-related operant conditioning technique used for assessment and therapy of many psychophysiological disorders, especially the stress-related ones. Its objective is to increase the voluntary control over the physiological processes that are otherwise outside awareness, using the information about them in the form of an external signal.

Various biofeedback approaches are increasingly used worldwide as non-pharmacological and cost-benefit effective research and therapeutic tools. A significant increase in research has documented the efficiency of biofeedback for children and adolescents that manifest behavioural, emotional and cognitive. Unfortunately, biofeedback methods are not yet well known in paediatric settings.

We published our results obtained with biofeedback methodology for different group of disorders: eating disorders; somatoform disorder and ADHD; especially we have very positive experience with neurofeedback in mental disorders (ADHD, OCD, depression, anxiety etc.) (see ref. 35-48). Obtained results corresponded with results presented by other researchers in this field.

CONCLUSION

In psychosomatic medicine stress represents a powerful link in the pathophysiological chain of disorder. Having enough proofs about the power of stress on the body, the interest in medicine was how to measure it in appropriate, fast way and with minimal cost. Electrodermal activity seems to be available for this purpose.

Biofeedback has arisen as a modern computer-related operant conditioning technique used for assessment and therapy of many psychophysiological disorders, especially the stress-related ones. Its objective is to increase the voluntary control over the physiological processes that are otherwise outside awareness, using the information about them in the form of an external signal. The peripheral biofeedback, based on electrodermal activity, is very helpful tool for stress-related disorders in children.

We propose this methodology as adjuvant practically for all pediatric disorders especially stress related ones. It is non-pharmacological, non-invasive, cost-beneficial and interesting methodology for children. The only need is good motivation and support for family members.

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Резиме

ЕЛЕКТРОДЕРМАЛНА АКТИВНОСТ И ПРОЦЕНА НА СТРЕСОТ

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Стресот претставува вид емоција што е неизбежна во секојдневниот живот. Во психосоматската медицина стресот претставува моќна алка во патофизиолошкиот ланец на болестите. Имајќи докази за силината на стресот врз телото, интересот во медицината бил како тој да се мери на соодветен, брз и евтин начин. Електродермалниот одговор се чини дека е соодветен за ваквите цели.

Галванскиот кожен одговор (GSR) претставува објективна менлива индикација за возбуденоста на автономниот нервен систем, како одговор на стимулус. Тој одговара на промените во активната на потните жлезди, кои реагираат на интензитетот на емоционалната возбуда.

Во овој напис дискутираме за физиолошките специфики на кожната спроводливост/отпор и како тие се мерат во практиката. Најчестата користена апликација на GSR е во биофидбек-методологијата. Биофидбек-процената и тренингот ја користат токму кожната реакција на разни стимулуси за да се постигне свесна контрола на автономниот нервен систем. Целта на написот е да се покаже ефективната на овој метод во педијатриската практика.

Клучни зборови: електродермална активност, стрес, биофидбек, педијатрија