DE GRUYTER OPEN

EUROPEAN POLYGRAPH

Volume 8 • 2014 • Number 2 (28)

DOI: 10.2478/ep-2014-0007

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Field Examination: Certain Phenomena Related to Electrodermal Activity

Key Words: galvanic skin response (GSR), electrodermal activity (EDA)

Introduction

The electrodermal activity (EDA) refers to all exosomatic and endosomatic changes in electrical properties of the skin (Krapohl & Sturn, 2002). There is ample empirical evidence that electrodermal phenomena are generated by sweat gland activity in conjunction with epidermal membrane processes

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(Boucsein, 2012). Generally, under control of sympathetic nervous system, EDA is regarded as a valid indicator of emotional, motivational, and cognitive states. EDA is divided into tonic (EDL = electrodermal level) and phasic (EDR = electrodermal response or reaction) phenomena (Boucsein, 2012).

Phasic EDA is a response of the central nervous system to a situational stimulus which usually depends on novelty (Varlamov & Varlamov, 2000).

Tonic EDA is a certain state of the nervous system which changes slowly (within minutes or hours) and is determined by metabolic processes in biological tissues (Varlamov & Varlamov, 2000). According to Boucsein (2012), tonic electrodermal measures are obtained either as EDLs in response-free recording intervals or as the number of non-stimulus-specific EDRs in a given time window.

EDA is measured as resistance in ohms or as conductance in siemenses.

The article begins with an overview of our experience and observations concerning EDA, and continues with a description of certain phenomena of phasic and tonic EDA that have received little attention from other authors (Handler, Nelson, Krapohl & Honts, 2010; Konieczny, 2009; Matte, 1997).

Phasic EDA

We have noticed earlier that in polygraph examination changes following the stimulus (the question) hardly ever occur in phasic EDA in persons with psychopathic symptoms (Saldžiūnas & Kovalenka, 2010). According to some authors (Verschuere, Crombez, Koster & Van Baelen, 2005; Verschuere, 2011), results further demonstrate reduced electrodermal response to concealed information in antisocial inmates. The electrodermal hyper-responsiveness in antisocial individuals might therefore threaten the validity of concealed information tests. Investigations of phasic EDA parameters yielded a general decrease of electrodermal reactivity in old age (Boucsein, 2012). In older age, a decrease in skin thickness and elasticity is likely to occur. Representatives of certain professions (field workers, mechanics, etc.) have very thick and rough skin on their fingers, therefore, they are more difficult to examine by EDA (Varlamov & Varlamov, 2000).

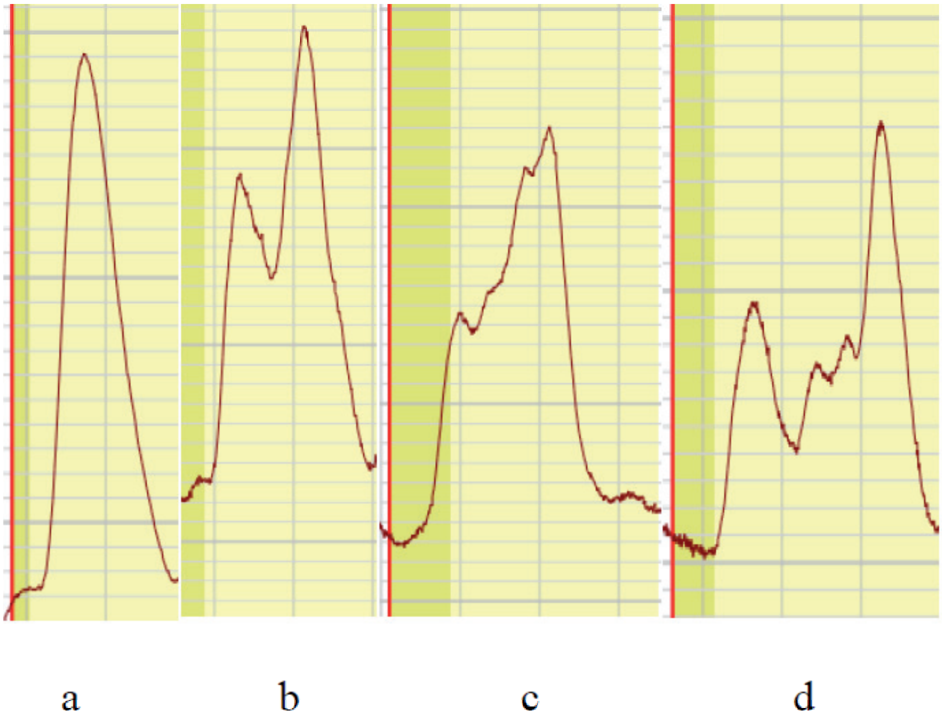

Figure 1. Shapes of EDA curves in polygraph charts

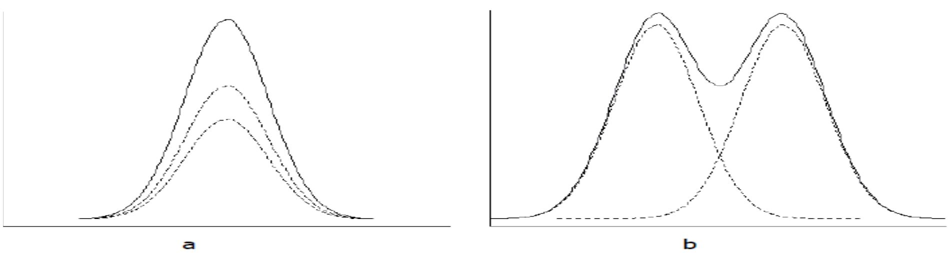

Figure 2. Examples of the way complex responses are formed from two responses

With a few individual exceptions (Saldžiūnas & Kovalenka, 2010; Varlamov & Varlamov, 2007;Verschuere, Crombez, Koster & Van Baelen 2005), EDA is very important in polygraph tests (Boucsein, 2012; Handler, Nelson, Krapohl & Honts, 2010). The contribution of EDA channel accounts for approximately 50 per cent of all data (Krapohl, 2011). Hira and Furumitsu (2002) show that

EDA response was largest to a relevant alternative in about 62 per cent of cases.

Simple amplitude response and complex response of phasic EDA are evaluated in polygraph examinations (Department of Defence of Polygraph Institute, 2006). Four variations of phasic EDA peaks are shown in Figure 1. The relative magnitude of EDA is shown vertically, whereas time is registered horizontally. The darker field is the time interval when the examiner asks the examinee a question. All EDA responses are complex ones in Figure 1, as they consist of at least two EDA peaks. US specialists (Bradley, 2009; Handler, Nelson, Krapohl & Honts, 2010) do not explain the reasons for occurrence of the second peak. Russian polygraph examiners (Varlamov & Varlamov, 2000) believe that the second response (a repeated peak) may occur because the examinee additionally remembered some information related to the question after answering it. Ekman (2003) has expressed an opinion that, in the case of a sudden threat, the emotion of fear comes (and is recorded) first, and is subsequently replaced by horror or anger. Explanation of a multi-complex response consisting of two or more peaks (Figures 1 b, c, and d) is probably even harder. Another reason (Stankus, 2004;2012) may be the fact that the processes in the examinee's brain occur in several stages. Handler (2012) thinks that this is caused by a filtering effect of the instrument (polygraph). We consider that if polygraphs alter the shape of EDA peaks in a different way due to the filtering effect, they consequently distort charts, and such instruments cannot be used for examination. As a consequence, scientific works explaining the occurrence of EDA complex response in an unambiguous manner are still lacking.

The way a complex peak is formed from two peaks is shown in Figure 2. An assumption that although EDA looks like a non-complex peak in the charts, it is a sum of two peaks which may be caused by several psycho-physiological factors may be made with regard to the conjuncture of the responses illustrated in Figure 2a. This means that the examiner does not know whether EDA peak is complex or not when identifying it. In such a case the examiner may commit the error of misassessment.

We performed several laboratory tests. We used to give the examinee a mathematical task during polygraph examinations: perform addition or multiplication of numbers (5+12=?; 13×6=?; 17×5=?; 127×9=?). Each following mathematical calculation was more complicated than the previous one. The charts typical for this experiment are shown in Figure 3. It is obvious that the examinee's EDA responses may be the result of mental activity. Thus, it can be assumed that the complexity of EDA responses may be determined not only by the question of the examination but also by other processes of mental activities in the examinee's brain.

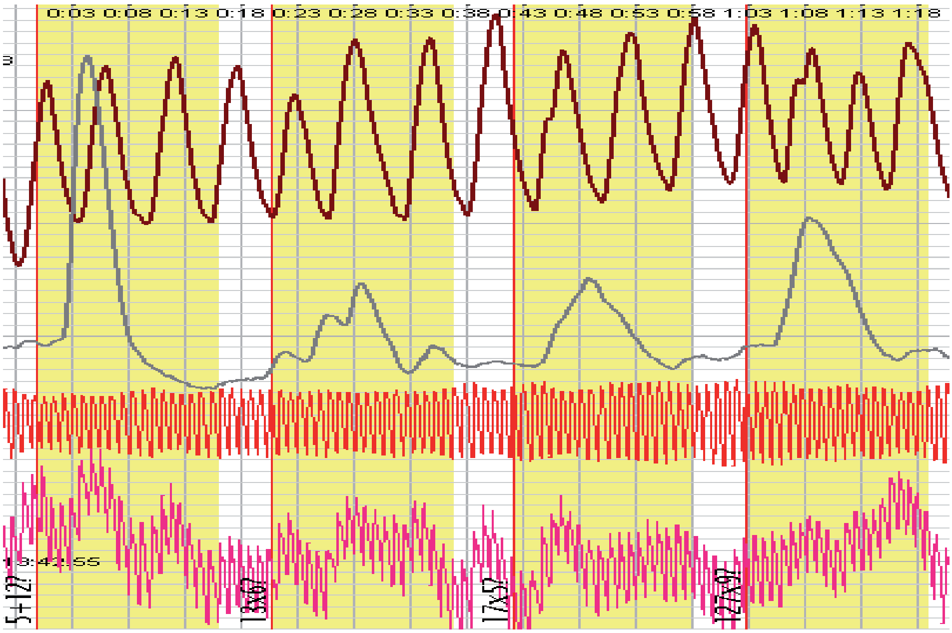

Figure 3. Mathematical calculation test charts

Tonic EDA

As tonic EDA changes slowly, it receives very little attention in polygraph examinations (Handler, Nelson, Krapohl & Honts, 2010; Hira & Furumitsu, 2002, Osugi, 2011). Varlamov & Varlamov (2007) noted that tonic EDA levels exceeding 300 kohms usually indicate that the examinee is a drug addict. We have recorded examinees' tonic EDA in polygraph examination for a number of years. Several illustrative examples from field examinations results (which have as yet received no scientific treatment) are provided below. We only want field examiners to take a note of certain potential tonic EDA effects which we recorded during field examinations.

The change of tonic EDA in examinees honest in answering the questions (a further criminal investigation established that they did not commit crime) is illustrated in Figure 4. We can see that tonic EDA hardly changes during polygraph examination for most examinees. A slightly more labile system of the body was recorded for examinee K. Figure 4 shows that tonic EDA for examinees P, K, and C was below 300 kohms. Prior to the examination, the examinees confirmed that they were not taking any medicine. The examiners did not have any reasons to believe they were taking medicine or using drugs prior to polygraph examination.

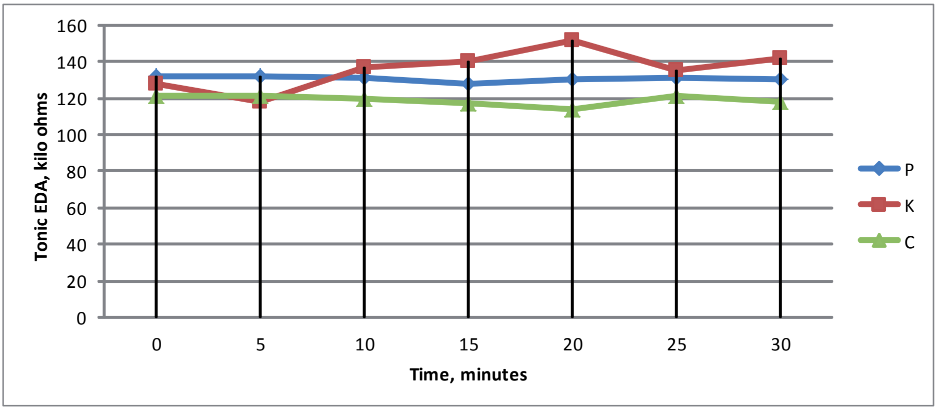

Figure 4. The change of tonic EDA during polygraph examinations (it was determined that the examinees were honest when answering the questions and had not used any psychotropic substances before examination).

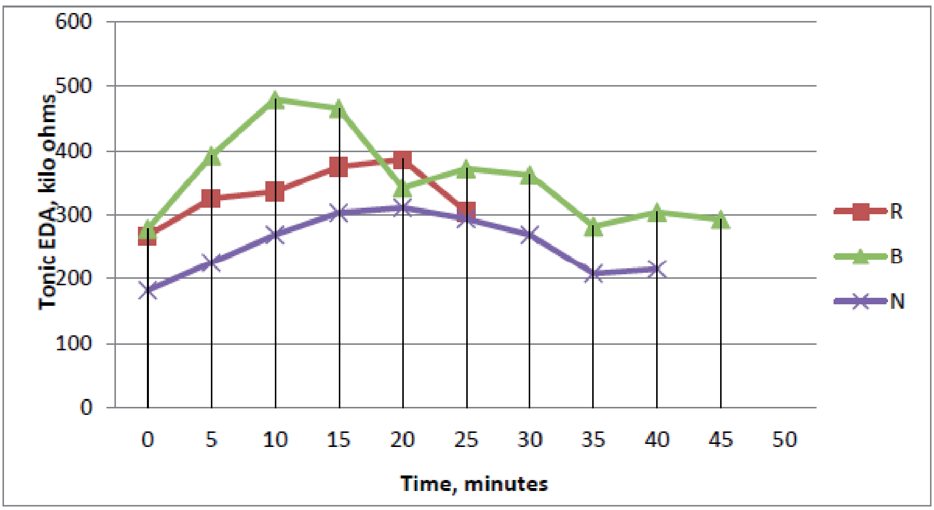

Figure 5. The change of tonic EDA during polygraph examinations (it was determined that these examinees were not honest when answering the questions and, possibly, had used psychoactive preparations before examination).

The change of tonic EDA during polygraph examinations when examinees B, D, R, and N were deceptive is illustrated in Figure 5. Such tonic EDA is not typical of all dishonest examinees. Not unlike Varlamov & Varlamov (2007), we assume that these examinees could be taking medicine prior to the examination, yet this is unknown to us. The subsequent criminal investigation established that all these examinees had committed a crime. Moreover, prior to the examination, none of the examinees admitted to having used psychoactive substances.

Since we are not able to have examinees' blood tested after polygraph examination and identify whether they used psychoactive substances, we added an additional question about the use of such substances to the Event Knowledge Test (EKT) (Saldžiūnas & Kovalenko, 2008a; 2008b; 2008c; 2009a; 2009b; 2009c; 2010; 2012a; 2012b).

Table 1. Additional EKT question for examinee N

How many medication tablets have you consumed today before the polygraph test?			
Answer options to the question presented by the examiner to the examinee		The examinee's answer to the presented answer option	The mark of the recorded psychophysiological response by the examinee
0.	6 tablets	no	
1.	5 tablets	no	
2.	4 tablets	no	Reaction responses
3.	3 tablets	no	
4.	2 tablets	no	
5.	1 tablet	no	
6.	None	yes	Reaction responses

The question and the answer options given to the examinee N are presented in Table 1. The examiner reads the question before the examination. The examinee repeatedly answers the question whether the examinee has consumed any medications (the question is asked during the pre-test interview first). Sometimes the examinee admits to consuming medications for heart (or other) diseases. The examiner explains that medications for heart diseases are not very important for the examination. What is important for the examination are medications with a sedative effect. No one has ever admitted to consuming medications with a sedative effect before the examination in our practice. In one case, the examinee admitted to having smoked some "weed".

The answers of examinee N after the examiner read the answer options during the examination are presented in the third column of Table 1. The examinee's responses following his answers are recorded in the following column based on polygraph charts. This example illustrates that one can assume that examinee N possibly took 4 medication tablets before the examination. The response after answer no. 2 and after answer no. 6 (Saldžiūnas & Kovalenka 2012b) confirms that he might possibly consume medications. If we see that tonic EDA for other examinees does not exceed 300 kohms during the examination, we do not ask the question about the medications taken at the end of the examination.

Figure 5 shows that for most persons the tonic EDA varied during the polygraph examination. We assumed that these persons could have consumed medications containing psychoactive substances before the polygraph examination (Varlamov & Varlamov, 2007). The course of the curves (Figure 5) is different; therefore, it is to be considered that:

- they could have consumed different medications
- each of them consumed different amounts of medications
- it is not known how long before the polygraph examination they took the medications
- each person's body reacts to medications in an individual way.

Regardless of the fact that all the curves follow a consistent pattern: tonic EDA increases after several minutes of the polygraph test. Tonic EDA decreases for examinees B, N, and R after approximately 30 minutes of the polygraph test. Therefore, it can be assumed that they consumed medications shortly before the examination.

Polygraph examiners from Poland and Latvia (Ivančika, 2012) who are familiar with the effect of some medications and drugs on EDA sometimes ask for our assistance. Both of us have noticed that phasic EDA is absolutely uninformative when the examinee's tonic EDA is about 500 kohms.

Discussion

The ideas presented in this article are partially inconsistent with the classical perception of phasic and tonic EDA (Boucsein, 2012; Handler, 2012). Irrespective of Handler's (2012) disagreement with our observations, we believe that they will be interesting for some field examiners.

On the grounds of our observations from practical polygraph tests, it may be claimed that each response must be assessed cautiously as long as the nature of the complex peak of phasic EDA is unknown. We hereby remind that the magnitude of EDA response is assessed with regard to the height of the amplitude and the peak duration (Handler, Nelson, Krapohl, & Honts, 2010). The reasons causing complex peaks must be analysed especially in the Comparison Question Tests (CQT) where EDA responses after the comparison and relevant questions are compared. Unfortunately, when complex responses coincide completely (Figure 2a), it is virtually impossible to assess whether a peak is complex.

Having measured the magnitude of the examinee's tonic EDA before beginning the examination, *ex ante* assumptions on whether the examinee is a drug addict or has consumed medications containing narcotic substances may be made. For the examiners, it may be the first symptom signalling that the examinee wants to distort the results of the test. Based on our experience and that of other examiners (Reid & Inbau, 1977), we may maintain that an honest (non-deceptive during the test) person who would apply no countermeasures during the test is a great rarity. We believe that further laboratory research is necessary to establish more precisely how tonic EDA changes after the examinee has taken certain medications or narcotic substances.

Our latest field examinations revealed that some food supplements can raise tonic EDA to 500 kohms. Experiments are required to explore how food supplements influence tonic EDA, and which ones actually do.

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