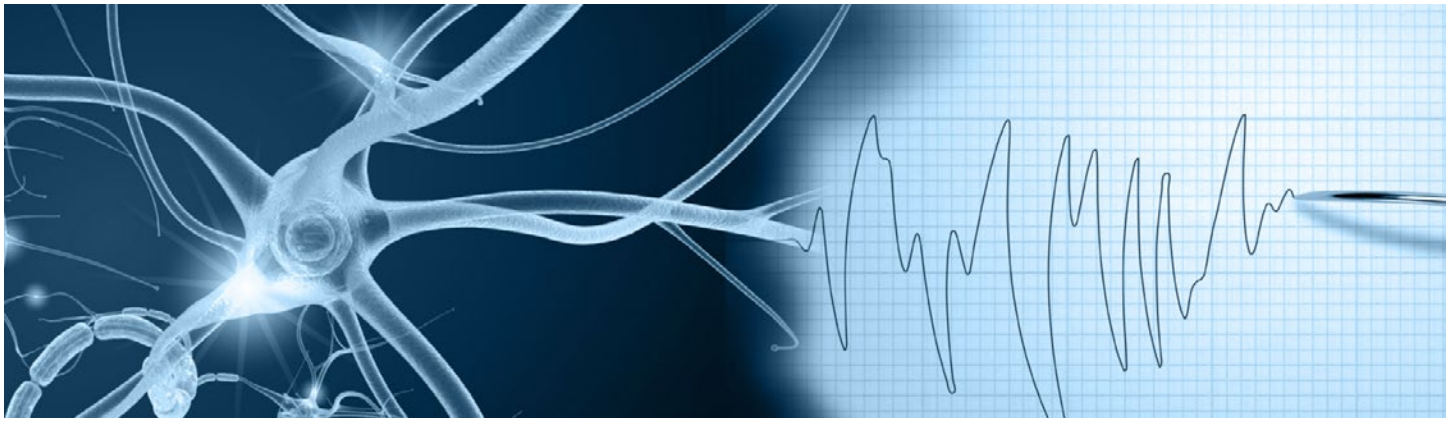


Practical Polygraph: An Enumeration of Electrodermal Artifacts

Raymond Nelson

Among the array of recording sensors and data that make up the computerized polygraph test, none is more important or intuitive than the electrodermal activity (EDA) which refers to variation in the electrical properties of the skin in response to different internal or external stimuli. Rooted in the autonomic nervous system, EDA serves as an indicator of psychological or physiological arousal. Research has consistently showcased the correlation between EDA and emotional, cognitive, and social stimuli. When an individual undergoes emotional or cognitive processes, or external events like stressors, changes occur in the autonomic nervous system. And although EDA is not synonymous with sweating,[1] subtle increases in autonomic activity and EDA can be easily recorded using electrical resistance or conductance units[2]. Fluctuations or changes in EDA are often measured using electrodes typically placed on the fingertips or palmar regions of the hands due to the high concentration of sweat glands in those areas.

Because EDA data, like many forms of data, is observed over periods of time, changes in EDA data can be thought of as change in the strength of information for a range of frequencies. And, although

[1] Sweating refers to the appearance of moisture on the surface of the skin when the layers of the skin are fully saturated. Sweating can be triggered by a variety of factors including high temperatures, physical activity, certain foods, some medications, and other causes.

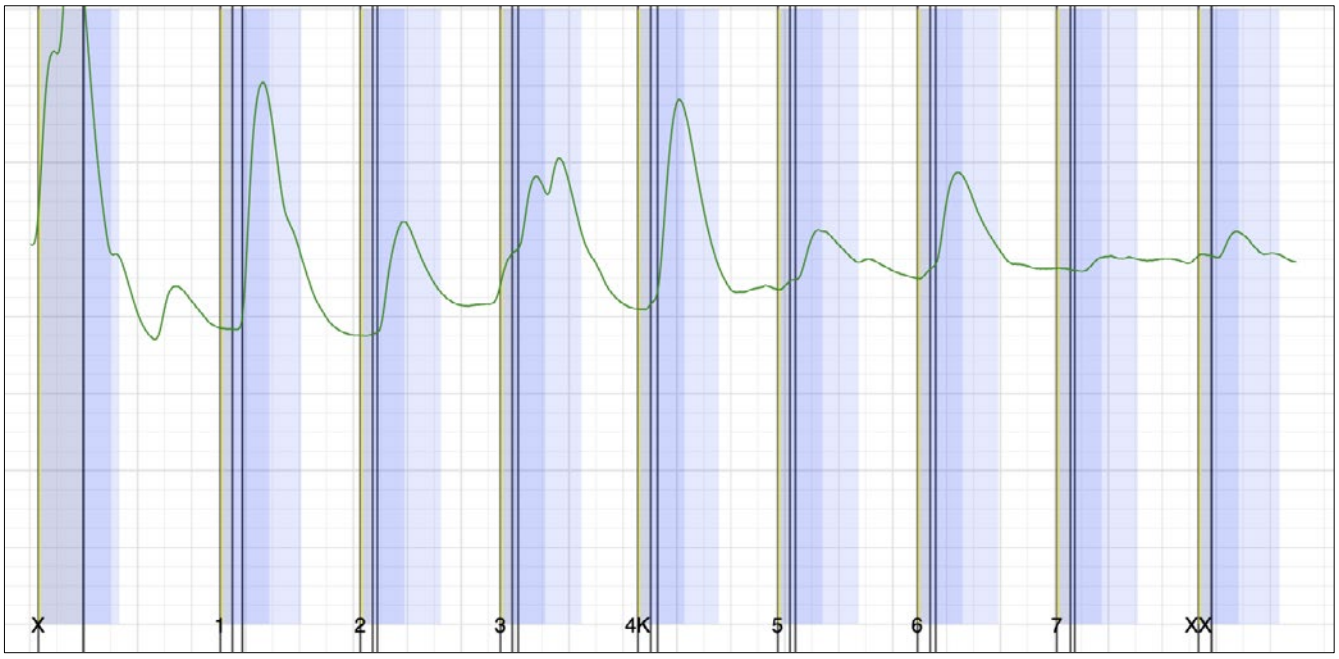
[2] All changes in autonomic activity, including EDA, sweating, and other activity can be thought of as intended to maintain homeostasis and minimize the potential for illness, disease, and death. Homeostasis – a form of balance – itself is not easily observed. However, allostasis and allostatic changes, intended to maintain homeostasis, are more easily observed.

subtle changes cannot be observed directly, observing and extracting subtle changes in EDA becomes much easier when recorded data are graphed in either the time-series or frequency domain. For simplicity, EDA is described as occurring in two forms: the tonic level, which is the baseline level of skin conductance or skin resistance, and the phasic component, which signifies rapid changes conductance or resistance in response to due to specific stimuli.

In the context of polygraph field testing, the collection and recording of usable and interpretable EDA data can have an important impact on whether test results can a level of statistical significance or probabilistic strength that is sufficient to classify a test result as either deceptive or truthful. (Test data of insufficient quality can lead to results that are not statistically significant, and for which the classification may be described as no-opinion or inconclusive.) And while EDA data is fairly robust and easy to interpret[3] it is not without potential complications. All forms of recorded data and all types physiological activity may be subject to characteristic vulnerabilities. In the polygraph context, difficulties with recorded EDA data are referred to as "artifacts," and these are of interest for several reasons, including their potential disruption to strength of correlation between EDA and deception or truth-telling. Some forms of EDA artifacts may be global in that they appear to influence the entirety of the recorded time-series, while other types of artifacts are localized to shorter segments of data.

Prototypical EDA data

Prototypical EDA data will exhibit an obvious tonic baseline along with equally obvious upward deflections in response to test stimuli. There should be little if any upward activity in between the test

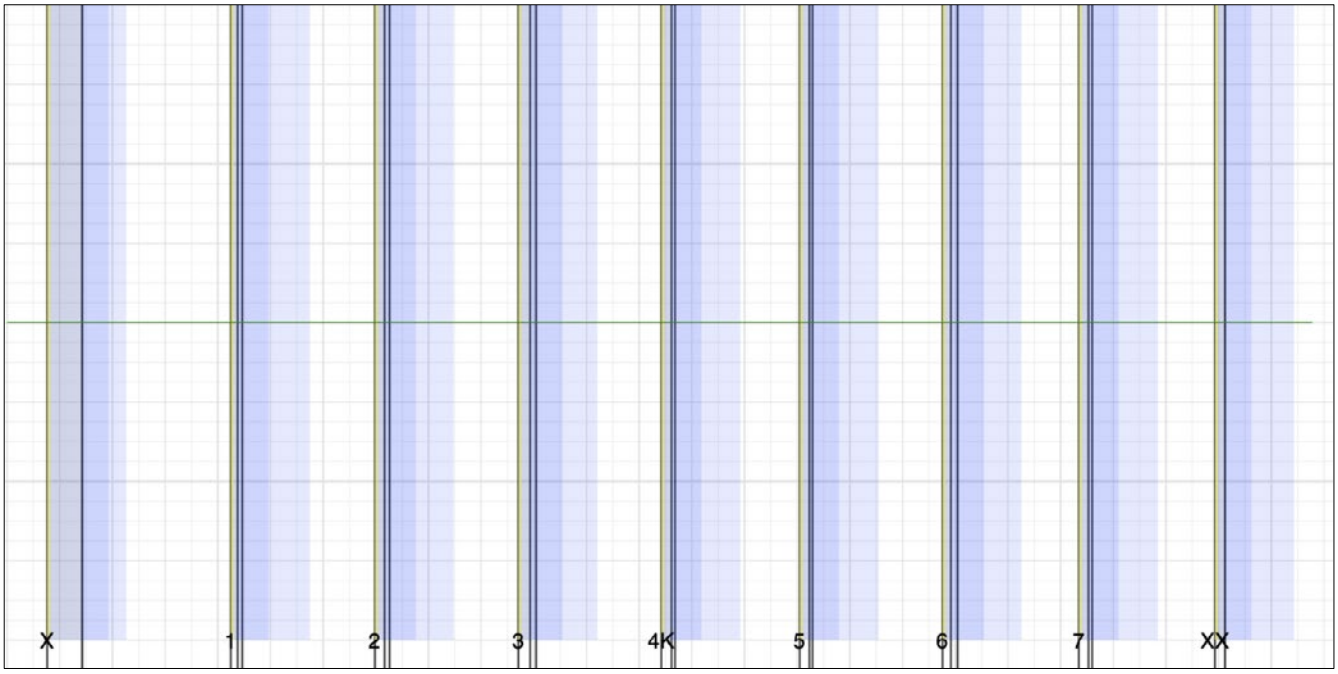


stimuli, and it should be easy to identify the onset and peak of each response.

Flat and unresponsive EDA data

Flat and unresponsive EDA data may indicate a sensor that is not connected or attached correctly to the examinee or the data acquisition system. This could also result from a broken or damaged sensor.

In the example below the condition exists throughout the entire recording, though it is also possible that flat or disconnected segments of EDA data could be localize to only some segments of the recording. Flat or unresponsive EDA data would often result in the halting the recording so that the cause of the problem can be identified and corrected before proceeding.

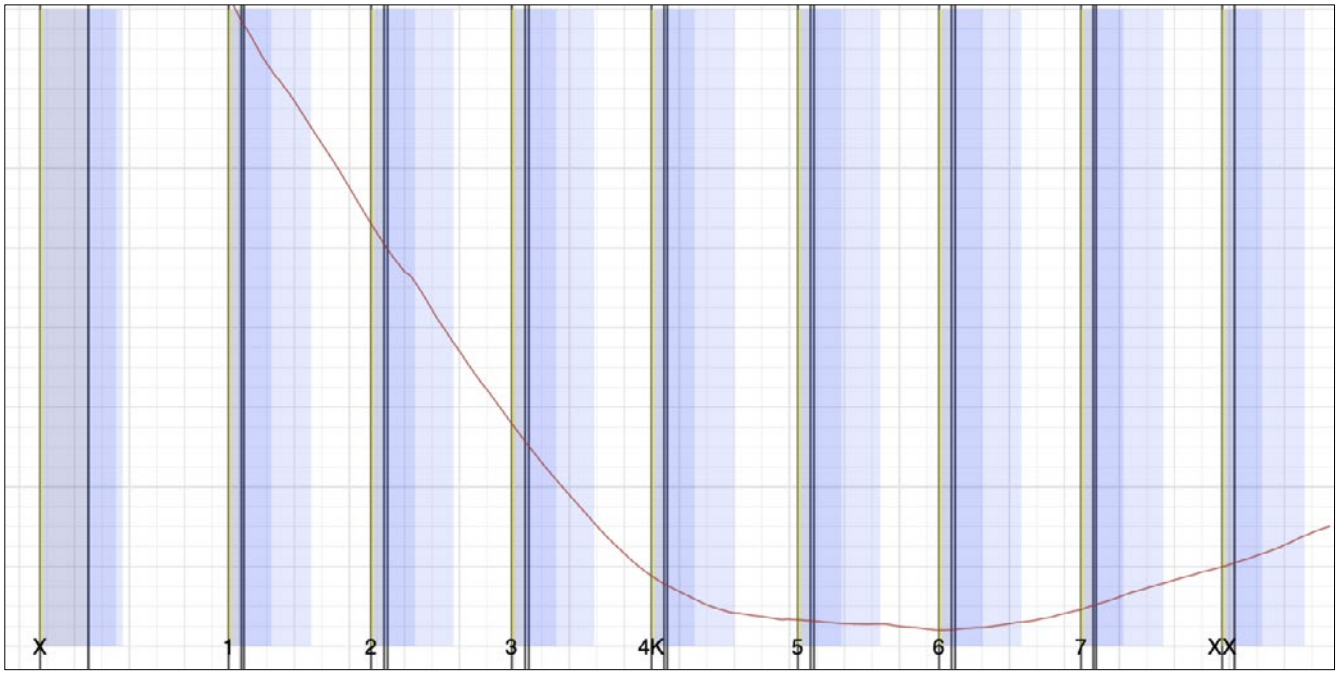


Tonic (low frequency) EDA instability

Tonic (low frequency) instability can be observed in the descending trend of manually centered EDA data below. A less common form of tonic instability is observed as an ascending trend. Tonic EDA data is not used in the interpretation or scoring of field polygraph data, and this condition can often be improved with the

Respiration and cardio data may also be influenced by a variety of factors related to general health and physical condition.

use of a correctly designed auto-centering (high-pass) EDA filter that improve the ratio of the phasic and tonic EDA frequencies. The rather extreme example shown may require the use of specialized filters to reduce the tendency of the tonic information to obscure the phasic information of interest to polygraph examiners.

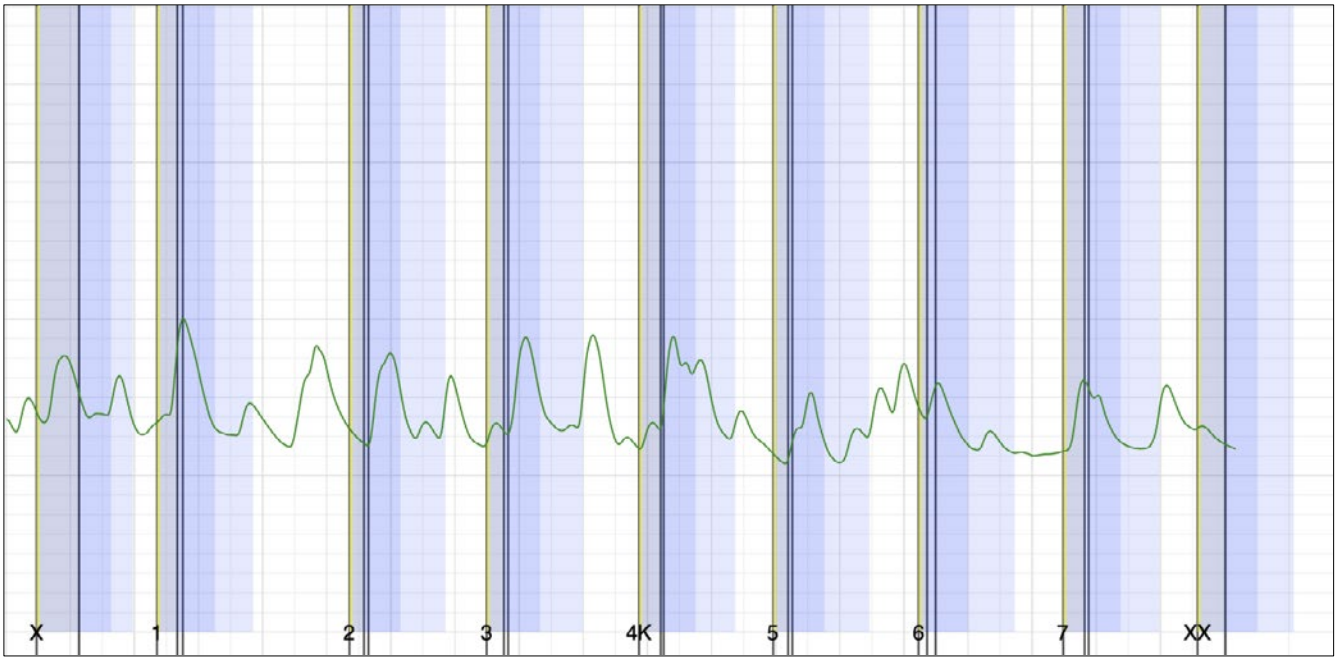


Dampened and under-responsive EDA data

Dampened or under-responsive EDA data can be thought of as a less extreme variant of the tonic instability condition shown above. It is unknown whether the sub-optimal ratio of tonic information (below .03Hz) and higher frequency phasic signals (approximately .03Hz to .2Hz) is the result of strong tonic or weak phasic information. Regardless, of the cause, the usability of this data can sometimes be improved with the use of a correctly designed auto-centering (high-pass) EDA filter. In this example the manually centered EDA data is shown in order to better illustrate the condition.

Labile EDA data

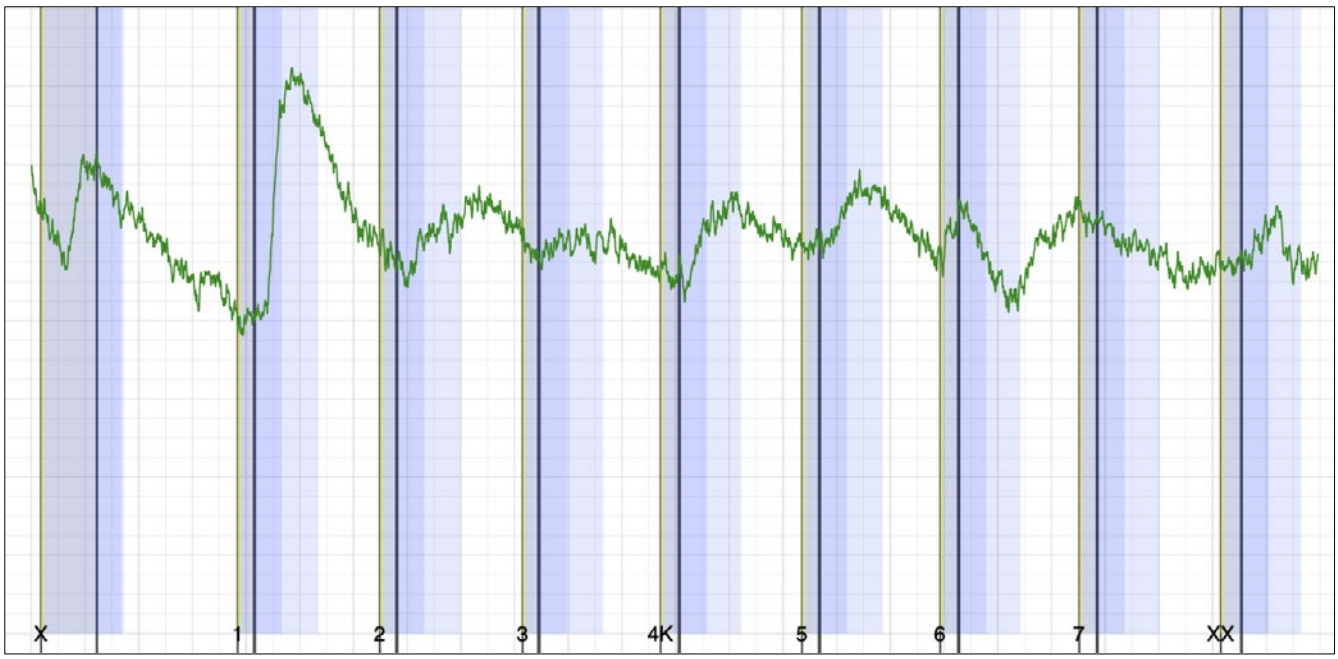
Labile EDA data is characterized by numerous upward deflections that are not associated with the test stimuli and which are often of similar or greater magnitude as response that are timely with the test stimuli. An important aspect of labile EDA is that the observed activity cannot be attributed to any observable environmental cause (e.g., noises or activity in the testing environment). It is sometimes tempting to make attributions such as "anxiety" as a cause for this condition. However, it is incorrect to do this because "anxiety" refers to a collection of different mental health disorders, and EDA data of this type is an insufficient source of information to make a psychiatric or psychological diagnosis. Instead, it is correct to refer descriptively (not causally) to this data as labile.



High frequency EDA noise

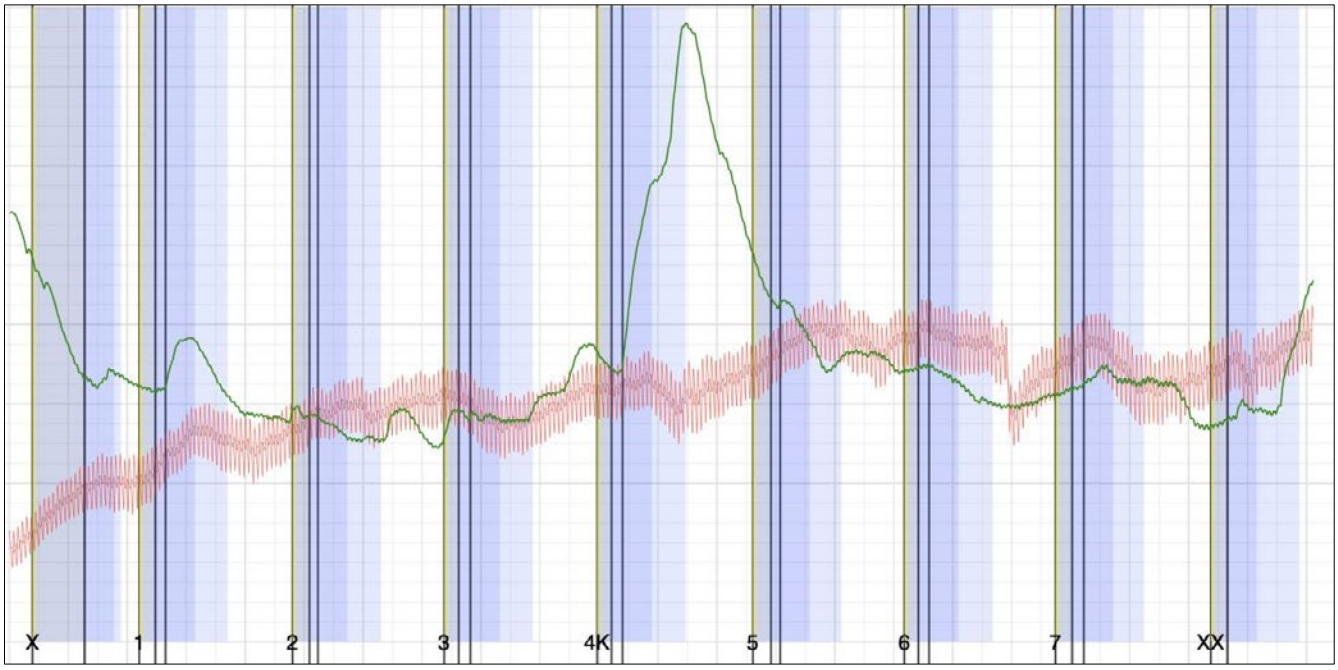
High frequency EDA noise can be observed as a characteristic "fuzziness" superimposed on the tonic and phasic information. Although it may be possible to correct or reduce this condition with correctly designed filters, this problem is sufficiently rare that field polygraph instruments have historically not included that functionality. The exact causes for this condition may be unknown and may include radio electrical or radio frequency interference. It may also be the result of differences in individual physiology. Field examiners who observe this condition may wish to compete a field functionality check to rule out problems with the

recording sensor and data acquisition system. Interestingly, it is sometimes the case, such as in the example shown, that tonic and phasic activity can still be easily identified despite the high frequency EDA noise.



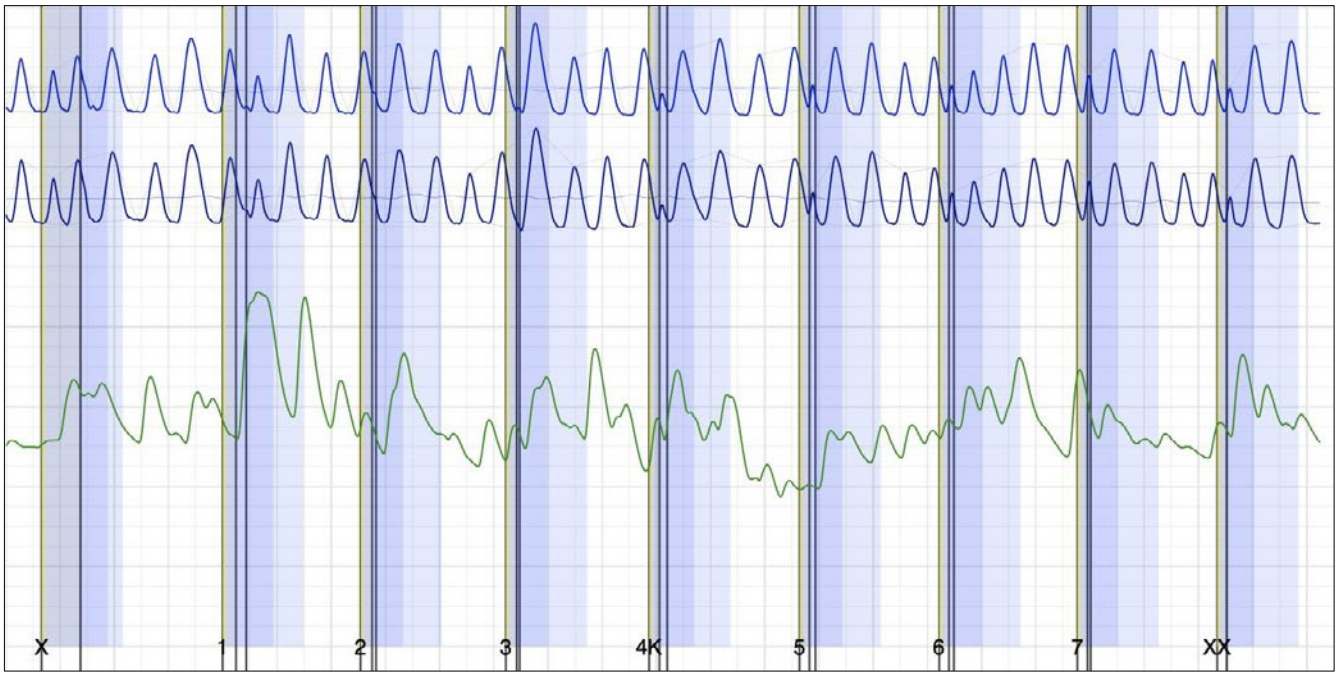
Cardio signal within the EDA data

The cardio signal can sometimes be observed as high frequency EDA noise. Cardio data are shown in the example below so that the similarity of the cardio pulse can be seen. This condition can be easily disregarded or ignored when phasic EDA can be easily distinguished from tonic activity. Interestingly, the cardio pulse frequency is often present in the EDA signal, but at such a low amplitude (relative to the tonic and phasic frequencies) that is cannot be observed without the use of specially designed filters.



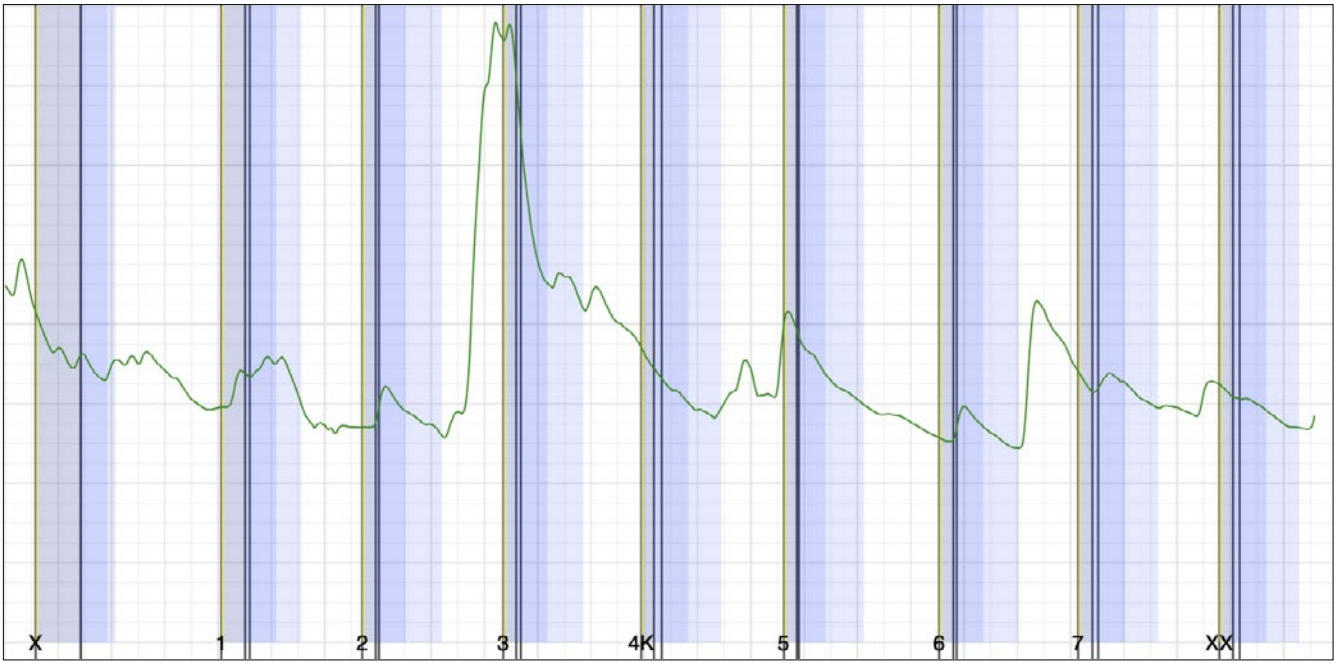
Respiration signal with the EDA data

A respiration signal can also sometimes be easily observed within the EDA data. Respiration signals in the EDA differ from the more general form of EDA lability in that the peak points and low points can be somewhat easily aligned with respiration peak and low points. Like the cardio signal, the respiration signal is very often present though at amplitudes that are not accessible through visual analysis.



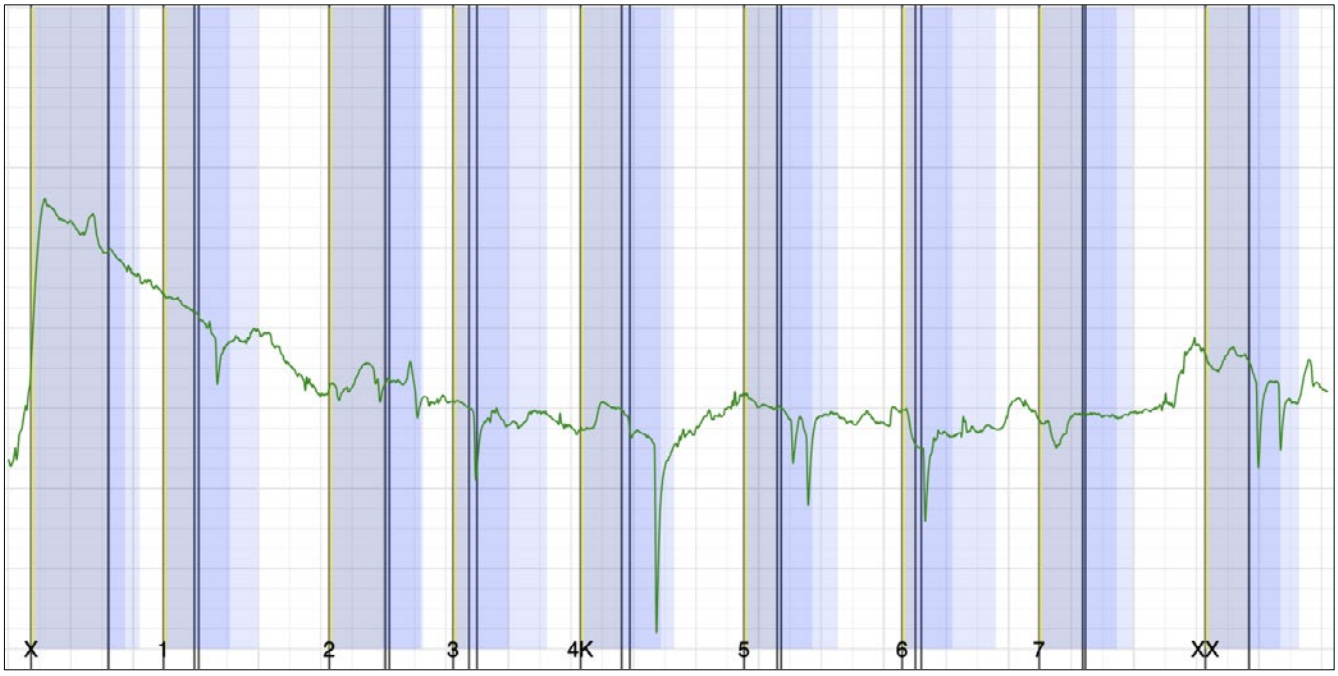
Non-specific physiological activity

Non-specific physiological activity (NSPA) can be observed in several different ways in the chart below. These include large a upward deflection of the EDA data during the normally silent period of time between questions 2 and 3, along with the upward deflection that begins near the end of the 15 second window of evaluation at question 4K. Other examples can also be easily seen, including the upward deflection that starts approximately 1 second before question 5, and the upward deflection that occurs after the end of the 15 seconds window of evaluation for question 6. The common characteristic of each of these examples is that they are not timely with the test stimuli, and therefore cannot be scored or interpreted. Causes for NSPAs are varied, and can include environmental distractions (i.e., noises or activity in the testing room), attentional factors. NSPAs can also result from behavior such as deep breaths or physical movements, though these data are not shown in this example.



Movement artifacts

EDA movement artifacts are observed as a characteristic sudden downward deflection, followed by a very rapid return. These are known to be reproducible via small finger movements that disrupt the electrical contact between of the EDA sensor and the surface of the skin. Metal plate electrodes may be more vulnerable to these artifacts. Another possible cause for these artifacts is a damaged or broken EDA sensors. Field examiners who observe this problem may want to complete a field functionality check to verify that the sensor is functioning correctly.



In summary, while sweating is a physical manifestation that can be visibly observed, EDA is a measure of the electrical changes associated with the activity of sweat glands, reflecting deeper physiological or psychological processes. While EDA data are highly robust and often easy to make use of, there is no form of data that will be completely invulnerable to some types of difficulty. Having an organized understanding of EDA artifacts will help polygraph field practitioners and polygraph researchers to more effectively separate EDA noise from autonomic signals that can be utilized for a variety of purposes, including research, clinical, forensic, and investigative applications.

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