Using Lafayette Electrodermal Modes

By Raymond Nelson

LXSoftware 11.0 includes a substantial improvement to the EDA sensors, and now includes several operating modes: 1) raw unprocessed EDA, 2) Detrended EDA, and 3) Automatic EDA. All modes are completely serviceable with results that will be highly correlated. There is no reason to regard any of the available EDA modes to be unsatisfactory or not suitable for use in field settings. Instead, all Lafayette EDA modes are intended to provide some important advantage to the field examiner. LX Software 11.0 allows the field examiner to view two EDA modes simultaneously, and to change the displayed modes to any desired selection upon review.

An important change to the LXSoftware is the inclusion of universal centering capabilities for the EDA and other recorded sensors. In an effort to ease the transition into the early use of computerized polygraph systems, the user interface was initially designed to reflect the activity and use of an analog polygraph instrument. One example of this is the handling of recorded data. An analog system records data by inscribing ink onto paper. Changes in centering or sensitivity would therefore have no effect on data already recorded, and examiners learned to carefully annotate all adjustments during testing. Computers record data as numerical values and display the data as a plot on a computer screen (which can be later printed). Centering and sensitivity changes during an exam conducted on a computerized polygraph system are not restricted to changing the display of new data. Instead recorded data is just as easily displayed using the new/changed settings at any time during the examination, as often as desired. There is no requirement for annotation, as the entire plot or tracing has been re-drawn instantly many times each second as the polygraph chart is scrolled across the computer screen. As a practical matter, universal centering and sensitivity changes mean that it is now easier than ever before to record polygraph charts of optimal interpretable quality and clarity. Another important change to the LXSoftware is the inclusion of an additional adjustment control for the manual EDA mode, which will be described more fully in subsequent paragraphs.

Electrodermal activity is a complex phenomenon that can be easily recorded with common electronic circuitry. Although the electrodermal sensors in present day and historic polygraph field systems have often been referred to as a measurement of *galvanic skin response* (GSR), there is actually nothing *galvanic* about electrodermal activity in the integumentary system. Galvanic process refers to the production of an electrical current as the result of a chemical reaction within a cell. Obviously, there is no electrical activity that is produced by the attachment of electrodermal sensors to a polygraph examinee. The term GSR therefore reflects an arcane and potentially embarrassing fact about the potential for misuse of scientific terms, and occasional lack of study. Electrodermal activity (EDA) is a more correct and general term, which does not pretend to make assumptions about a finite understanding or absolute knowledge pertaining to the physical cause of a very complex but well known phenomena.

EDA is driven exclusively by the sympathetic portion of the autonomic nervous system, and the EDA of interest to field polygraph examiners is accessible through the eccrine sweat pores that are found in dense concentrations on the hands and feet. Eccrine sweat pores are enervated by acetylcholine and can be thought of as a reflection of cholinergic activity in other areas of the sympathetic nervous system, especially the brain and cerebral cortex, which are also known to be enervated by sympathetic acetylcholine. EDA is ideally recorded on the palms using Ag/AgCl electrodes, though many examiners prefer to use metal plates due to their practical convenience.

Selection of electrode type should be a matter of examiner preference and agency policy, and there is no known loss of test accuracy with any type of electrode.

There exists a wealth of published information that states that the EDA is the most important of all polygraph sensors, responsible for approximately one-half of the final score and result. It is therefore very important that the Lafayette EDA sensors provide the best practical solution and highest quality of data to the field examiner who depends upon good data to produce test optimal and accurate test results. Test results, of course, are the basis for decisions about whether to pursue additional information from an examinee, either in the form of additional investigation after the polygraph or through additional discussion and questioning during the post-test phase immediately following the collection and scoring of the physiological data. While it would be a simple matter to question and scrutinize every examinee whose physiological data is less than perfect, such an approach would have the examiner engaging in all forms of unproductive activity and wasted effort with persons who have no further information to provide, and will ultimately accelerate the volume of ill-will that some members of the community and scientific professions have for the polygraph. With the goal of facilitating the collection of polygraph data of maximum accuracy and utility to field examiners, Lafayette Instrument has developed the optimal solutions for the recording and processing of EDA.

A known phenomena with many examinees is a tendency for the raw unprocessed EDA signal to display a persistent downward trend. This trend has been historically managed through the action of electronic filters that center the data automatically at the tracing arrow. All time-series data can be thought of as a composite of frequencies, and data that display a prominent trend in one direction or another are known to contain a frequency or range of frequencies that are strongly out of proportion with the other frequency ranges. Filtering is intended to correct the proportions and balance of frequency ranges in the signal, making the data more usable to professionals in the field. Because filtering will always cause subtle changes to the data, some examiners prefer to use the manual EDA mode whenever possible. While the manual EDA mode sounds desirable at first glance, like nearly everything in life and in science are a matter of choice and compromise. Unprocessed data will be impaired by disproportionate ranges of certain frequencies, while filtered data will be subject to subtle changes in the data. It will not be a surprise to see occasional differences in some of the discrete numerical scores obtained with different EDA solutions. The overall test results, however, will remain highly correlated for all EDA operating modes with large volumes of data.

Manual EDA

LXSoftware 11.0 includes an improved Manual EDA mode allowing field examiners to view the unprocessed signal. The new software version includes a powerful new adjustment that will improve the usability of Manual EDA data beyond what has ever been available in the past. Like driving a vehicle with a manual transmission, Manual EDA mode will require the greatest amount of attention and management, in the form of centering and adjusting during the examination. To the extent that the raw unprocessed EDA data are not impaired by a strong offending frequency that would cause a prominent trend (usually descending) in the data, the Manual EDA mode may at times make the greatest amount of data available to view and score.

Manual EDA will also display the fastest level of response, and the highest volume of noise within the recorded data. Noise can be high-frequency activity of no interpretable value, or more commonly low frequency activity causing a persistent descending trend in the data. (See Figure 1.) Persistent ascending data are also known, but are much less common. Historically, all EDA modes have included two adjustment settings: centering and sensitivity level. The new adjustment is a simple mathematical slope adjustment to the proportion of downward activity displayed to the examiner. Downward moving EDA is of no interpretable significance to field examiners, and is a feature of evaporation of sweat and re-sorption of acetylcholine. Upward reacting EDA is interpretable as activation of the sympathetic nervous system, from which we can make statistical inferences about the salience of the test stimulus, if we aggregate the measured or observed reactions from multiple iterations or presentations of the test stimuli. The new adjustment to the Manual slope of the EDA is therefore designed to correct only that data which is descending, leaving completely untouched any data indicative of upward movement or sympathetic activation.

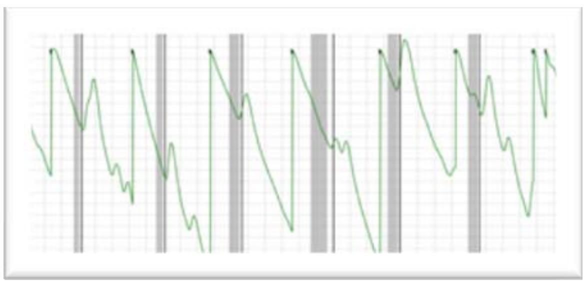

FIGURE 1

Persistent ascending data are also known, but much less common.

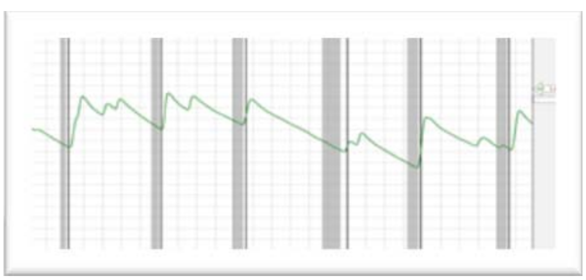

FIGURE 2

Shows the same data after attenuating the descending trend by adjusting the manual slope control.

Note that sympathetic reaction segments (upward activity) are perfectly rendered while using the manual slope adjustment. While the manual slope control will greatly increase the usability of the Manual EDA, some hands-on management of the data will always be necessary when using the Manual EDA mode.

Automatic EDA

LX Software 11.0 includes a new and highly sophisticated automatic filter intended to provide field examiners with a highly responsive and useful EDA solution that is both easy to use and will remain responsive with a vast majority of examinee physiological profiles. Automatic EDA, or filtered EDA, has been included in every polygraph system for many decades. Automatic EDA has been the classical *set-it-and-forget-it* EDA mode for examiners who want to devote as much attention as possible to the examinees behavior during testing. Electronic filters were historically constructed using resistors and capacitors. However, modern engineering can accomplish the exact same objectives using computer software or firmware. Automatic EDA has traditionally been limited to the application of a simple high-pass filter, which removed offending low frequencies which cause some data to descend persistently. The strength of the filter is a matter of engineering and design preference, and the normal solution is to attempt to have the data reentered at the tracing arrow within about 15 to 25 seconds, depending on the characteristics of the data itself. A consequence of this filtering is that complex reactions and reactions of longer duration have tended to become more attenuated and less diagnostic in field settings. Stronger filters, which make the data more visually appealing, more easily interpretable, and more easily managed, will tend to attenuate more of the data. In general, Automatic EDA mode can be expected to retain approximately 90% or more of the raw data. The new automatic mode consists of a low-pass component, intended to remove high-frequency noise, a high-pass component, intended to remove the well-known low-frequency descending EDA noise pattern for some examinees, and an exponential smoothing component, intended to stabilize the overall appearance and improve the interpretability of the signal while preserving maximum responsiveness within the EDA signal.

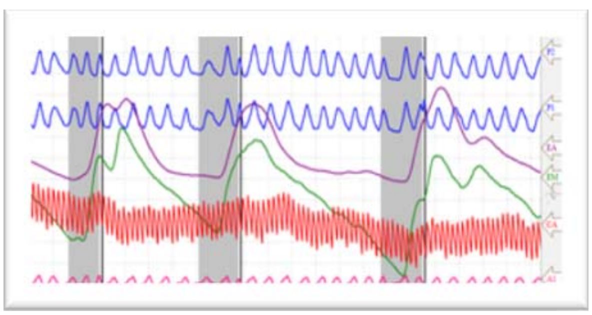

FIGURE 3

Shows an example of Manual EDA with adjustment to the slope, along with Automatic EDA mode.

Detrended EDA

Detrended EDA is a sophisticated mathematical solution to the challenge of providing a completely hands-free or s*et-it-and-forget-it* mode of operation, while preserving the maximum volume of physiological data for interpretation. Detrended EDA mode operates in principle by attenuating all activity below the tracing arrow, and by faithfully recording and displaying all sympathetic reaction segments. Physiological data that are impaired by phenomena such as persistent descending activity are systematically and strategically managed through complex mathematical procedures that result in perfect correspondence between the rendering of sympathetic reaction segments between Detrended EDA mode and Manual EDA modes. Although the Detrended EDA mode will assertively manage most, if not all, unstable EDA there may be some loss of normal (sensory) feedback activity in between stimulus segments. For this reason (loss of *road-feel*), some examiners prefer the Automatic or manual EDA mode over the Detrended EDA mode.

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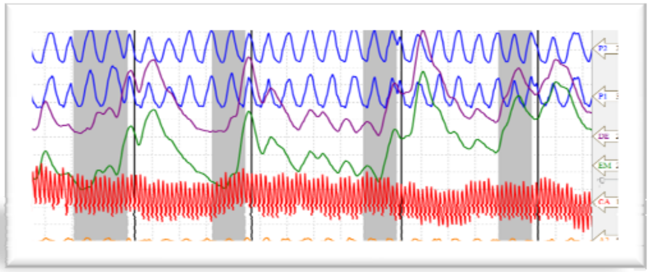

FIGURE 4

Shows the correspondence between the Detrended and Manual EDA modes.

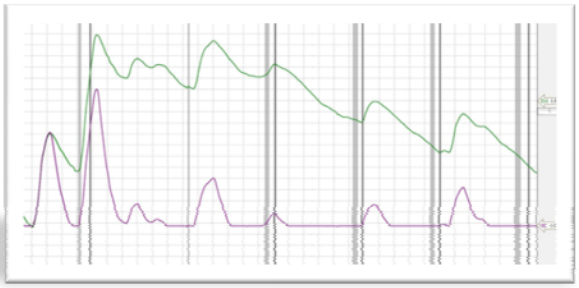

FIGURE 5

Shows the accurate rendering of sympathetic reaction segments for the Detrended and Manual EDA modes on a segment of data that displays a prominent descending pattern.

In summary, all EDA modes have their advantages and disadvantages. Manual EDA is thought to provide the most accurate data (though there is some evidence this assumption may be incorrect), but requires the greatest amount of effort to use. Manual EDA mode may also be unsatisfactory for examinees who display a persistent descending EDA pattern, indicative of prominent low-frequency noise in the signal. Automatic EDA mode can provide the most satisfying user experience with most examinees. Automatic EDA will manage most noisy and descending EDA problems effectively while ensuring maximum responsiveness of the signal interest of data to polygraph examiners. Automatic EDA mode will retain approximately 90% or more of the data, and will attenuate some complex reaction features. There may be occasional differences in discrete numerical scores of Automatic and Manual EDA modes, but the overall results will remain strongly correlated. Detrended EDA mode provides a solution to the need for an accurate rendering of the raw sympathetic reaction segments achieved with the manual EDA mode with the hands-free operation of the automatic mode, though with some loss of the sensation of normal variance (road feedback) when the data is very unstable. None of the electrodermal modes, nor any changes in sensitivity or display settings of actually change the recorded data. Instead, the raw data is always preserved in the electronic file, and changes in settings are processed only for the purpose of display and printing. Selection of an EDA operating mode is entirely a matter of preference for the field examiner or agency.

For further detailed reference on Electrodermal, we invite you to visit our website at www.lafayettepolygraph.com

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And download the following articles:

An EDA Primer for Polygraph Examiners, Understanding and Using Lafayette Electrodermal Modes, and Tech Talk – EDA Filtering and Operating Modes.