Practical Polygraph: Scaling, Offsetting, and Re-centering (Perspectives on the Past and Present) REGULAR FEATURES

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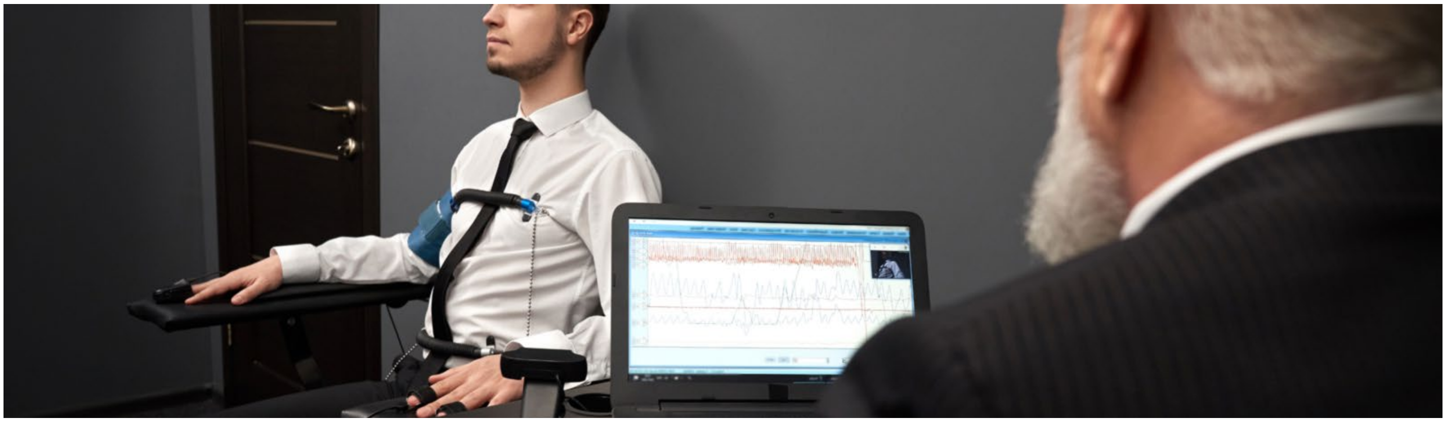

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Polygraph tests today are different from those of the early history of the profession. These differences are not limited to the addition of the electrodermal and abdominal respiration sensors in the mid-century, Nor are they limited to the inclusion of the activity and vasomotor sensors in recent years. Polygraph data itself is different today than it was in the past.

Recorded data in the past were the tracings left on the scrolled chart paper as the ink flowed through the pens by capillary action. Evaluation of polygraph data, beginning with feature extraction, was, in the past, a visible and subjective or intuitive task, because this was the best available technology and methodology before the widespread availability of powerful and inexpensive microcomputers. Inasmuch as much as the general concept of identifying greater changes in physiological activity is descriptive and instructional, reliability of the polygraph was a matter of arduous and exhaustive training, supervision, practice, and quality control – and was still the subject of more than occasional argument. In contrast, evaluation of polygraph data today involves standardized rules and numerical methods intended to increase reliability among different professionals, and can make use of statistical methods to quantify the margins of uncertainty and likelihoods associated with different possible categorical outcomes. Underlying these obvious technological and procedural and analytic differences are technological issues which mean that polygraph data itself is different today than it was in the past.

In the past, the ink-on-paper tracings, that examiners could observe visually, were the actual recorded data. Polygraph examiners were expected to have the skills to clean and service the pens and ink wells in the field, and to do basic maintenance on the mechanical apparatus for the moving pens. Once recorded on the chart paper, the data (ink) were fixed and unalterable. Visual analysis of the recorded tracings was the only way to analyze the data. As a result of the technology at the time, it was a matter of critical skill development that examiners adept at adjusting and optimizing the data in real-time, during the examination. Failure to correctly adjust the size and offset, (location on the y-axis of the chart paper) at the time of examination would mean that data would be forever inadequate. Failure or negligence around data adjustment, during the exam, may have been viewed at times as an ethical consideration. For example, how might it influence the analytic results if an examiner conducted a test with the gain/sensitivity settings set so low that physiological reactions were attenuated to a point that differentiation of responses to different types of test stimuli was not possible?

Polygraph instrumentation today is computerized, with software functions to provide all the adjustments that were accomplished either electronically or mechanically. Lone gone are the days in which polygraph field examiners began each workday by checking ink-pens and filling ink-wells, and ended each workday by cleaning ink stains off their fingertips. Polygraph data today are a time-series of numerical values that are recorded digitally and electronically on the computer media, and are subject to signal processing for display. In reality, there is much more information in the recorded data today than can be observed though the visual methods. For example, digital signal processing methods can extract the pulse information from either the electrodermal or respiration data. Or, respiration information can be extracted from the cardio or electrodermal data. Visual analysis and visual feature extraction, once the most advanced available technology for polygraph data analysis, will inevitably be outperformed by advancing technologies.

Polygraph tracings today are not themselves not the actual recorded data, but are a moving pattern of tiny lights that provide essentially the same visual information. the actual data but are merely a graphic – a picture of the data. Data today is obtained from the physiological sensors and then converted via transducers to electrical values. Data are then amplified, and subject to hardware filtering as necessary (virtually all electronic data devices will have filters to remove unwanted noise associated with 60hz AC current). Electronic signals are submitted to an analog-to-digital converter and then packeted and transmitted from the polygraph device to the computer where the digital information can be transformed again and reassembled as a time series of numerical values that may be subject to (amplification or reduction), interpolation or decimation as needed, in addition to digital signal processing, scaling, and offsetting to a desired aesthetic for the graphic display. Today there is no such thing as raw data. (In fact there was no such thing as raw data for old-time polygraph instruments either, as all data is an abstraction of reality and subject to influence from the technology in use – including filtration from the moving mass and friction of mechanical apparatus.) The graphical images that present day polygraph examiners make use of are not the actual data but are instead a graphical representation or picture of the data.

Computer graphics are highly useful things. They allow us to process a massive amount of information visually – much more information than most professionals could processes numerically in their attention and working memory. Another useful aspect graphics is that they can be re-processed or adjusted and displayed in a different way, without alteration of the actual recorded data. For example, time-series data can be subject to the fast-fourier transform and displayed in the frequency domain. In this way we could graph and analyze the relative strengths of the spectrum of frequencies contained in the recorded data. Other, more mundane example of reprocessing the data for graphic display is that virtually all computerized polygraph systems will include functions to magnify or reduce the size displayed time series data. Computerized polygraph systems also include functions to adjust the offset or y-axis location of the tracings on the computer screen. Magnification, reduction, and offsetting of the recorded data was not possible after the completion of polygraph exams with old-time polygraph systems.

In addition to scaling and offsetting the data display, another form of in-test data management involves a function to re-centering a tracing when the data average had either moved or drifted to a range near the mechanical limits of the pen-stops of old-time polygraph machines. Examiners would simply re-center the tracing at the desired vertical (y-axis) location and mark the recorded test chart accordingly. Because old-time polygraph data was recorded in ink on paper, re-centering events would have no effect on data recorded prior to a re-centering event. Field examiners marked the x-axis (time-scale) location of this operation by putting a downward or upward arrow on the tracing at the x-axis location where the re-centering event was entered. Similar functions have been included in computerized polygraph systems. However, re-centering may be an arcane feature today when considering that computerized polygraph systems can move the y-axis (vertical) location or offset of the entire recorded tracing – including data recorded prior to an adjustment.

Field polygraph examiners in the past were expected to develop the skill to manage the data while refraining from entering re-centering during the question stimulus segments as this would disrupt an ability to interpret the data segment. Equally important, skillful examiners would be expected to learn to refrain from entering gain/sensitivity setting changes within a "spot," which was defined as a pair of relevant and comparison questions that would be analyzed to achieve a numerical score. This is because differences in the gain or sensitivity setting might begin to influence the numerical score. As with offset adjustments, computerized polygraph systems offer capabilities that were impossible in the past, including the ability to adjust the gain/sensitivity size of the displayed graphic from start to finish of the recording, and the ability to do this in real-time while recording the examination data. In interesting thing about gain/sensitivity functions of computerized polygraph systems is that involve only a numerical multiplier or divisor that is applied to the display data. They do not make changes to the actual sensitivity of the sensor itself. Nor do they involve changes to an electronic amplifier. For this reason gain/sensitivity setting functions of computerized polygraph systems may be more correctly described as scaling functions.

Another differences between computerized and older analog polygraphs involves the graphic display space. Computer monitors come in a wide variety of shapes, display ratios, and pixel sizes, and pixel densities. Analog polygraphs also came in a variety of physical sizes, though it was convention to move the scrolled paper chart at 1 inch per 10 seconds. This served to reduce inconsistency in visual perceptions among different examiners who may become accustomed to different instruments. It was however, an arbitrary standard that was not connected in any way with physiological activity or deception. In other words test validity would be unchanged with a different specification. Conventional data adjustment recommendations varied somewhat but generally advised field practitioners to adjust the respiration and cardio data to an average vertical amplitude of ¾ inch to 1 inch, while adjusting the electrodermal activity data so that maximum response amplitudes were between 2 inches to 4 inches. Once again, computers offer the capability to make scaling adjustment after the completion of a test. A potential consequence of this is that younger examiners may not have the same motivation to develop their skills at real-time data management.

Another consequence is occasional discussion about the correct tracing size for computerized data display. In the same way that paper speed is arbitrary and unrelated to physiology, computerized polygraph systems often include some form of horizontal chart division that is arbitrarily determined, and often influenced by the dimensions of the display device. This is inconsequential when considering that the actual numerical values of computerized polygraph systems are as arbitrary and unrelated to any physiological metric as the ink-on-paper tracings of old-time polygraph machines, polygraph data can be interpreted as to the relative magnitude of the change in physiological activity with no known justification for an expectation for linear correspondence between the changes in numerical values changes in physiology. Said differently, when greater responses are observed within recorded polygraph data it can be interpreted as a greater change in physiological activity, but it cannot be expected that a recorded differences of, for example, 2 to 1 is indicative of a similar ratio of change in physiological activity. In other words, the autonomic activity of interest during polygraph testing is not measured in inches or millimeters of polygraph chart paper or computer screen. For this reason, the actual dimensions of the display space are unimportant. When the display space include horizontal scale lines, for visual reference only, they should be thought of as dimension-less or unitless[1].

Modern computerized polygraph systems have no physical or mechanical pen-stops, and may have no limits as to the traditional y-axis limits of a scrolled paper chart. Whereas old-time polygraph machines could not record data beyond the pen-stops or the physical margins of the scrolled paper, computerized polygraphs can easily record data using numerical values that extend well beyond the limits of the computer screen or graphic display. Another interesting feature of computerized polygraph systems is that re-centering events and gain/sensitivity changes for computerized systems are may not, depending on the design of the system, alter the recorded data. Computerized data may also be displayed without re-centering events simply by turning off the display of these events. This can be done without actually deleting these events and without altering the recorded test data. Similarly, computerized polygraph systems can change the displayed offset of the tracings, from start of recording to finish, without altering the recorded data. Because there was no way to move the ink after it was traced onto the scrolled chart paper, re-centering events and gain sensitivity changes with old-time polygraphs could only affect the data recorded after these events were entered.

Another difference between old-time and computer polygraphs is that computer polygraphs can easily include a function to recenter all tracings simultaneously. Although seemingly convenient, moving all tracings simultaneously, regardless of whether it improves the data display, can also begin to introduce visual disarray to the time series data, making it more difficult to visualize and observe what has occurred within the data.

Suggestions for skillful using of scaling, offset and re-centering functions.

- Move the data offset instead of re-centering whenever possible.

- Recenter only to keep the data on-screen and observable

[1] These dimension less units (or unitless dimensions) can be referred to as 'bouts – a humorous device used to illustrate an ancient system of measurement, in use prior to the standardized metric and Imperial systems, when the need for precision and standardization was less than that of today, and when it may have been sufficient to give measurements such as 'bout 2 or 'bout 3 or 'bout 4.

•Recenter only when moving the data is a less desirable solution.

•Recenter individual tracings and only as necessary to keep the data on-screen and visible.

• Refrain from using use the center-all feature between the X and XX announcements.

• Consider not re-centering whenever the data are likely to remain on-screen and visible.

• Wait several seconds (5 or more) or more after re-centering before presenting next stimulus.

• Consider reducing the sensor gain if the EDA data go off-screen repeatedly.

• Adjust the scale size of the respiration data to about 2 or 3 'bouts.

• Adjust the scale size of the cardio data to about 2 or 3 'bouts.

• Electrodermal activity data can be adjusted so larger responses are between 4 to 8 'bouts.

• Adjust the vasomotor data to about 1 to 2 'bouts.

• Activity sensor data can be adjusted to about ½ to 1 'bout.

• Minor adjustment and movement of the data can be performed during the evaluation.

• Consider slightly reducing the scaling size of messing or unstable data to reduce difficulty.

• Consider slightly increasing the scaling size of very stable data to facilitate visual analysis.