PSYCHOPHYSIOLOGICAL DETECTION OF DECEPTION PROGRAM

PSYCHOPHYSIOLOGICAL DETECTION OF DECEPTION ANALYSIS II--COURSE #503

TEST DATA ANALYSIS:
DoDPI Numerical Evaluation Scoring System

August 2006

This page intentionally left blank

TABLE OF CONTENTS

1. INTRODUCTION

1.1. This document introduces you to the DoDPI Numerical Evaluation Scoring System. There are other numerical scoring systems in existence; however, the DoDPI system is the preferred and standardized system of evaluation used throughout the Federal government.

1.2. The information in this document pertains only to manual numerical evaluation of physiological data. You will learn the diagnostic features and decision rules DoDPI uses in evaluating physiological waveforms/tracings obtained by the following three polygraph recording sensors: pneumograph (PN), electrodermal (ED), and cardiovascular (CV) sensor.

1.3. The DoDPI system consists of two numerical evaluation scales; the three- and seven-position scale. Although the three-position scale is more conservative and objective, DoDPI advocates use of the seven-position scale. The seven-position scale has a tendency to reduce the number of No Opinion decisions by allowing an examiner to assign greater values to each recording channel.

1.4. You will initially be introduced to the three-position scale. When you have acquired the requisite proficiency with its usage, you will transition to learning the seven-position scale. The three-position scale is easier to learn than the seven-position scale because there are fewer scoring rules and the range of potential values to assign is less. Some Federal agencies rely principally on the three-position scale, others rely only on the seven-position scale and yet other agencies use both scales situationally. Consequently, DoDPI teaches both evaluation scales.

1.5. The three- and seven-position numerical evaluation scales are technique or format dependent and therefore are not applicable to all testing formats used in psychophysiological detection of deception (PDD) (i.e., Peak-of-Tension Test, Relevant/Irrelevant Screening Test). The evaluation of physiological data pertaining to other testing formats that are not dependent on manual numerical scoring are addressed in other publications and other courses of instruction within the DoDPI Psychophysiological Detection of Deception Program (i.e., PDD 504, Methods I and PDD 505, Methods II).

1.6. It is absolutely critical that you dedicate yourself to mastering test data analysis for peoples' lives may, at times, depend upon it. As you will learn, there may be few lonelier times in an examiner's life than when rendering a decision outcome that is in opposition to the expectation of others. In other words, you are going to routinely make decisions about the veracity of an individual and the decisions you make will, at times, not be what others anticipated.

1.7. There is a direct correlation between the quality and interpretability of the data collected and your ability to defend a decision outcome. You must be able to articulate what decision rules you applied to your analysis and which diagnostic features drove the value you assigned to each analysis spot. Consequently, your data collection goal should be to obtain courtroom quality charts. Irrespective of whether your examination results ever see the light of a courtroom, you need to invest the time to obtain the most interpretable data possible for it will make your data analysis more defensible and will ultimately enable others (i.e., SAC, commander, team leader,

quality control, administrative review boards, etc.) to better understand how you arrived at your decision.

1.8. There is an axiom in PDD and that axiom is as applicable today as when it was first uttered. The axiom is, "Believe in your charts!" A PDD examination under the control of a seasoned and disciplined examiner is a well-orchestrated event from the moment you first greet the examinee until you release him or her. Because examiners systematically approach each examination and consistently apply the respective testing protocol, they gain a calming confidence in the end product. Their data is interpretable, the decision rules are uniformly applied, the diagnostic features are distinguishable and the decision outcome is defensible.

2. CONCEPTS AND TERMINOLOGY

2.1. For a valid PDD examination to exist, respiration, ED, and CV activity must be monitored and recorded.

2.1.1. At least one of the two standard respiration sensors must be operational.

2.1.2. A PDD examination is not invalidated solely because one or two of the systems being monitored lacks diagnostic features.

2.2. A PDD examination consists of four phases: pretest, data collection, test data analysis, and posttest. This pamphlet focuses on the pivotal third phase—test data analysis.

2.3. Test data analysis is the systematic process by which a particular set of scoring and decision rules is applied to the evaluation of diagnostic features and other physiological data resulting in one of three outcome decisions.

2.3.1. In specific issue testing the decision outcomes or diagnostic opinions, as they are sometimes called, are: No Deception Indicated (NDI), Deception Indicated (DI), and No Opinion (NO).

2.3.1.1. The Zone Comparison Test (ZCT) and the Air Force Modified General Question Test (AFMGQT) are two testing formats used in specific issue testing.

2.3.2. In pre-employment testing and in other screening applications the diagnostic opinions are: No Significant Response (NSR), Significant Response (SR), and NO.

2.3.2.1. The Law Enforcement Pre-Employment Test (LEPET), Relevant/Irrelevant (R/I) Screening Test, and the Test for Espionage and Sabotage (TES) are techniques and testing formats used in applicant, tenured employee testing, and in other screening contexts.

2.3.3. The three-position numerical evaluation scale permits a range of only one of three values that may be assigned to an analysis spot. The range is: minus one (-1), zero (0), and plus one (+1).

2.3.4. The seven-position numerical evaluation scale permits a range of seven values that may be assigned to an analysis spot. The range is: minus three (-3), minus two (-2), minus one (-1), zero (0), plus one (+1), plus two (+2), and plus three (+3). When using the seven-position scale, a minus three (-3) is considered less than a minus two (-2) and a plus three (+3) is greater than a plus two (+2).

2.3.5. The standard unit of measurement is a vertical chart division, with a grid setting of one-quarter inch, appearing either on a computer screen or paper chart.

2.3.5.1. Changing grid settings from one-quarter inch to some other measurement standard can impact the assignment of weighted values under some very specific conditions (i.e., something-versus-nothing principle).

2.4. There are some very important terms and definitions that you need to become intimately familiar with in order to better understand the concepts and discussion that follows in this text. The remainder of this section is dedicated to an introduction of these terms and concepts. Refer to Appendix H, in the back of this pamphlet, for additional terms and further clarification of terminology.

2.4.1. Analysis Spot. An analysis spot refers to the specific location, or applicable relevant question on a chart where the spot analysis concept is applied.

2.4.1.1. Analysis spots are technique and format dependent. For example, in the traditional ZCT format, there are three analysis spots, which are relevant questions 5, 7, and 10. In Version 2 of the four relevant question AFMGQT format, there are four analysis spots, which are relevant questions 4, 5, 7, and 8. In the TES format, there are three sets of two relevant question pairings or six relevant question analysis spots comprising each Sub-test (i.e., Sub-test A: 1R1-1R2, 2R1-2R2, & 3R1-3R2).

2.4.2. Artifact. An artifact is the cause for a change in the examinee's physiological data that is not attributable to an applied stimulus or recovery (i.e., movement, sensor slippage).

2.4.3. Channel. A channel refers to any one of the four sensor inputs used to monitor and record activity of the respiration, ED, and CV systems. The term channel and component are used interchangeably.

2.4.4. Comparison Question. A question or group of questions that are used for direct comparison against the applicable relevant question(s). The probable-lie and directed-lie are the two types of comparison questions utilized in the Federal government.

2.4.4.1. When using the probable-lie comparison (PLC) technique, comparison questions are similar in nature to the matter under investigation but sufficiently distanced from the relevant issue by time (i.e., Prior to 2005, . . .), place (i.e., Before arriving in the United States, . . .), or category (i.e., Have you ever stolen *private* property?). Comparison questions that attempt to achieve a clear line of demarcation from events surrounding the relevant issue, by using time, place, or category separation are called exclusionary comparison questions.

2.4.4.2. Comparison questions that use the directed lie comparison (DLC) technique, explore minor transgressions that most people will readily admit to having engaged in at sometime in their lifetime. However, these questions traditionally do not seek time, place, or the traditional category separation from the relevant question (i.e., Have you ever said something that you later regretted?).

2.4.5. Comparison Question Technique. Refers to a family of testing formats whereby values are assigned to various analysis spots based upon comparisons between relevant and comparison questions. The two types of comparison questions that are principally used in the Federal government are the PLC question and the DLC question. The ZCT and AFMGQT employ the comparison question technique; however, the formats (structure) are different yet they both use PLC questions. The TES also employs the comparison question technique; however, its format is unique and it uses DLC questions.

2.4.6. Comparison Question Theory. Theory that predicts differential arousal between relevant and comparison question pairings. The theory essentially holds that non-deceptive examinees will meet a predetermined numerical threshold, based upon the technique and format selected, on the positive side of zero. Deceptive examinee's will reach a predetermined numerical threshold on the negative side of zero.

2.4.6.1. When a testing format permits use of multiple comparison questions for evaluation against a relevant question analysis spot (i.e., TES format), utilize the comparison question exhibiting the most significant response. In other words, each question pairing involves an independent analysis, channel-by-channel. It is permissible to use the ED channel from one comparison question and the CV channel from another comparison question for evaluation against a relevant question in the same analysis spot. It is also acceptable to use the upper respiration waveform from one comparison question and the lower respiration from an adjacent comparison question for evaluation against the relevant question in the same analysis spot.

2.4.7. Diagnostic Features. The physiological phenomena used in the numerical evaluation of PDD test data. Examiners use the term feature(s) and criteria/criterion interchangeably.

2.4.8. Homeostasis. Refers to a complex interactive regulatory system by which the body strives to maintain a state of internal equilibrium. Being able to recognize an examinee's homeostatic signature, for each of the recording systems being monitored and recorded, is truly essential to effective test data analysis. Examiners often use the following terms interchangeably with homeostasis: physiological norm, pre-stimulus baseline, resting state, and tonic level.

2.4.9. Latency. Refers to the period of time between stimulus onset and response onset. Any physiological response that begins following stimulus onset is said to display response latency. Response latency, depending upon its consistency, may enable an otherwise untimely response to be evaluated. Pronounced latency may be seen in all recording channels or in just one. An effective method for assessing response latency is to look holistically at all of the physiological data collected, channel-by-channel.

2.4.10. Question String. Refers to all of the questions posed to an examinee between test commencement and test termination.

2.4.11. Relevant Question. A question that pertains directly to the matter under investigation or issue that generated the request for PDD support (i.e., Did you steal any of those missing classified documents?") The serial positioning of the relevant questions, in a question string, defines the applicable analysis spots for the testing format involved. Refer to PDD Course 502, Analysis I, Test Question Construction, for a more comprehension discussion on question typologies and their use in specific issue PDD testing.

2.4.12. Response Onset Window. Refers to the typical time period, from stimulus onset, where we would predict a physiological response to occur in order for that response to be deemed timely.

2.4.13. Serial Position. Refers to the specific location of a question within a question string.

2.4.14. Spot Analysis. Spot analysis is a fundamental concept for assigning weighted values, by individual recording channel, based upon comparisons between a relevant question and the applicable comparison question(s). The TDA decision rules for a particular testing format, dictate which relevant and comparison question(s) to use for analysis.

2.4.15. Waveform. The term waveform and tracing are used interchangeably and refers to the particular visual representation of the physiological data that is studied for its diagnostic value.

3.0. GENERAL EVALUATION CONSIDERATIONS

3.1. The DoDPI Numerical Evaluation Scoring System utilizes eight primary diagnostic features and three secondary considerations in evaluating physiological data obtained through a polygraph.

3.2. A positive value (i.e., +1) is assigned to an analysis spot if the physiological response is more significant at the applicable comparison question than at the relevant question.

3.3. A negative value (i.e., -1) is assigned to an analysis spot if the physiological response is more significant at the relevant question than at the comparison question(s).

3.4. Zero scores are assigned when there is either no response to either the relevant or applicable comparison question(s) or the difference is indiscernible.

3.4.1. Assign a value of zero with a line through it (Ø) if any recording channel is unable to be evaluated due to an artifact or other excessive noise.

3.5. There are preliminary steps you should consider before assigning values to particular question parings or an analysis spot.

3.5.1. One of the most crucial steps in beginning your analysis process is to make a holistic or global assessment of all the physiological data collected. Understanding an examinee's stereotypy is extremely important because examinees often display trends in the physiological data displayed. Look for trends and note deviations from them in order to better perform your data analysis.

3.5.1.1. Consider the following: Some examinees tend to be one-channel dominant. Other examinees present answering artifacts in the PN channel. Some examinees' answering artifacts have a propensity to affect other channels while others do not. Some examinees respond at stimulus onset while others have more pronounced latencies and yet others may prove relatively devoid of response in one or more recording channels. These idiosyncratic characteristics, and many others, impact your data analysis.

3.5.1.2. Determine the examinee's physiological resting state, or homeostasis, for each recording channel. You will get a good sense for this by globally evaluating the data collected on each chart. Ideally, homeostasis should exist in each channel prior to stimulus onset. However, there are exceptions for evaluating each channel even in the event homeostasis was not present at stimulus onset.

3.5.2. Determine if an artifact or excessive noise impacted the evaluation of an analysis spot. The decision rules for the testing technique and format employed will dictate the applicable questions and channels to use for comparison purposes.

3.5.2.1. Excessive noise on a signal of interest is inherently problematic and might be an artifact, lingering response stemming from a previously applied stimulus, recovery, or product of a highly unstable baseline.

3.5.2.2. If an artifact or excessive noise affects each of the recording channels of an analysis spot, do not use that spot for evaluation.

3.5.2.2.1. If the testing format permits use of either of two comparison questions against a relevant question analysis spot (i.e., TES), and one of those two comparison questions is unable to be evaluated, then you must use the other comparison question for evaluation.

3.5.2.3. If an artifact affects two of three recording systems, do not use that analysis spot for evaluation.

3.5.2.4. Particular attention should be made to any artifact that impacts the respiration channel. The respiration channel has a tendency to influence other recording channels. As Holmes et al. (1980) and others (Sroufe, 1971; Leavenson, 1979; Obrist, 1981) have pointed out, alterations in either the depth or rate of breathing is a source of variance in heart rate and heart rate control. Because of this phenomenon, you will hear examiners refer to the PN channel as "the effector."

3.5.2.5. A significant artifact (i.e., an extremely deep breath or extended yawn) affecting the PN channel will almost certainly render other channels non-scoreable.

3.6. Response timeliness is a critical data analysis consideration. There are defined time windows for each recording channel (pronounced latency exceptions exist) in which we would predict an examinee to begin to manifest some physiological response to the question (stimulus) presented. Responses commencing beyond the standard time windows become suspect unless the examinee consistently responds in that manner. This time window is referred to as the response onset window.

3.6.1. The response onset window for each respiration channel, of which there are two, is from stimulus onset to one complete respiration cycle past the examinee's answer.

3.6.2. The response onset window for the ED and CV channel is from stimulus onset to the examinee's answer.

3.7. One of the difficulties during data analysis is determining when a legitimate physiological response begins and when recovery begins. This line of demarcation may be unclear because, at times, there is a transition period that occurs between response and full recovery and you may not know how much residual response existed during the transition to full recovery.

3.7.1. Generally, ED and CV response ends when the waveform either returns to the pre-stimulus level (assuming homeostasis existed) or has sufficiently stabilized at a new tonic level. Respiratory response typically ends when recovery begins to reestablish homeostasis.

3.8. When you have completed your global assessment, identified idiosyncratic trends and deviations from those trends and have a good sense for the authenticity of the data, the decision rules can be applied to the specific testing technique and format you have employed.

3.8.1. To apply the scoring rules for the particular testing technique or format, you must know the decision rules and which diagnostic features to assess within each channel.

3.9. Respiratory Features. There are six diagnostic features used in evaluation of the respiration channel. Five of these features involve some form of suppression or slowing of the respiratory rate. The features are:

3.9.1. Apnea-blocking (suppression)

3.9.2. Decrease in amplitude (suppression)

3.9.3. Progressive decrease in amplitude (suppression)

3.9.4. Decrease in rate

3.9.5. Inhalation/Exhalation (I/E) ratio change

3.9.6. Temporary increase in baseline

3.10. <u>Electrodermal Features</u>. There are three diagnostic features used in the evaluation of the ED channel. Two of these features are secondary features that are only considered in certain instances. The features are:

3.10.1. Amplitude

3.10.2. Complex Response (secondary)

3.10.3. Duration (secondary)

3.11. <u>Cardiovascular Features</u>. There are two diagnostic features used in evaluation of the CV channel. One of these diagnostic features is a secondary feature.

3.11.1 Phasic response (baseline arousal) is the primary diagnostic feature used in evaluating the CV channel. A phasic response is defined as a short-term change in physiological activity following question presentation. Typically, this response has a relatively rapid onset and may return to the pre-stimulus baseline or establish a new baseline within a period characteristic of the response system.

3.11.2. Duration is a secondary CV waveform diagnostic feature considered in certain instances.

4.0. RESPIRATION WAVEFORM

"Breathing is truly a strange phenomenon of life, caught midway between the conscious and unconscious."
Richards, D.W., Jr., 1953

4.1. <u>Anatomy and Physiology</u>. The respiratory system consists of the lungs, the conducting airways, parts of the central nervous system concerned with the control of the muscles of respiration, and the chest wall (Levitzky, 1986).

4.2. The lungs occupy most of the thoracic cavity. They are elastic structures and their elasticity helps with breathing movements (Bevan, 1996). According to Bevan, the main muscles for breathing are the diaphragm and the intercostals muscles. During normal breathing (eupnea) the diaphragm is the more dominate of the two muscles (Bevan, 1996).

4.3. The main functions of the respiratory system are: (1) to obtain oxygen from the environment and to supply it to the cells of the body; and (2) to remove carbon dioxide from the body produced by cellular metabolism (Comroe, 1974). The brain and heart collectively comprise less than 3% of total body weight but account for over 30% of oxygen usage (West, 1985).

4.4. The respiration waveform that is monitored reflects either pulmonary ventilation (which actually facilitates respiration), or the mechanics of a person's breathing, that is obtained through

the PN sensor of a polygraph. Traditionally, whether viewing a computer screen or a printed PDD chart, the upper two waveforms/tracings are representative of the examinee's breathing.

4.4.1. The respiratory waveform consists of inspiration (taking in of outside air) and expiration (removal of air carrying waste products) cycles which are more commonly referred to as inhalation and exhalation (I&E) cycles. Bevan (1996) states that during inspiration, the diaphragm contracts and becomes flatter than the rib cage. This expansion causes the volume of the thorax to increase causing air to be drawn into the lungs. Expiration occurs passively by the natural elasticity of the lung tissue and is a relatively effortless movement. The intercostal and abdominal muscles can produce more forceful or active expiration.

4.5. Many things impact an examinee's breathing pattern—some may be naturally occurring (i.e., athleticism, age, & disease), while others may be forced (i.e., excessive deep breath). Most people display a resting respiration rate or breathing pattern of between 12 to 18 breaths per minute (Tobin et al, 1988 & J. Reicherter, personal communication, September 6, 2002).

4.6. An examiner is only concerned with within-subject comparisons and not with between-subject comparisons. Use the term normal breathing (eupnea) to refer only to the examinee being tested. Examinees that present a relatively fast respiration pattern (tachypnea) or a very slow respiration pattern (bradypnea) may actually be displaying a true representation of their normal breathing pattern. There are techniques that will be taught to enable you to gauge whether examinees are attempting to thwart the PDD examination process by deliberately manipulating the mechanics of their breathing.

4.6.1. Particular attention should be given to a person's breathing pattern because, of the physiological systems that are currently monitored, it is the respiration system over which an examinee exercises the greatest degree of control (Abrams, 1989).

4.7. Homeostasis Considerations. Ideally, before stimulus onset, the examinee should present a respiration waveform that is in homeostasis. Generally, if homeostasis does not exist at stimulus onset, the applicable spot will not be used for evaluation.

4.7.1. There are occasions where the stimulus is applied prematurely yet the comparative spot may be evaluated. This occurs when the waveform returns to homeostasis during the response onset window with subsequent response or remains in homeostasis beyond the ROW. The following illustration (Figure F.1) depicts an example where evaluation is permitted despite a lack of homeostasis at stimulus onset.

Figure F.1. Homeostasis Exception
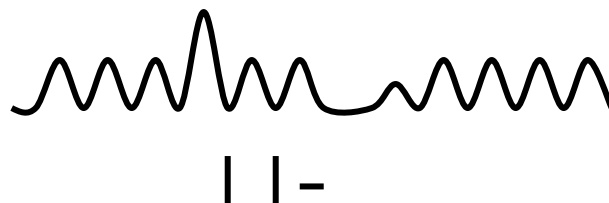
4.8. During the data collection phase of an examination, the examiner attaches two sensors to the examinee to record and monitor the examinee's respiration system.

4.8.1. Typically, the PN chest assembly consists of a convoluted tube, return mechanism (i.e., spring or rubber band), anti-roll bars, beaded chain or Velcro fastener strips and rubber tubing for connection to the computer sensor box or analog instrument.

4.8.2. Although the two sensors collect data from different parts of the examinee's upper torso, the data they obtain often mirrors each other. However, because some examinees are either predominately thoracic or abdominal breathers and because those two areas of the body are subject to different nerve (i.e., intercostals and phrenic) innervations, we are able to capture any differentiation should it occur by using two sensors.

4.8.2.1. Place one sensor over the examinee's upper chest (thoracic area) and the other over the diaphragm. Be sure you obtain adequate separation between sensor placement.

4.9. Obtain a waveform or tracing amplitude of between one-half inch and one-inch (three-quarter inch is ideal), irrespective of grid setting, prior to going into actual operation.

4.10. <u>Respiration Line Length (RLL)</u>. Howard Timm (1981) is credited with advancing the concept of RLL. Respiration line length refers to the linear measurement of a waveform over a specified period of time. It is the primary diagnostic measure used in evaluation of the respiration waveform. DoDPI adopted the RLL concept with some modifications to the manner in which Timm and others (Kircher et al, 1988) employed it. Krapohl (2001) states that the use of RLL reduces reliance on signature and pattern recognition. Moreover, it provides an objective means of evaluation because all respiration waveforms share one commonality—a line length

4.10.1. <u>RLL Features</u>. Five of the six diagnostic features applicable to evaluation of the respiration waveform invoke the RLL evaluation methodology.

4.10.1.1. The five diagnostic features pertaining to RLL are as follows: (1) apnea—blocking (suppression), (2) decrease in amplitude (suppression), (3) progressive decrease in amplitude (suppression), (4) decrease in cyclic rate, and (5) inhalation/exhalation (I/E) ratio change.

4.11. There are provisions to evaluate the respiration channel when none of the RLL diagnostic features are present at either the relevant question analysis spot or applicable comparison question(s). This is where signature recognition and pattern matching become important.

4.11.1. <u>Non-RLL Feature</u>. The one non-RLL feature that research indicates is diagnostic in detection of deception is temporary increase in baseline.

4.12. This section will discuss the six respiration phenomena or diagnostic features used to evaluate PDD data and provide a representative signature of each feature.

4.12.1. Apnea. Refers to a temporary cessation of the respiratory cycle. Some forms of apnea are considered diagnostic of deception while others are not.

4.12.1.1. If the temporary cessation of breathing (apnea) occurs at or toward the very end of the expiration cycle, it is defined as blocking and is diagnostic of deception (Figure F.2). When apnea occurs at the top of the inspiration cycle, it is not considered diagnostic but is more likely behavioral in origin. Apnea is considered the ultimate manifestation of respiratory suppression.

Figure F.2. Apnea – Blocking

4.12.2. Rate Changes. Diagnostic respiratory rate changes are exhibited in the form of a decrease in cyclic rate relative to an examinee's homeostasis (Figure F.3). This change may also take the form of a change in the inhalation/exhalation (I&E) ratio (Figure F.4, pg 16), where there is a more protracted exhalation cycle than what occurs during homeostasis. Assessing rate changes involves a three-way comparison between what transpired at the relevant question, comparison question(s), and over the course of data collection. This is sometimes referred to as the waveform/tracing average.

Figure F.3. Decrease in Cyclic Rate
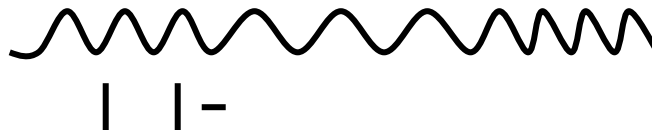


Figure F.4. Change in Inhalation/Exhalation Ratio
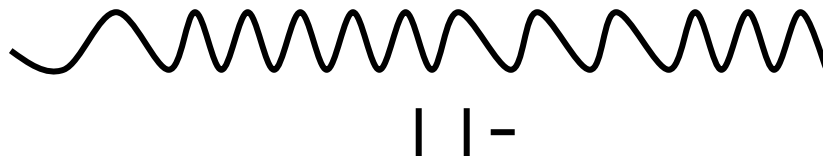
4.12.3. Amplitude Changes. Changes in amplitude may be exhibited in the following forms: (1) decrease in amplitude (suppression) (Figure F.5), or (2) progressive decrease in amplitude (suppression) (Figure F.6). The waveform/tracing average is defined as the average respiratory amplitude for a given chart.

**Figure F.5. Decrease in Amplitude (Suppression)**

Figure F.6. Progressive Decrease in Amplitude (Suppression)
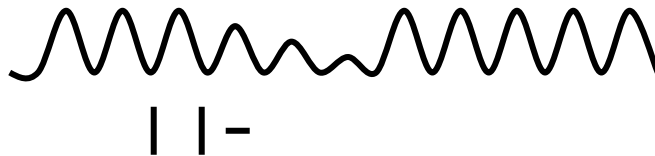
4.12.4. <u>Temporary Baseline Change</u>. Not all baseline changes are diagnostic of deception. For example, a permanent baseline change is not diagnostic of deception and is believed to be more a by-product of behavior (i.e. sensor slippage) than physiology. Also, research has shown that a temporary decrease in baseline is not diagnostic.

4.12.4.1. A temporary increase in baseline (Figure F.7) is considered diagnostic of deception. A temporary increase in baseline is said to occur when the amplitude of the respiration cycle troughs, representing the point of maximum exhalation, temporarily increases relative to the homeostatic or pre-stimulus tonic level.

Figure F.7. Temporary Increase in Baseline
(Trough temporarily increases relative to homeostasis)
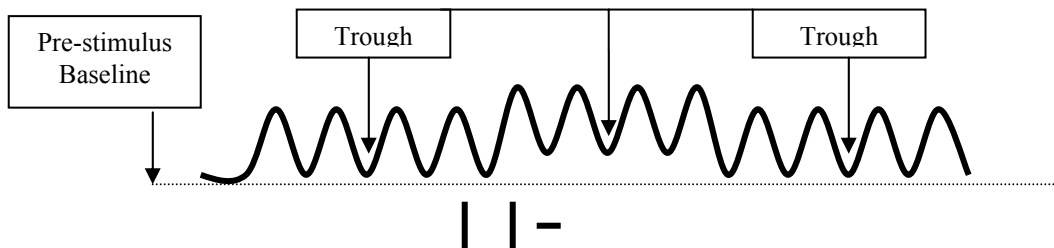
4.13. <u>One-Cycle-of-Something-is-Nothing Principle</u>. When assigning values to the respiratory waveform, you typically want to see some response patterning or consistency. Consequently, when you observe only a one-cycle deviation from homeostasis, that deviation is suspect and therefore there is reluctance to assign any value to it.

4.14. <u>Three-Position Numerical Evaluation Scale.</u>

4.14.1. When using the three-position numerical evaluation scale, only one of three values may be assigned to an analysis spot (i.e., -1, 0, +1). If any recording channel or analysis

spot is unable to be evaluated for any reason, assign a value of zero and place a line through the number **(Ø)**.

4.14.2. <u>Employing RLL</u>. Use the RLL evaluation method when an analysis spot or the applicable comparison question(s) exhibits any form of suppression (e.g., decrease in amplitude or apnea-blocking) or decrease in cyclic rate relative to homeostasis.

4.14.3. The following will enable you to employ the RLL scoring methodology:

4.14.3.1. Are any of the RLL features present at the relevant question analysis spot? If the answer is "yes", RLL applies irrespective of whether the applicable comparison question(s) have a RLL feature or not.

4.14.3.2. Are any of the RLL features present at the applicable comparison question(s)? If an RLL feature appears at either applicable comparison question, use the RLL method irrespective of whether the applicable relevant question analysis spot has an RLL feature or not.

4.14.3.3. If RLL features are present at two of the applicable comparison questions, determine which comparison question has the more significant RLL response duration? The question with the most significant degree of response duration will be used for comparison against the relevant question in that analysis spot.

4.14.3.4. If the relevant question and comparison question in an analysis each have an RLL feature, determine which has the most significant response duration? The question exhibiting the most significant response duration shall serve as the default time window. That default time window is measured from response onset to response end.

4.14.3.4.1. The default time window, once determined, defines or becomes what is called the window-of-evaluation.

4.14.3.4.2. Unlike Kircher et al (1988) and Timm (1981), who always used a set time window beginning at stimulus onset and extending out for 10 or 15 seconds respectively, DoDPI uses response onset as the point where the window-of-evaluation begins and extends the window to the point where response ends. The DoDPI method offers advantages over other methods because it better considers individual response differences than do fixed-window methods.

4.14.3.4.3. If a relevant question spot has 10 seconds of response apnea-blocking and the applicable comparison question has six seconds of decrease in amplitude (suppression), the relevant question spot defines the default time window and that 10-second period serves as the window-of-evaluation for the relevant and comparison question.

4.14.3.4.4. Recognize that even though both windows of evaluation contain 10 seconds of data, one window will contain a waveform comprising only response while the other may contain response, recovery, and perhaps some respiratory cycles reflective of homeostasis. For example, refer to Figure 9 below and the explanation immediately preceding it.

4.14.3.4.5. During the comparative process, the data within each of the respective windows of evaluation, is visually transposed to a linear line length. For example, the respiration waveform depicted in Figure F.8 below is reduced to the line length depicted on the right for evaluation purposes.

Figure F.8. Waveform Transposed

This waveform approximates this line length

4.14.3.4.6. The shorter line length, be it at the relevant or comparison question, signifies the more intense or significant response and therefore is assigned the value.

4.14.3.4.7. The comparative question tracing having the shorter line length is assigned a value of either minus one (-1) or plus one (+1). If the line lengths are similar or no appreciable difference exists between them, assign a value of zero.

4.15. The following examples (pgs 19-23) illustrate proper implementation and evaluation of the respiratory waveform using RLL. The waveforms to the reader's left reflect a comparison question while the comparative waveform on the reader's right depicts the relevant question. For reader ease in determining response duration, polygraph chart grid lines have been included in all of the examples.

4.15.1. In the first example (Figure F.9, pg 19), RLL applies because the comparison question (on the left) displays one of the five RLL features—apnea-blocking. The relevant question response on the right depicts another RLL feature – progressive decrease in amplitude. The comparison question response is 10 seconds in duration, while the relevant question response is 15 seconds in duration. Since the relevant question has 15 seconds of response duration, it establishes the default window of evaluation. When employing RLL evaluation procedures, both comparative responses must have equivalent windows of evaluation. Accordingly, during the evaluation process, both comparative responses must include 15 seconds of data (arrows represent equivalent windows of evaluation). As such, one of the comparative responses may include recovery or homeostasis data within its equivalent window of evaluation. In the analysis process, the comparison question is assigned a value of plus one (+1). The comparison question line length within the 15 second window-of-evaluation is shorter (even though it includes a recovery cycle) than the line length within the 15 second relevant question window.

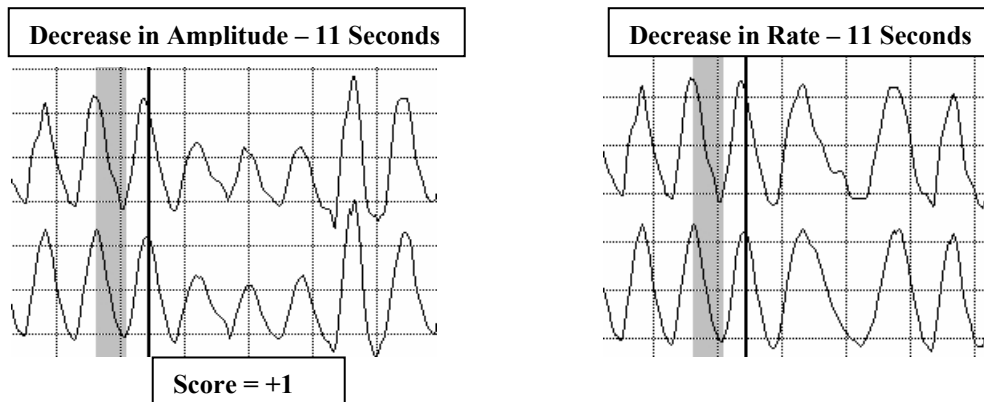**Figure F.9. Respiration Question Pairing #1**
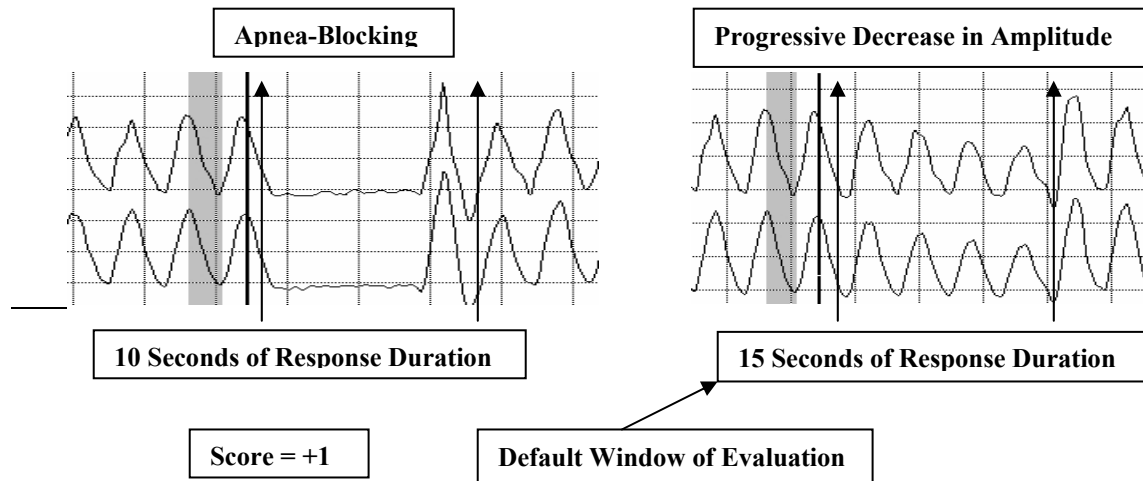
4.15.2   In the next example (Figure F.10), RLL applies because both comparative questions display one of the five RLL features—decrease in amplitude (suppression). Also, both comparative questions exhibit approximately 11 seconds of response duration. As such, the default window of evaluation becomes 11 seconds. A value of plus one (+1) is assigned because the line length of the waveform for the comparison question is shorter than the line length of the waveform at the relevant question. Note that while both questions have a decrease in amplitude response, the amplitude in the comparison question response is smaller. Therefore, it has to have a shorter line length than the relevant question.

Figure F.10. Respiration Question Pairing #2
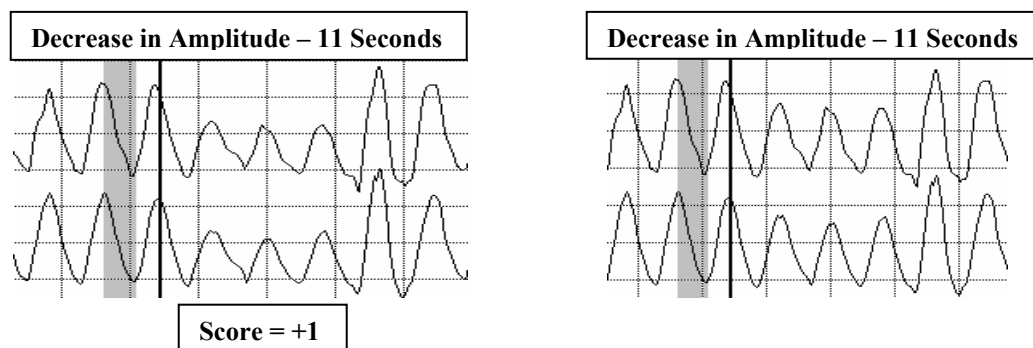
4.15.3. In Figure F.11 (pg 20), RLL applies because both comparative questions display RLL features. The comparison question has 11 seconds of decrease in amplitude and the relevant question has 11 seconds of decrease in rate. Because the data within the comparison question window, when visually transposed into a straight line, results in a shorter line length than the data contained in the relevant question window, it is assigned a value of plus one (+1).

Figure F.11. Respiration Question Pairing #3

Decrease in Amplitude – 11 Seconds	Decrease in Rate – 11 Seconds

Score = +1

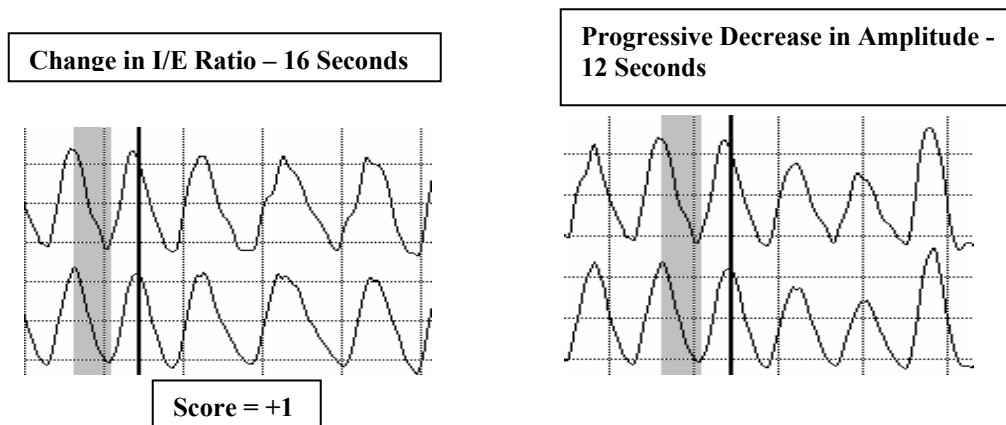4.15.4.   In the next example (Figure F.12), RLL applies because both comparative questions display RLL features. The comparison question has 16 seconds of change in I/E ratio and the relevant question has 12 seconds of progressive decrease in amplitude. In the analysis process, the relevant question would include a complete cycle of recovery within its 16 second window of evaluation. As such, when visually transposed into a straight line, the comparison question results in a shorter line length for a value of plus one (+1).

Figure F.12. Respiration Question Pairing #4

Change in I/E Ratio – 16 Seconds	Progressive Decrease in Amplitude - 12 Seconds

Score = +1

4.15.5. In Figure F.13 (pg 21), RLL applies because the one of the comparative questions displays an RLL feature. The relevant question has a progressive decrease in amplitude response. The comparison question has a non-RLL response, temporary increase in baseline. Since the analysis spot has a non-RLL feature and an RLL feature, the relevant question would get a value of minus 1 (-1) since it is an RLL feature.

Figure F.13. Respiration Question Pairing #5

Temporary Increase in Baseline

Progressive Decrease in Amplitude

Score = -1

4.15.6. In the next example (Figure F.14), RLL applies because both of the comparative questions display RLL features. During the analysis process, there may some instances where it is difficult to determine which RLL response has a shorter line length. In those situations, it would be feasible to assign a value of zero (0).

Figure F.14. Respiration Question Pairing #6

Apnea-Blocking – 8 Seconds

Decrease in Amplitude – 15 Seconds

Score = 0

4.15.7. In Figure F.15, (pg 22), RLL applies because one of the comparative questions displays an RLL feature. Although we typically think of a temporary increase in baseline as a non-RLL response, if this response displays a decrease in amplitude as indicated in the example below, it becomes an RLL response. Since the relevant question response is RLL, during the evaluation process, it would receive a value of minus one (-1).

Figure F.15. Respiration Question Pairing #7

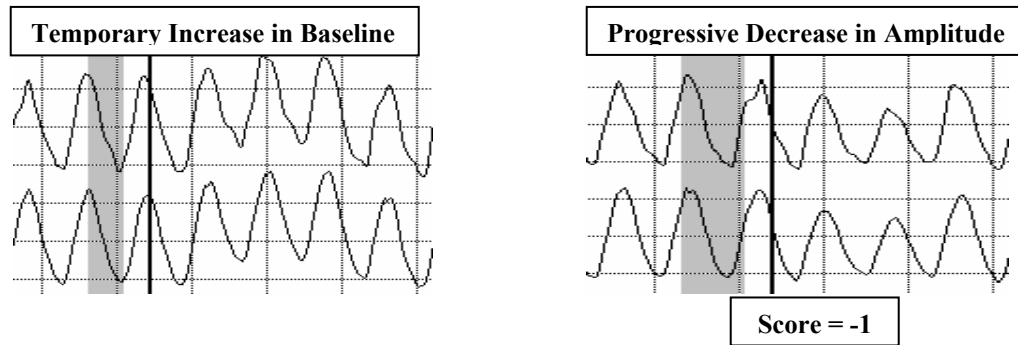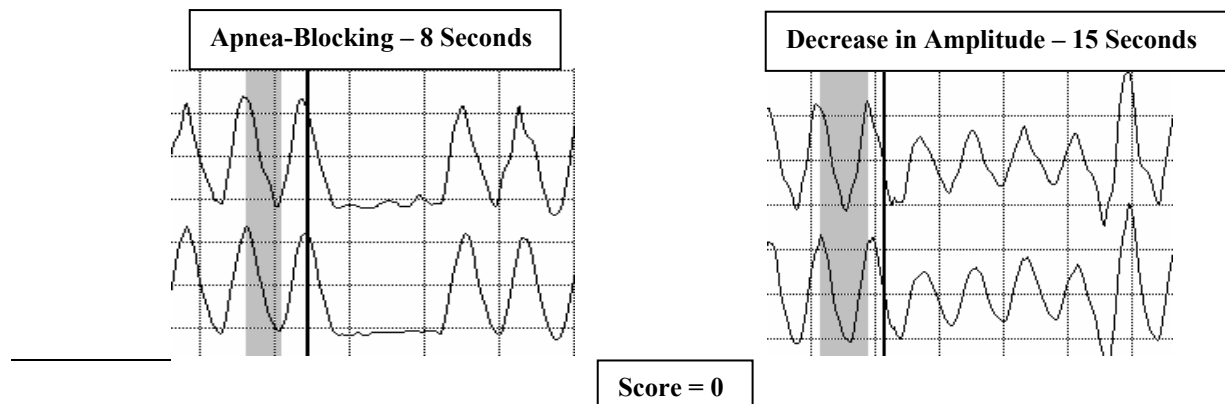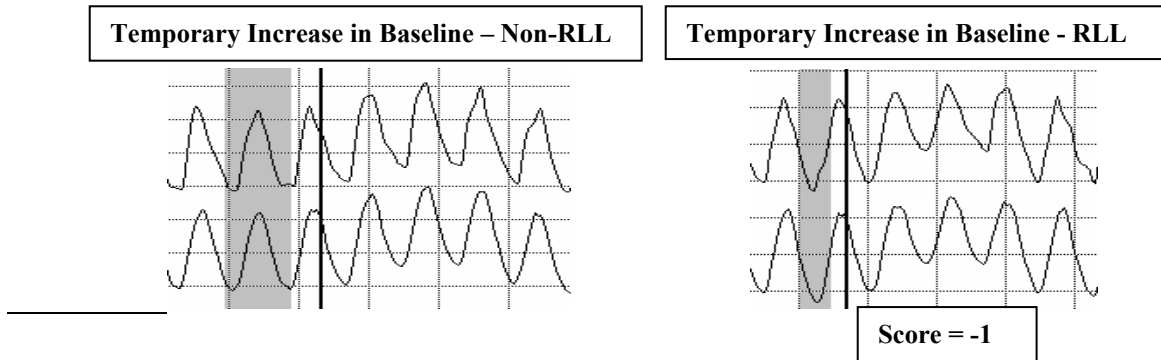| Temporary Increase in Baseline – Non-RLL	Temporary Increase in Baseline - RLL

Score = -1

4.15.8. In the next example (Figure F.16), RLL applies because one of the comparative questions displays an RLL feature. The comparison question has a temporary increase in baseline response which is non-RLL; however, the relevant question displays a decrease in amplitude response.   Since the relevant question response is RLL, during the evaluation process, it would receive a value of minus one (-1).

Figure F.16. Respiration Question Pairing #8

Temporary Increase in Baseline – Non-RLL	Decrease in Amplitude - RLL

Score = -1
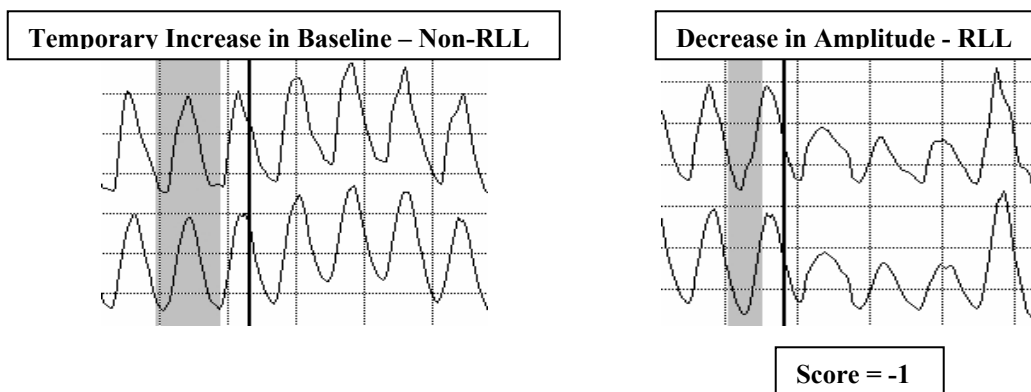
4.15.9.   There are going to be instances where you will not be able to discern, without use of a measuring device (i.e., planimeter, ruler, etc.), which comparative response has the shorter line length. In such instances, assign a value of zero. Your assessment should be visual and not based on the use of a measuring device.

4.16. When RLL is not applicable, the comparative response (i.e., relevant or comparison) exhibiting the most significant change in significance or duration is assigned a value of either minus one (-1) or plus one (+1). If no appreciable difference exists between comparative responses, assign a value of zero.

4.16.1. In the Figure F.17 (pg 23), both responses exhibit a temporary increase in baseline, which is a non-RLL response. The relevant question is much more significant in

22

response and duration than the comparison question response. During the analysis, the relevant question would be assigned a value of minus one (-1).

Figure F.17. Respiration Question Pairing #9
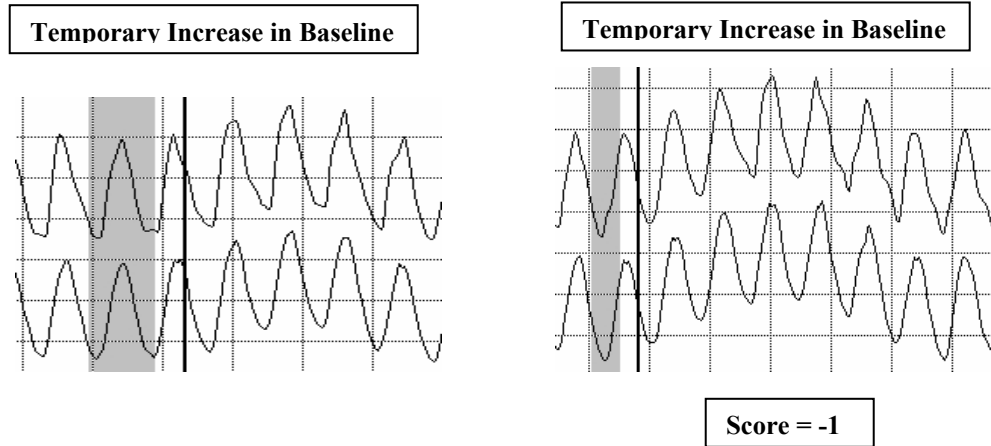
4.16.2. In the final respiratory example (Figure F.18), RLL does not apply. In the comparison question, there is no response as the respiratory tracing remains in homeostasis. During presentation of the relevant question, there is a temporary increase in baseline response which is a non-RLL response. During the evaluation process, since there was no response in the comparison question, a value of minus one (-1) would be assigned for the relevant question response.

Figure F.18. Respiration Question Pairing #10
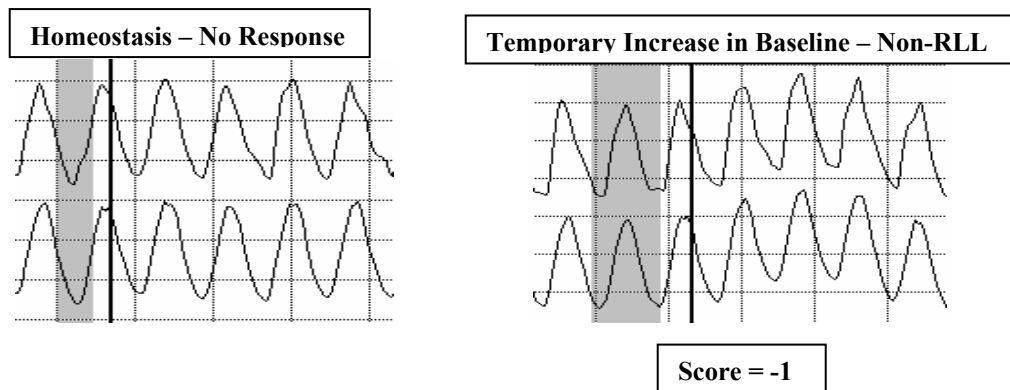
4.17. Seven-Position Numerical Evaluation Scale.

4.17.1. The conventional approach to evaluating the respiration waveform has generally been one of conservatism (J. C. Kircher, personal communication, September 11, 2002). The seven-position numerical evaluation scale introduces more subjectivity into the evaluation process than the three-position scale because the range of values that can be assigned to an

23

analysis spot increases three fold. Also, examiners typically temper their evaluation of the respiration waveform based, in part, on the realization that examinees can exercise control over the data displayed in the respiratory channel. Moreover, the respiratory channel utilizes the most diagnostic features (i.e., 6) and is subject to a wide range of variability. When the waveform trend is highly erratic, an examiner's confidence in the diagnostic value of a response is less than when the waveform is stable.

4.17.2. Under the seven-position scale, any of the following values may be assigned to a respiration analysis spot: - 3, - 2, -1, 0, + 1, + 2, + 3.

4.17.2.1. While values greater than a plus one (i.e., +2 or +3) or less than a minus one (i.e., –2 or –3) may be justified, they are seldom used. While a plus or minus two (+/-2) is occasionally utilized, a plus or minus three (+/-3) is very rarely used.

4.17.3. There are three descriptive words that correlate to the values assigned to evaluation of the respiration waveform. They are subtle, obvious, and dramatic. The ability to discriminate between what is obvious from what is dramatic is a subjective and often difficult enterprise. Notwithstanding the subjectivity in assigning values utilizing the seven-position scale, values must be uniformly applied and consistent with the applicable testing protocol.

4.17.3.1. If the difference between one of the comparative spots is *subtly* more significant, assign a value of plus one or minus one (+/- 1).

4.17.3.2. If the difference between one of the comparative spots is *obviously* more significant, a value of plus or minus two (+/- 2) is justified.

4.17.3.3. If the difference between one of the comparative spots is *dramatically* more significant, a value of plus or minus three (+/-3) is justified.

4.18. It is virtually impossible to identify all instances where values higher than plus one or lower than minus one may be warranted. However, consider the points below as a general guideline in helping you to determine whether values other than plus or minus one are warranted. Ultimately, your respective agency, if it employs the seven-position scale, may govern when and how to assign values using this scale. Remember, relative significance and duration should drive your decision and your decision process must be consistently applied.

4.18.1. When comparing two similar responses (i.e., apnea-blocking), and one response has twice as much response duration as the other, a value greater than plus one or less than minus one is justified because the difference is at least obvious.

4.18.2. When comparing a comparative question that is devoid of response against a comparative question consisting of 15 seconds of response, a value greater than plus one or less than minus one is justified because the difference is at least obvious, if not dramatic. This is particularly so if the examinee's respiration response stereotypy is approximately five seconds in duration.

4.18.3. When comparing one question that is devoid of response against one question that has several diagnostic features (irrespective of whether RLL is applicable), a value greater than plus one or less than minus one is justified because the difference is at least obvious.

4.18.4. When comparing two dissimilar responses (i.e., decrease in rate for two cycles versus decrease in amplitude lasting for five or more cycles), where one response is at least twice as significant in terms of response duration, a value greater than plus or minus one may be justified.

5.0. ELECTRODERMAL ACTIVITY (EDA) WAVEFORM

"The galvanic skin phenomenon is under the influence of exciting mental impressions and the will has no effect upon it."
Sticker, A., 1897

5.1. <u>Anatomy and Physiology</u>. The ED waveform is a reflection of the electrical changes in human skin (Dawson et al, 2000). Examiners are principally involved in monitoring and recording either the examinee's skin resistance level (SRL) or skin conductance level (SCL) and deviations from those levels that we refer to as phasic activity. This is accomplished through the passage of an electrical current across the skin and is termed an exosomatic ED measure.

5.1.1. Traditionally, whether viewing a computer screen or a printed PDD chart, the third waveform/tracing from the top is representative of the examinee's EDA. The ED channel appears to be the most heavily relied upon measure of physiological activity.

5.2. While various theories have been postulated for what contributes to changes in the skin's electrical property, examiners tend to favor the secretory theory advanced by Tarchanoff (1890). Tarchanoff believed EDA was related to sweat gland activity. Darrow's research (1927) supported Tarchanoff's theory. Is it the moisture on the surface of the skin or the activity of the sweat glands per se that is critical for EDA? Darrow found that ED activity actually began one second before moisture appeared on the surface of the skin, so it was concluded that activity of the sweat glands, not sweat on the skin, was critical for EDA (Dawson et al, 2000).

5.2.1. Veraguth (1907) wrote, ". . .that the electrical phenomena picked up with the galvanometer was attributable to activity of the sweat glands." What we know is that EDA is highly correlated with the psychological concepts of emotion, arousal, and attention (Dawson et al, 2000), and therefore, is of tremendous benefit to us in PDD.

5.3. The skin is the largest organ of the human body. It primarily serves as a protective coating (Weinstein, 1994). The eccrine sweat gland is the component of skin that examiners are most interested in, not so much because of its thermoregulatory function, but because of its responsiveness to a wide variety of external stimuli.

5.3.1. Eccrine sweat glands are generally found all over the human body. However, they can be found in greatest concentration on the palmar surface of the hand and soles of the feet (Weinstein, 1994). According to Weinstein, there are between 2000 to 2500 eccrine sweat glands per square centimeter of skin surface.

5.3.2. The eccrine sweat gland constantly strives to maintain its homeostatic state of being empty (Weinstein, 1994). Not surprisingly, the positioning of sweat constantly fluctuates between the secretatory portion of the sweat gland and the skin's surface.

5.3.2.1. Passive re-absorption and active re-absorption are two mechanisms that help us explain ED waveform activity that is monitored and recorded. When the sweat gland is innervated, sweat begins to rise through the sweat duct. The sweat, as it continues its journey toward the skin's surface, will penetrate through a membrane and hydrate the corneum (comprised of dead dry skin cells) through a passive process. Assuming there is a sufficient amount of sweat, the sweat will then continue toward the skin's pore and exit onto the skin's surface (Weinstein, 1994).

5.3.2.2. Active re-absorption is the process by which the body attempts to return the sweat, which is rising through the sweat duct, back to its homeostatic state of being empty. However, sometimes there exists a competition between sweat rising through the duct and the bodies desire to return it back to the secretory portion of the sweat gland (Weinstein, 1994).

5.3.2.3. The ED tonic level is a reflection of the average moisture level of the skin's surface (Weinstein, 1994). We attribute an increase in baseline arousal, or change in waveform amplitude, to sweat rising from either the sweat gland or from some other fluctuating point between the gland and the skin's pore at the time the stimulus was applied. Electrodermal waveform recovery is most often attributable to active re-absorption. The time it takes for sweat to begin rising up through the duct to the time it returns to the pre-stimulus level is a reflection of response duration. An ED complex response is evidenced by multiple peaks (the largest peak may be on the rise or recovery side) and suggests that as active re-absorption is occurring sweat production increases, overcoming the sweat gland's return to homeostasis.

5.4. During the data collection phase of an examination, the examiner attaches two sensors (known as fingerplates or electrodes) to the underside surface of two fingers of an examinee's hand or to the palmer surfaces of the hand to record and monitor their EDA. If used, most examiners favor placing the fingerplates on the volar surfaces of the distal phalanges (the pad opposite the fingernail) on the examinee's non-dominant hand (Dawson et al, 2000).

5.4.1. Typically, the fingerplate electrode assembly consists of two stainless steel plates or two silver-silver chloride cup electrodes, with Velcro fastening straps and an electromagnetic shielded cable for connection to a computer sensor box or analog instrument.

5.5 Waveform/Tracing Amplitude. Obtain a waveform or tracing amplitude of between one inch and two inches, irrespective of grid setting, prior to going into actual operation.

5.6. Electrodermal Features. There are three physiological phenomena or ED diagnostic features used to evaluate PDD data. One feature is the primary diagnostic feature (amplitude) and two others are secondary features. The following examples will provide you with a representative signature of each feature.

5.6.1. <u>Amplitude (primary feature) (Figure F.19)</u>. Waveform amplitude is measured from response onset to the highest peak of a response, irrespective of whether the response is a simple or complex response. Remember, an amplitude increase from homeostasis is a result of sweat rising from the gland up through the duct and out through the duct pore on to the surface of the skin.

       5.6.1.1. The pre-stimulus tonic level refers to the waveform when it is either in homeostasis or when a temporary leveling of the waveform occurs resulting in a newly established baseline.

       5.6.1.2. An ED response is represented graphically as an increase in amplitude, regardless of whether it represents an increase in conductance or a decrease in resistance. An amplitude change may be displayed as a simple or complex response.

Figure F.19. Amplitude

Simple Amplitude Response
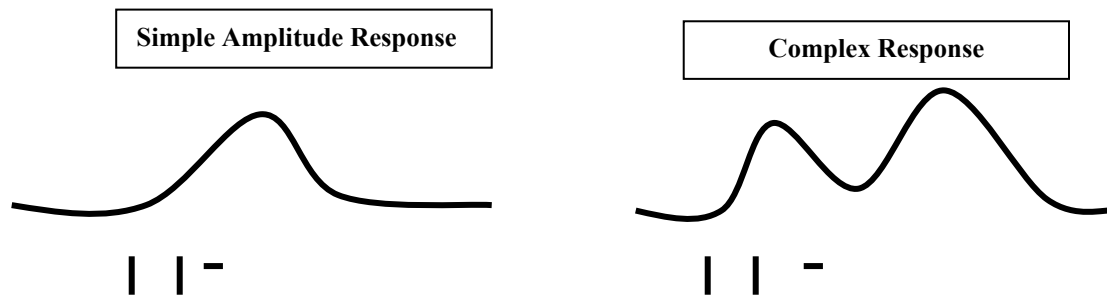
Complex Response

5.6.2. <u>Complex Response (secondary feature) (Figure F.20)</u>. An ED complex response is differentiated from a simple response in that a complex response has multiple peaks. A response is considered complex when there is some observable recovery that falls short of the pre-stimulus tonic level with subsequent physiological arousal.

Figure F.20. Complex Response

Rise Side Complexity

Recovery Side Complexity
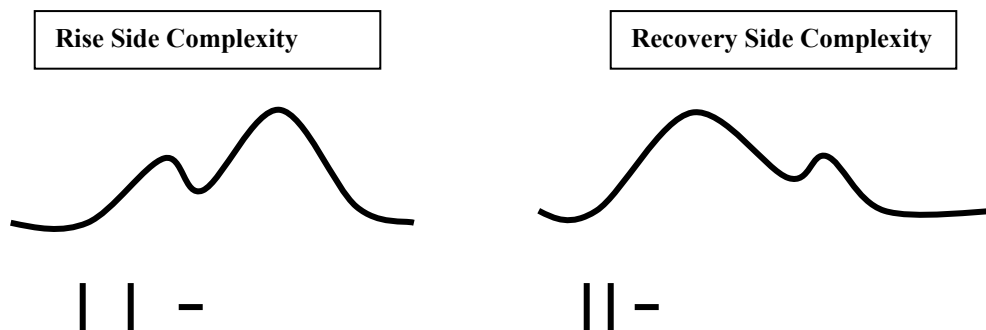
       5.6.2.1. If the trough, between multiple peaks, returns to or below the pre-stimulus tonic level, the response is not considered a complex response. In Figure F.21 (pg 28), the responses are not complex, even though they have multiple peaks, because the trough fell

slightly below the pre-stimulus tonic level in the example on the left, and it returned to the pre-stimulus level in the example on the right.

Figure F.21. Trough Depiction
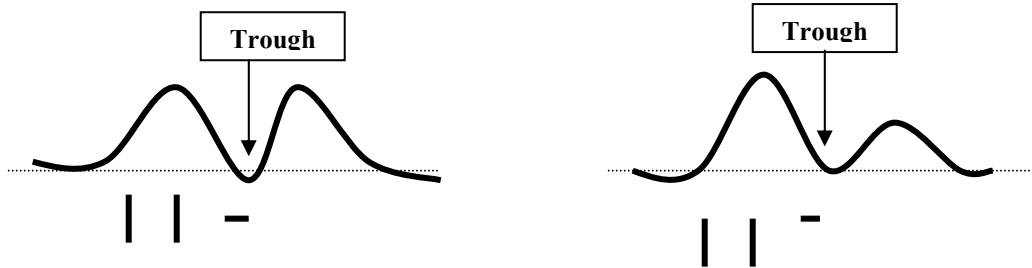

5.6.3. Response complexity, in part, is due to the competition that occurs between sweat rising from the eccrine sweat gland through the duct on its way to the sweat pore and active re-absorption where the sweat is being returned to its homeostatic state that is empty (Weinstein, 1994). Environmental conditions and other factors affect response latency, response magnitude and other components or attributes of response complexity.

5.7. Duration (secondary feature) (Figure F.22). The ED response duration is the time period between response onset and return to the pre-stimulus tonic level or establishment of a new baseline. Generally, ED response duration is highly correlated with amplitude.

Figure F.22. Response Duration
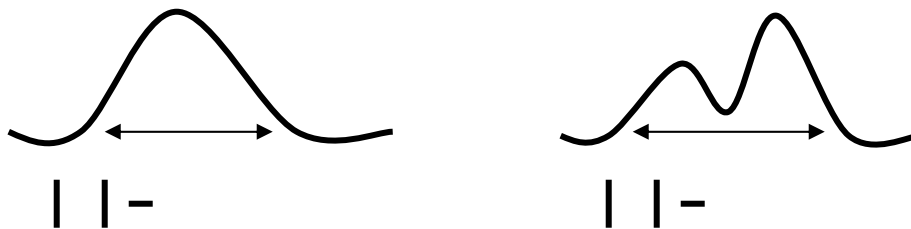
5.7.1. Electrodermal response duration is attributable to the continuation of sweat production or the time period between the initiation of sweat rising from the sweat gland up the duct to its eventual return to the pre-stimulus tonic level. During a complex response, the return to the pre-stimulus tonic level is interrupted by subsequent rise of sweat in the duct.

5.8. Three-Position Numerical Evaluation Scale.

5.8.1. Evaluating Similar ED Responses. When evaluating similar comparative responses (i.e., each waveform exhibits a simple amplitude response or they exhibit a complex response), response amplitude is the primary diagnostic feature used to assign a value.

5.8.2. If a simple amplitude response is the only applicable feature used in evaluating comparative responses (i.e., neither comparative response has complexity), the response with the most significant amplitude (as determined by the waveform peaks) receives the value. Assigning

a value of plus or minus one (+/- 1) is justified any time there is a visually discernible amplitude difference between competing responses.

5.8.3. When the amplitude of two simple or two complex ED responses are essentially the same but one comparative response has more duration, the response with the more significant duration is assigned the value.

5.8.4. Evaluating Dissimilar ED Responses. The following decision rules apply in evaluating dissimilar (or unlike) ED comparative responses:

5.8.4.1. When one waveform exhibits a simple amplitude response and another displays a complex response, amplitude is the primary diagnostic feature used to assign a value.

5.8.4.1.1. When two dissimilar comparative responses share equivalent degrees of amplitude, the response exhibiting complexity receives the value.

5.8.4.2. Response complexity neither takes precedence over, nor does it neutralize, a response with more amplitude.

5.8.4.3. Duration is never a decision factor when comparing dissimilar ED responses. The basis for this is that complexity, by its nature, will generally have more duration than a simple response.

5.8.5. Homeostasis Considerations. Homeostasis should exist prior to stimulus onset. If homeostasis does not exist at stimulus onset, the ED waveform may generally be evaluated if any of the conditions listed below exist. When employing one of the exceptions to homeostasis, the paramount consideration is whether the response you anticipate evaluating is a by-product of the activity that preceded stimulus onset or more likely a result of stimulus presentation. A standard of reasonableness should drive your decision. If you have no confidence that the response of interest is relatively free from influence of other activity, assigning a value of Ø (zero with a line through it) to the respective analysis spot is appropriate.

5.8.5.1. The means by which an examiner annotates that portion of an ED waveform that is not used for evaluation is by placing a double slash mark (//) on the rise side of the suspect portion of the waveform. Figure F.23 (pg 30) depicts how this annotation is displayed when an early ED response is not considered for evaluation, yet the subsequent response is evaluated. Examiners tend not to use this annotation as much today as in the past. Only when you are trying to convey which portion of the waveform was used for evaluation, or when there is a possibility that someone may not understand which portion of the waveform was used for evaluation is the annotation called for.

Figure F.23. Use of the Double Slash Mark
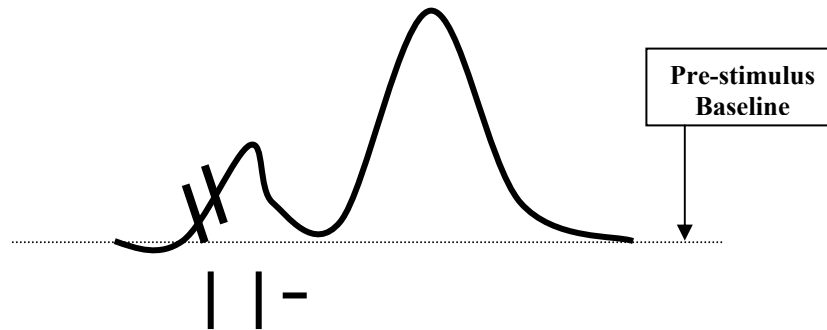
5.8.6.1. Homeostasis Exception #1 (Figure F.24).The waveform returns to the pre-stimulus baseline with subsequent response occurring within the response onset window. Note that the presentation of the stimulus occurred on the rise side of the non-specific response.

Figure F.24. Homeostasis Exception #1
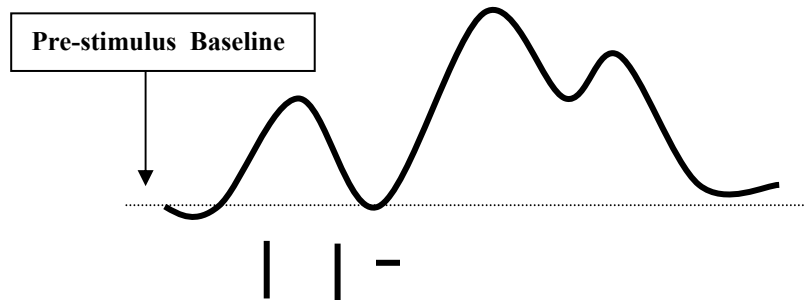
5.8.6.2. Homeostasis Exception #2. The waveform establishes a new tonic level with subsequent response occurring within the response onset window.

5.8.6.2.1. Generally, there is no set period of time that the ED waveform must be stable before deeming it to have established a new tonic level. However, the longer the stabilization of the waveform, the greater confidence the evaluator will have in the authenticity of the response of interest. For example, the waveform depicted on the left in Figure F.25 (pg 31) would not be used for evaluation because there is no waveform stabilization separating the two peaks. However, the waveform to the right may be used for evaluation because arguably a new tonic level was established. Moreover, the evaluator can be reasonably more confident that the response on the right was, more likely than not, a result of the stimulus' content and the examinee's answer to the stimulus, whereas such confidence is not possible given the response on the left. Note that the stimulus, in each case, was presented on the rise side of the non-specific response.

Figure F.25. Homeostasis Exception #2

Pre-stimulus Baseline
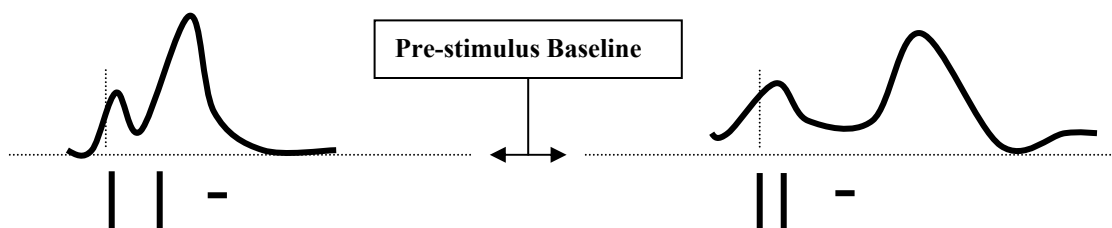
5.8.6.3. Homeostasis Exception #3. During recovery from a non-specific response, the stimulus was presented resulting in a subsequent but distinct response that occurs within the response onset window. In Figure F.26 below, note that the recovery side of the non-specific response falls short of the baseline before a secondary response occurs.

Figure F.26. Homeostasis Exception #3

Recovery Side of a
Non-Specific Response

Pre-stimulus Baseline
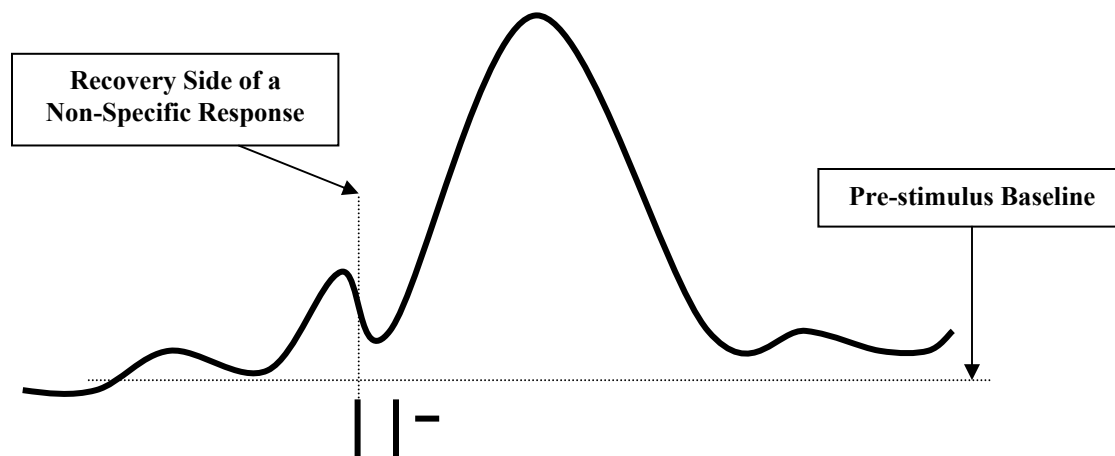
5.8.6.3.1. Apply this last exception judiciously, as several factors will dictate whether the response of interest is of diagnostic value. In the example above, the response occurring within the response onset window is arguably sufficiently distinct from the preceding non-specific response. As such, it may be reasonable to conclude that it is more likely a product of the presented stimulus than to what generated the initial non-specific response. Global evaluation of a subject's response capability and pattern throughout the examination will be helpful in assessing the diagnostic value of the response of interest.

5.9. Seven-Position Numerical Evaluation Scale. Many of the decision rules used to evaluate EDA using the three-position scale are equally applicable using the seven-position scale. Only differences between the two scales are identified below.

5.9.1. To assist in assigning a weighted value defer to the standard unit of measurement—a vertical chart division set at a one-quarter grid setting.

5.9.2. A ratio method was devised to assist is evaluating the ED waveform, particularly in assigning values other than zero and plus or minus one.

5.9.2.1. When using the ratio method, first determine the ratio between comparative responses and then assign a value based on the following:

5.9.2.1.1. If the ratio is less than 2:1, defer to the "bigger-is-better" principle.

5.9.2.1.2. If the ratio is at least 2:1, but less than 3:1, assign a plus or minus one.

5.9.2.1.3. If the ratio is at least 3:1, but less than 4:1, assign a plus or minus two.

5.9.2.1.4. If the ratio is at least 4:1, or greater, assign a plus or minus three.

5.10. Bigger-is-Better Principle. How do you evaluate two comparative responses, irrespective of whether they are similar or dissimilar in nature, where the amplitude ratio is less than two-to-one? The principle of "bigger-is-better" was adopted to address this situation. When the ratio between comparative responses is less than 2:1, the response with the more significant amplitude will receive the value.

5.10.1. When the bigger-is-better principle is applicable, it may not result in assignment of any value other than a plus or minus one.

5.10.2. Any visually perceptible amplitude difference between comparative responses is sufficient to award a value. Generally, if any type of measuring device is needed to discern which comparative amplitude response is greater, assign a zero to the analysis spot.

5.11. Duration. When duration is the only discriminator between two similar comparative responses, evaluation rules permit assignment of a value of plus or minus one only.

5.12. Dissimilar Responses. The following decision rules apply to evaluation of dissimilar comparative responses:

5.12.1. Response amplitude is the primary criterion or diagnostic feature used in evaluating dissimilar ED responses.

5.12.2. Duration is not an evaluation consideration when comparing dissimilar ED responses.

5.12.3. Response complexity is not a decision factor once the amplitude ratio between comparative responses reaches a 2:1 ratio. Response complexity will not be assigned values higher than plus one or lower than minus one.

5.13. Something-Versus-Nothing Principle. When comparing one question containing any type of diagnostic response to another question that is devoid of response, the something-versus-nothing principle holds.

5.13.1. When applying the something-versus-nothing principle, defer to vertical chart divisions as a standard unit of measurement to assist in assigning a value. By utilizing this

procedure, an examiner can always be consistent in assigning values. It's important to remember that all guidance in this pamphlet assumes vertical chart divisions are set at a quarter inch grid setting. If any other grid setting is used, modify the following guidance as appropriate.

5.13.1.1. If one comparative spot is devoid of response and the other comparative spot has a response that measures less than two chart divisions, assign a value of plus or minus one.

5.13.1.2. If one comparative spot is devoid of response and the other comparative spot has a response that measures at least two but less than three chart divisions, assign a value of plus or minus two.

5.13.1.3. If one comparative spot is devoid of response and the other comparative spot has a response that measures at least three chart divisions, assign a value of plus or minus three.

5.13.2. If a response appears to be an anomaly for that channel or waveform, a lesser value than would otherwise be justified, under the something-versus-nothing principle, can be assigned to an analysis spot. This conservative approach to evaluation of an analysis spot must be uniformly applied and exercised in only the most unique circumstances.

6.0. CARDIOVASCULAR (CV) WAVEFORM

"Though the observed actions of men hide their real thoughts and feelings, these are revealed by the observation of their hearts."

Gantt, W. H., 1960

6.1. <u>Anatomy and Physiology</u>. The CV system consists of the heart, blood vessels and blood. The principal functions of this system are to transport nutrients, oxygen and hormones to cells and the removal of waste products. The system also protects the body by white blood cells, antibodies and proteins that circulate in the blood and defend the body against foreign microbes and toxins. The CV system is also responsible for body temperature regulation, fluid pH and water content of cells (Pack, 1997).

6.2. The heart is a muscular organ that beats about 100,000 times a day and is ultimately responsible for all CV functions (Martini, 2000). The heart is also a four-chamber muscular pump with an average size of a grapefruit and weighs about 300 grams (Bevan, 1996).

6.3. Polygraph examiners are interested with pulmonary and systemic circulatory pathways; the heart itself, particularly the chambers and valves; cardiac conduction; cardiac muscle contraction; the cardiac cycle, specifically the segments of a heart beat; cardiac output, such as stroke volume and heart rate; and blood pressure.

6.3.1. Pulmonary circulation and systemic circulation are responsible for transporting blood throughout the body via a 96,500-kilometer network of blood vessels (Bevan, 1996). The pulmonary circuit transports oxygenated blood from the lungs to the left atrium where it is temporarily housed before entering the left ventricle for release throughout the body via the systemic circuit. The systemic circuit then takes the deoxygenated blood from the body and

transports it to the right atrium, where it is temporarily housed before being passed into the right ventricle. The right ventricle pumps the deoxygenated blood through the pulmonary trunk to facilitate pulmonary circulation (Pack, 1997).

6.3.1.1. With respect to the functioning and flow of blood through the heart, the activity of the right and left atrium and the right and left ventricles of the heart are of particular interest to examiners as are the valves (i.e., bicuspid & tricuspid) that facilitate and control blood flow. Also of interest is the functioning and movement of blood (i.e, blood volume changes) at particular arterial monitoring sites on the body.

6.3.2. The cardiac cycle describes all the activities of the heart through one complete heartbeat that involves one contraction and relaxation of both the atria and ventricles (Pack, 1997). The contraction phase is known as systole and the relaxation phase is known as diastole (Brownley et al, 2000).

6.3.3. As ventricular contraction occurs, there is an increase in pressure (ventricular pressure exceeds arterial pressure) causing the aortic and pulmonary semi-lunar valves to open and blood is ejected out of the ventricles (Brownley et al, 2000). As the ventricles begin to relax, blood in the aorta and pulmonary trunk begins to flow backward, against the now-closed semi-lunar valves.

6.3.3.1. The rebounding of blood against the closed semi-lunar valves, causes a momentary interruption in the flow of blood and a small increase in blood pressure which appears as the dicrotic notch on the CV waveform (Abrams, 1989). At times, the presence of a dicrotic notch may not be visible in the waveform depicted on your computer screen or printed charts.

6.3.3.1.1. The presence of the dicrotic notch, irrespective of its positioning along the diastolic segment of the cardiac cycle (high, middle, or low), is of no diagnostic value with respect to an examinee's veracity.

6.3.4. Heart rate refers to the number of heartbeats that occur per minute (bpm). Larsen (1986) and Abrams (1989) cite 70 bpm as the approximate normal human adult heart rate. Obrist (1981) cites 72 bmp where as Martini (2000) cited the average heart rate ranges between 70-80 bpm. Interestingly, during sleep this heart rate may decrease by 10 to 20 bpm; during emotional excitement it may reach 150 bpm (Larsen et al, 1986).

6.3.4.1. A heart rate below 60 bpm is termed bradycardia while a heart rate above 100 bpm is termed tachycardia (Martini, 2000). While many things may contribute to bradycardia (i.e., athleticism) or tachycardia (i.e., increased body temperature), examiners are most interested in these conditions when they are associated with emotional excitement and behavioral states (Larsen et al, 1986).

6.3.4.2. An examinee's heart rate can be quickly estimated by counting the number of heartbeats occurring within a five-second period and then by multiplying that number by 12.

6.4. The primary site where we monitor and record CV activity during a PDD examination is over the brachial artery of the upper arm. Other arterial (i.e., radial & ulnar) monitoring sites include the forearm and wrist and in rare instances (i.e., suitable CV waveform cannot otherwise be obtained) behind the gastrocenemius muscle (i.e., calf) of the lower legs.

6.4.1. During the data collection phase, the sensor attached to the examinee is a standard CV blood pressure cuff. This sensor and assembly consists of a rubber bladder, covered with a cloth or vinyl sleeve and a fastening component (velcro wrap), pump bulb assembly that includes a sphygmomanometer and rubber tubing for connecting the sensor to the computer sensor box or analog instrument.

6.5. Ideally, obtain a CV waveform amplitude of between one-half inch and one inch, irrespective of grid setting, prior to going into actual operation.

6.6. <u>CV Features</u>: There are two diagnostic features used to evaluate CV physiological data. One of these is a primary feature and the other is a secondary diagnostic feature. A representative signature of each feature will be shown. Traditionally, whether viewing a polygraph computer screen or a printed chart, the fourth waveform from the top is representative of the examinee's CV activity.

6.6.1. <u>CV Baseline Arousal (Primary Feature)</u>. In numerical analysis, CV baseline changes typically present themselves in the form of phasic responses. Phasic baseline changes occur as a short-term change in physiological activity following question presentation that has a relatively rapid onset and may return to the pre-stimulus baseline or establish a new baseline within a period characteristic of the response system. In Figure F.27 (pg 36), the fact that one phasic response returned to the pre-stimulus baseline and the other response resulted in establishment of a new baseline is insignificant in determining the degree or amount of baseline arousal.

6.6.1.1. Most examiners believe that CV baseline arousal is governed by increases in blood volume changes that occur at the respective monitoring site (Weinstein, 1994). According to Abrams (1989), changes in baseline arousal are likely the result of a combination of blood volume and pressure changes.

6.6.1.2. Generally, baseline arousal is associated with sympathetic nervous system (SNS) activation and is the type of response one would typically predict of an examinee who was experiencing the fight, flight, freeze (F3) phenomenon.
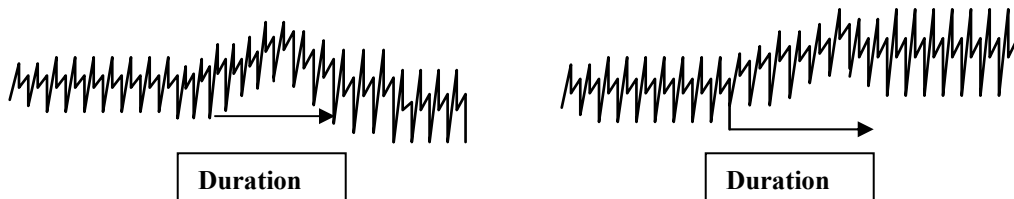
Figure F.27. CV Baseline Arousal Features

6.6.2 Secondary Diagnostic Feature:

     6.6.2.1. Duration (Figure F.28). CV duration is the amount of time that elapses from response onset to when the response returns to the pre-stimulus tonic level or establishes a new tonic level.

Figure F.28. CV Baseline Arousal Duration

     6.6.3. CV amplitude refers to the measurement or height of the actual systolic and diastolic segments of the cardiac cycle (increase or decrease in size of CV tracing). Some research PDD literature use the term amplitude and baseline arousal interchangeably.

     6.6.3.1. Among examiners, it is generally held that amplitude increases and decreases of the CV waveform segments (size of waveform), relative to homeostasis, represents pressure changes (Weinstein, 1994).

6.7. Three-Position Numerical Evaluation Scale.

     6.7.1. Baseline Arousal. The primary diagnostic feature or criterion used in evaluation of the CV waveform is the degree of baseline arousal (phasic response) one comparative response has in relation to another.

     6.7.1.1. Assign the value to the comparative response that has the most significant increase in baseline arousal. Any visual degree of increase in baseline arousal may be awarded the value. Baseline arousal (Figure F.29) is typically determined by looking at the diastolic portion or points found on the underside of the waveform curve (Podlesny et al, 1999).

36

Figure F.29. Evaluation Focus Involving Phasic Arousal
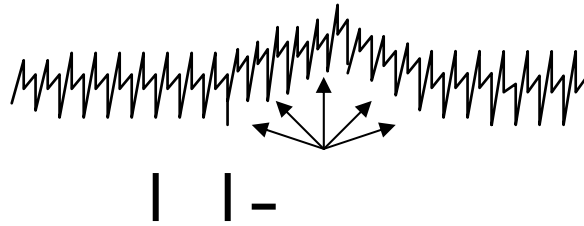
6.7.2. If there is no visually discernible difference in the degree of baseline arousal between comparative responses and the secondary feature of duration is not a consideration, assign a value of zero (0) to the analysis spot.

6.7.3. Secondary Evaluation Consideration. The following secondary consideration applies to comparative responses exhibiting baseline arousal only. When a secondary consideration is the only means of discrimination between otherwise similar responses, a value of plus or minus one only may be assigned.

6.7.3.1. Duration. Duration of response is of diagnostic significance when comparing two phasic CV responses. If two comparative phasic responses share the same degree of baseline arousal and one response exhibits more duration than the other response, a value of plus or minus one is awarded to that phasic response.

6.7.4. Other Evaluation Considerations - Sympathetic Response (Baseline Arousal) versus Parasympathetic Activity (Figure F.30). Although not a primary or secondary evaluation feature, there may be occasions when an examiner will encounter this situation. Assuming homeostasis existed at stimulus onset, a response displaying sympathetic arousal (phasic or tonic) is assigned the value over a comparative response displaying parasympathetic activity as sympathetic arousal is recognized as a flight, flight, freeze (F3) response .

Figure F.30. Sympathetic Response versus Parasympathetic Activity
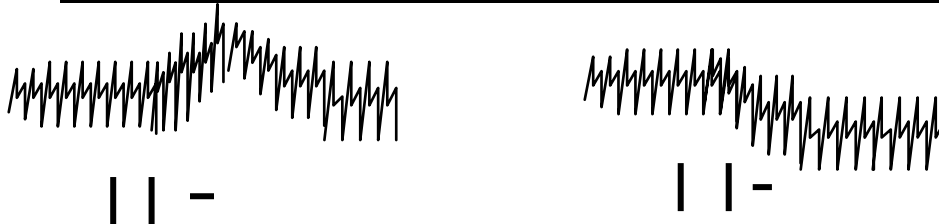
6.8. Homeostasis Considerations. Ideally, homeostasis should exist prior to stimulus onset. If homeostasis does not exist at stimulus onset, the CV waveform may generally be evaluated if any of the conditions listed below exist. When employing one of the exceptions to homeostasis, the paramount consideration is whether the response you anticipate evaluating is a consequence of the activity that preceded stimulus onset or is attributable to stimulus onset. A standard of reasonableness should drive your decision. If you have no confidence that the response of

interest is relatively free from influence of other activity assigning a value of Ø (zero with a line through it) to an analysis spot is appropriate.

6.8.1. The waveform returns to the pre-stimulus baseline with subsequent response occurring within the response onset window.

6.8.2. The waveform establishes a new tonic level with subsequent response within the response onset window.

6.8.3. During recovery from a non-specific response, the stimulus is applied resulting in a subsequent but distinct response that occurs within the response onset window.

6.8.3.1. Apply this last exception judiciously as several factors will dictate whether the response of interest is of diagnostic value.

6.9. Seven-Position Numerical Evaluation Scale. Many of the decision rules used to evaluate the CV waveform using the three-position scale are equally applicable to the seven-position scale. The differences between the two scales are identified below.

6.9.1. If a comparative response displays phasic arousal and the other comparative response has visually more but less than twice as much arousal, assign a value of plus or minus one.

6.9.2. If a comparative response displays phasic arousal and the other comparative response has twice, but less than three times as much arousal, a value of plus or minus two is justified.

6.9.3. If a comparative response displays phasic arousal and the other comparative response has three or more times the arousal, a value of plus or minus three is justified.

6.9.3.1. Values more significant than plus or minus one are not assigned when comparing CV responses that are differentiated by less than the equivalent of one standard chart division (i.e., one quarter inch or six millimeters in height). In other words, do not consider a situation where one CV comparative response has two millimeters of baseline arousal and another response has four millimeters of baseline arousal as warranting assignment of a plus two given one response is twice as significant as the other.

6.10. Any visually perceptible baseline arousal difference between comparative responses is sufficient to award a value. If any type of measuring device is needed to discern which comparative response is greater, assign a zero to the analysis spot.

6.11. In the seven position analysis scale, the secondary CV feature of duration may be assigned a value of plus or minus one only.

6.12. Something-Versus-Nothing Principle. When comparing one question containing any type of diagnostic response to another question that is devoid of response, the something-versus-nothing principle applies.

6.12.1. Generally, when applying the something-versus-nothing principle, defer to vertical chart divisions as a standard unit of measurement to assign a value.

6.12.1.1. If one comparative spot is devoid of response and the other comparative spot has a phasic response that measures less than two chart divisions, assign a value of plus or minus one.

6.11.1.2. If one comparative spot is devoid of response and the other comparative spot has a phasic response that measures at least two but less than three chart divisions, assign a value of plus or minus two.

6.11.1.3. If one comparative spot is devoid of response and the other comparative spot has a phasic response that measures at least three chart divisions, assign a value of plus or minus three.

6.12. If a response appears to be an anomaly for that channel or waveform, a lesser value than would otherwise be justified under the something-versus-nothing principle can be assigned to an analysis spot. This conservative approach to evaluation of an analysis spot must be uniformly applied and exercised in only the most unique circumstances.

7.0. <u>Conclusion.</u> This document provides you with essential information needed to conduct an analysis of the physiological data you obtain through the use of a polygraph. There are certainly principles or rules governing test data analysis; however, these principles or rules must be tempered with an appreciation for the uniqueness that every individual brings to the testing environment and the uniqueness that potentially every question pairing holds on a given chart. Expertise is a relative term and reading this document will not make you an expert in the field of test data analysis; however, practice and time will!

APPENDIX A

1.0. <u>Comparison Test Formats</u>

    1.1. The DoDPI provides instruction in the use of various comparison question techniques that employ probable-lie and directed-lie formats. The principal probable-lie testing formats are the Zone Comparison Test (ZCT), Air Force Modified General Question Test (AFMGQT) and the DoDPI (Army) Modified General Question Test (MGQT). The Test for Espionage and Sabotage (TES) is the exclusive directed-lie comparison question format currently taught at DoDPI.

APPENDIX B

1.0. <u>Zone Comparison Test (ZCT) Evaluation Procedures</u>

1.1. The traditional ZCT is a single-issue test consisting of ten questions. This ZCT format contains three relevant question analysis spots that are compared to at least one of three comparison questions.

1.2. The relevant question analysis spots are: relevant question five (R5), relevant question seven (R7), and relevant question 10 (R10). The serial positioning of each relevant question, within each of the respective question strings (Chart I-1 through Chart I-3), remains the same.

1.3. On Chart I-1, the serial positioning of the comparison questions is at positions four, six and 10 within the question string. Following Chart I-1, comparison questions may be rotated at the examiner's discretion to ensure that the most responsive comparison from the previous chart is aligned adjacent to the most responsive relevant question from the previous chart.

1.4. The irrelevant, sacrifice relevant and symptomatic questions are not evaluated and their serial positioning generally remains unchanged from chart to chart. The following depicts the serial positioning of each question in the question string for Chart I-1. Question one (I1) is an irrelevant question. Question two is a sacrifice relevant (SR2) question. Questions three (S3) and eight (S8) are symptomatic questions. Questions five, seven and ten are relevant questions and questions four, six and nine are comparison questions.

I1 - SR2 - S3 - C4 - R5 - C6 - R7 - S8 - C9 - R10

1.4.1. Relevant question five is evaluated against the most responsive of comparison question four or six.

1.4.2. Relevant question seven is evaluated against comparison question six only.

1.4.3. Relevant question 10 is evaluated against comparison question nine.

1.5. Test Data Analysis. The three ZCT decision outcomes that can be rendered are NDI, DI and NO. The ZCT decision rules are predicated on vertical and horizontal spot analysis totals.

1.5.1. For a No Deception Indicated (NDI) opinion, there must be a plus (+) in the each overall vertical spot with a horizontal grand total of plus six (+6) or greater.

1.5.2. For a Deception Indicated (DI) opinion, there must be either a minus three (-3) at any overall vertical spot or a horizontal grand total of minus six (-6) or less.

1.5.3. Any numerical score not meeting the threshold for a DI or NDI decision shall be deemed No Opinion.

APPENDIX C

1.0. <u>You-Phase Zone Comparison Test (ZCT) Evaluation Procedures</u>

1.1. There are several versions or formats related to the traditional ZCT (i.e., You-Phase, Exploratory, S-K-Y). The You-Phase ZCT is a single-issue test consisting of nine questions. This ZCT format contains two relevant question analysis spots that are compared to at least one of three comparison questions.

1.2. The relevant question analysis spots are: relevant question five (R5) and relevant question seven (R7). The serial positioning of each relevant question within each of the respective question strings (Chart I-1 through Chart I-3) remains the same.

1.3. On Chart I-1, the serial positioning of the comparison questions is at positions four, six and eight. Following Chart I-1, comparison questions may be rotated at the examiner's discretion to ensure that the most responsive comparison from the previous chart is aligned adjacent to the most responsive relevant question from the previous chart.

1.4. The irrelevant, sacrifice relevant and symptomatic questions are not evaluated and their serial positioning generally remains unchanged from chart to chart. The following depicts the serial positioning of each question in the question string for Chart I-1. Question one (I1) is an irrelevant question. Question two is a sacrifice relevant (SR2) question. Questions three (S3) and nine (S9) are symptomatic questions. Questions five and seven are relevant questions and questions four, six and eight are comparison questions.

I1 - SR2 - S3 - C4 - R5 - C6 - R7 - C8 - S9

1.4.1. Relevant question five is evaluated against the most responsive of comparison question four or six.

1.4.2. Relevant question seven is evaluated against either comparison question six or eight.

1.5. Test Data Analysis. The three decisions that can be rendered are NDI, DI and NO. The You-Phase ZCT decision rules are predicated on vertical and horizontal spot analysis totals.

1.5.1. For a No Deception Indicated (NDI) opinion, there must be a plus (+) in each overall vertical spot with a horizontal grand total of plus four (+4) or greater.

1.5.2. For a Deception Indicated (DI) opinion, there must be either a minus three (-3) at any overall vertical spot or a horizontal grand total of minus four (-4) or less.

1.5.3. Any numerical score not meeting the threshold for a DI or NDI decision shall be deemed No Opinion.

APPENDIX D

1.0. <u>Air Force Modified General Question Test (AFMGQT) Evaluation Procedures.</u>

1.1. The AFMGQT is a modified version of a polygraph technique originally developed by John Reid. In 1968, the U.S. Army Military Police Polygraph School modified Reid's technique and called it the Army MGQT. In the mid 1970s, the Air Force modified the Army MGQT by adding a sacrifice relevant, adding more comparison questions and allowing for a two, three or four relevant question test. The Air Force called its modified version the AFMGQT (AFMGQT 2005).

1.2. The AFMGQT allows for a minimum and maximum number of relevant questions involving the same primary target. The AFMGQT has two, three and four relevant question tests. Depending on available case facts and personal preference, the PDD examiner may utilize any of these tests in resolving specific issue crimes, assuming that all relevant issues are resolved by the chosen relevant question test (AFMGQT 2005).

1.3. There are two authorized versions of the AFMGQT. It is the examiner's discretion as to which version is utilized in specific issue testing (AFMGQT 2005).

1.3.1. Version 1 is the original AFMGQT format that was modified from the Army MGQT in the mid 1970s. Version 1 of the AFMGQT has a two, three and four relevant question test. In this version, chart 2 is always a mixed chart. At the examiner's discretion, chart 3 may also be a mixed chart or it may be in straight sequence

1.3.1.1. The following depicts the question string for a two relevant question test of version 1: I(1), SR(2), C3, R4, C5, R6, C7.

1.3.1.1.1 The analysis spots for this test are R4 and R6. R4 is always a secondary relevant question and R6 is always the primary relevant question. Comparisons C3 and C5 are evaluated against R4. Comparisons C5 and C7 are evaluated against R6. If the serial positions of the comparison or relevant questions are moved in the question string for charts 2 and 3, the comparisons bracketing each relevant question are used in the evaluation process.

1.3.1.2. The question string for a three relevant question test of version 1 is: I(1), SR(2), C3, R4, C5, R6, C7, R8.

1.3.1.2.1. The analysis spots for the three relevant question test are R4, R6 and R8. Relevant questions R4 and R8 are secondary relevant questions and R6 is always the primary relevant question. Comparisons C3 and C5 are evaluated against R4. Comparisons C5 and C7 are evaluated against R6 and comparison C7 is evaluated against R8. In the three relevant question test, the last relevant in the question string is evaluated against the preceding comparison only. If the serial positions of the comparison or relevant questions are moved in the question string for charts 2 and 3, the comparisons bracketing each relevant question are used in the evaluation process. Also, for these two charts, the last relevant question in the question string is evaluated against the preceding comparison question only.

1.3.1.3. The four relevant question string of version 1 is: I(1), SR (2), C3, R4, C5, R6, C7, R8, C9, R10.

1.3.1.3.1. The analysis spots for the four relevant question version are R4, R6, R8 and R10. Relevant questions R4, R8 and R10 are secondary relevant questions. Relevant question 6 is always the primary relevant question. Comparisons C3 and C5 are evaluated against R4. Comparisons C5 and C7 are evaluated against R6. Comparisons C7 and C9 are evaluated against R8. Comparison C9 is evaluated against R10. In the four relevant question test, the last relevant in the question string is evaluated against the preceding comparison only. If the serial positions of the comparison or relevant questions are moved in the question string for charts 2 and 3, the comparisons bracketing each relevant question are used in the evaluation process. Also, for these two charts, the last relevant question in the question string is evaluated against the preceding comparison question only.

1.3.2. Version 2 is a modified version of the original AFMGQT created by the Air Force in the mid 1970s. Initially, it was devised as an authorized testing format for counterintelligence security polygraph examinations. It was subsequently approved as an authorized testing format for specific issue examinations. As in Version 1, version 2 of the AFMGQT also has a two, three and four relevant question test.

1.3.2.1. The primary difference between versions 1 and 2 of the AFMGQT is that each relevant question in version 2 is always bracketed by a comparison question. In the analysis process, each relevant is always evaluated against the most responsive bracketing comparison question.

1.3.2.2. The question string for each type of test in version 2 is as follows:

1.3.2.2.1. Two relevant question test: I(1), SR(2), C3, R4, R5, C6

1.3.2.2.2 Three relevant question test: I(1), SR(2), C3, R4, R5, C6, R7, C8

1.3.2.2.3 Four relevant question test: I(1), SR(2), C3, R4, R5, C6, R7, R8, C9

1.3.2.3. In this testing format, relevant question 5 is always the primary relevant question while all other relevant questions are secondary relevant questions. As in Version 1, chart 2 is always a mixed chart. At the examiner's discretion, chart 3 may also be a mixed chart or it may be in straight sequence.

1.4. Test Data Analysis. The three AFMGQT decision outcomes that can be rendered are NDI, DI and NO. The AFMGQT relies only on vertical spot totals (AFMGQT 2005).

1.4.1. For a NDI opinion, there must be at least a plus three (+3) or greater at each overall vertical spot total.

1.4.2. A minus three (-3) or less at any overall vertical spot total, regardless of the scores for the other overall vertical spot totals, will result in a DI opinion.

1.4.3. Any other combination of overall vertical spot totals is considered NO.

APPENDIX E

1.0. <u>DoDPI (Army) Modified General Question Test (MGQT) Evaluation Procedures</u>

1.1. The DoDPI MGQT is a multi-facet test in which the relevant questions are targeted toward different elements of the same crime (Kraphol et al, 2002).

1.2. The DoDPI MGQT format contains four relevant question analysis spots and two comparison questions (questions six and ten). The relevant question analysis spots are: relevant question three (R3), relevant question five (R5), relevant question eight (R8), and relevant question nine (R9). Generally, the serial positioning of each question within the question string is identical on the first two charts (Charts I-1 and I-2); however, at the examiner's discretion, the comparison questions may be moved in the question string for Chart I-2. The third chart (Chart I-3) is presented in a mixed order and the serial positioning of the relevant questions is at the examiner's discretion. (MGQT, 2004).

1.3. The DoDPI MGQT format utilizes two comparison questions that are serial positioned, on Chart I-1 and Chart I-2, at position six and ten within the question string. On Chart I-3, each of the two comparison questions are asked twice and their serial positioning is at the examiner's discretion.

1.4. The following depicts the serial position of each question in the question string for Chart I-1 and Chart I-2. Questions one, two, four and seven are irrelevant questions. Questions three, five, eight and nine are relevant questions and questions six and ten are comparison questions.

<div style="text-align:center">I1 - I2 - R3 - I4 - R5 - C6 - I7 - R8 - R9 - C10</div>

1.5 The following depicts examples of the serial position of each question in the question string for the mixed chart that is labeled I-3:

<div style="text-align:center">I4 - I1 - R5 – C6 - R3 - C10 - R9 - C6 - R8 - C10</div>

<div style="text-align:center">I4 – I1 – R9 – C10 – R8 - C6- R5- C10 - R3 - C6</div>

<div style="text-align:center">I4 – I1 - R8 - C6 - R9 - C10 - R3 - C6 - R5 - C10</div>

1.5.1. Spot I: For Charts I-1 and I-2, relevant question three is evaluated against comparison question six.

1.5.1.1. On Chart I-3, the first relevant question (which is typically the least responsive from the previous two charts collected) is only compared against the first comparison question.

1.5.2. Spot 2: For Charts I-1 and I-2, relevant question five is evaluated against comparison question six.

1.5.2.1. On Chart I-3, the second relevant question appearing in the question string is compared against the adjacent comparison question that elicited the most significant response in each of the respective recording channels.

1.5.3. Spot 3: For Charts I-1 and I-2, relevant question eight is evaluated against either comparison question six or comparison question 10.

1.5.3.1. On Chart I-3, the third relevant question appearing in the question string is compared against the adjacent comparison question that elicited the most significant response in each of the respective recording channels.

1.5.4. Spot 4: For Charts I-1 and I-2, relevant question nine is evaluated against comparison question 10.

1.5.4.1. On Chart I-3, the fourth relevant question appearing in the question string is compared against the adjacent comparison question that elicited the most significant response in each of the respective recording channels.

1.6. Test Data Analysis. The three DoDPI MGQT decision outcomes that can be rendered are NDI, DI and NO. The DoDPI MGQT relies only on vertical spot totals (MGQT 2004).

1.6.1. For a NDI opinion, there must be at least a plus three (+3) or greater at each overall vertical spot total.

1.6.2. A minus three (-3) or less at any overall vertical spot total, regardless of the scores for the other overall vertical spot totals, will result in a DI opinion.

1.6.3. Any other combination of overall vertical spot totals is considered NO.

APPENDIX F

1.0. <u>Test for Espionage and Sabotage (TES) Evaluation Procedures</u>.

1.1. The TES was designed to provide a means of ensuring that the loyalty of individuals entrusted with our Nation's secrets is further confirmed (TES, 2004). In the TES format, developed by DoDPI, there are three sets of two relevant question pairings or six relevant question analysis spots comprising each of two sub-tests (i.e., Sub-test A & Sub-test B).

1.2. Sub-test A: The standard serial positioning of each question within the question string is as follows:

I1 - I2 - SR - 1C1 - 1R1 - 1R2 - 1C2 - 2R1 - 2R2 - 2C1 - 3R1 - 3R2 - 2C2

1.3. Sub-test B: The standard serial positioning of each question within the question string is as follows:

I1 - I2 - SR - 1C1 - 1R3 - 1R4 - 1C2 - 2R3 - 2R4 - 2C1 - 3R3 - 3R4 - 2C2

1.4. Each relevant question presentation is compared against the most responsive comparison question positioned immediately preceding or following it. For example, for Sub-test "A" above, relevant questions 1R1 and 1R2 may be compared against either 1C1 or 1C2. For Sub-test "B" above, relevant questions 3R3 or 3R4 may be compared to either 2C1 or 2C2.

1.5. Test Data Analysis. The three TES decision outcomes that can be rendered are Significant Response (SR), No Significant Response (NSR) and NO. The decision outcomes are predicated on vertical and horizontal spot analysis totals.

1.5.1. The analysis spots for sub-test "A" are relevant questions 1R1, 1R2, 2R1, 2R2, and 3R1 and 3R2.

1.5.2. The analysis spots for sub-test "B" are relevant questions 1R3, 1R4, 2R3, 2R4, and 3R3 and 3R4.

1.5.3. For a NSR opinion, each overall relevant question score (i.e., the sum of the three askings of each of the two relevant questions) must be positive (i.e., >0) with a combined overall horizontal sub-test score of a plus four or greater.

1.5.4. A minus three or less (i.e., -3, -4) for any overall relevant question score or an overall horizontal sub-test score of minus four (-4) or less will result in an opinion of SR.

1.5.5. Any other combination of scores for either the overall question score or overall sub-test score is considered NO.

APPENDIX G

FIGURES

APPENDIX H

GLOSSARY

Air Force Modified General Question Test (AFMGQT)
A modified version of the Army MGQT that falls within the category of comparison test formats. It includes a sacrifice relevant, relevant, comparison, and irrelevant questions. This particular format allows for a two, three or four relevant test that addresses multiple facets of a specific issue. Variations of the AFMGQT may be used to test multiple issues for personnel screening and source validation.

Amplitude
The physiological activity reflected in a PDD waveform/tracing occurring between response onset and response peak (highest level from pre-stimulus baseline). Magnitude of a physiological response.

Analysis spot
The specific location, or applicable relevant question on a PDD chart, where the spot analysis concept is employed. An analysis spot includes a relevant question and applicable comparison question(s).

Artifact
An artifact is a change in a physiological pattern not attributable to stimulus (question presentation) or recovery.

Baseline
The physiological level at which an examinee's system is during stimulus onset. The term tonic level is often used interchangeably with the term baseline. A baseline is subject to change, irrespective of whether a stimulus has been applied or not.

Baseline arousal
Term used in PDD to characterize a marked upward shift in the respiratory, electrodermal, or cardiovascular waveforms. These shifts represent physiological responses to sensory or cognitive stimulation. Baseline arousals do not always occur during deception; however, when they are observed they can be indicative of deception. Some baseline arousals are relatively short-lived, while others can continue for much longer.

Blocking
Respiration pattern wherein the examinee discontinues respiration at or near the end of the expiratory segment of the respiration cycle.

Blood pressure
The pressure blood exerts against the walls of the arteries, usually measured in millimeters of mercury. PDD examiners evaluate relative blood volume changes, as current polygraphs are not capable of providing absolute blood pressure measurements.

Blood volume
Quantity of blood in an organ or limb, usually recorded as relative increases or decreases in the circumference of the affected area or size of blood vessels. Changes in blood volume are mediated by local, neural, and humeral mechanisms, such as the shunting of blood to the major muscle groups during sympathetic nervous system activations. Traditional PDD methods use changes in blood volume for diagnostic purposes rather than blood pressure per se.

Brachial artery
Major blood vessel of the upper arm that receives blood from the aortic arch via the subclavian and axillary arteries. Traditionally, the blood pressure cuff is placed around the upper arm and inflated to partially occlude the brachial artery. Sensors placed over the artery transduce the various Korotkoff sounds produced by blood flowing through the partially occluded artery. This is the preferred placement site for the blood pressure cuff in PDD.

Bracketed relevant question
A question string wherein a relevant question has a comparison question that precedes and follows it and either comparison question may be used for evaluation against the relevant question.

Cardiograph
General term, often abbreviated cardio, applied to any recording of cardiovascular activity. In PDD, the use of a blood pressure cuff to monitor relative arterial blood pressure and pulse wave changes is more precisely described as sphygmography (recording arterial pulse waveforms) or occlusion plethysmography (recording size or volume changes of a body part that is partially occluded). While the term cardiograph is not incorrect in this context, it lacks precision in denoting the actual phenomenon being recorded in PDD. Cardiograph in the psychophysiological and medical literature most often denotes the electrocardiograph.

Cardiosphygmograph
An alternate term for a device that records the pulse wave and relative blood volume waveform used in PDD. While the term cardiosphygmograph was common parlance in the 1930s through 1950s, it is used less frequently today even though it is more precise than the current expression, cardiograph or its abbreviated counterpart, cardio.

Cardiovascular sensor
One of the three types of sensors routinely used in the conduct of a PDD examination. The cardiovascular sensor monitors relative blood volume and pulse rate. The standard cardiovascular sensor is the blood pressure cuff assembly, consisting of an arm cuff, manometer, and connecting tubing (sphygmomanometer).

Cardiovascular waveform
The display of physiological patterns of the examinee's relative blood volume and pulse rate.

Channel
Any one of the four sensor inputs used to monitor and record activity of the respiration, electrodermal and cardiovascular system.

Chart
A graphic representation containing selected physiological data generated by an examinee during the data collection phase of a PDD examination.

Comparison question
A question designed to produce a physiological response. The physiological responses of the comparison questions are compared to the physiological responses of the applicable relevant questions. The probable and directed lies are the two types of comparison questions utilized within the federal government.

    --Directed-Lie Comparison (DLC)
A comparison question that addresses a minor transgression to which most people will readily admit. Upon acknowledging having committed such a transgression, the examinee is directed to lie when asked that question on the test. The Test for Espionage and Sabotage (TES) employs DLC questions.

    --Probable-Lie Comparison (PLC)
A question designed to be a probable lie for the examinee. The PLC question should be similar in nature but unrelated to the specific crime or issue being tested. The question should be separated from the relevant issue by time, place, or category. The comparison question should use the same action verb or similar in nature action verb as that of the relevant issue. A comparison question should be broad in scope and time so that it captures as many of the examinee's past life experiences as possible.

Comparison question technique. Refers to a family of testing formats whereby values are assigned to various analysis spots based upon comparisons between relevant and comparison questions. The two types of comparison questions that are principally used in the Federal government are the PLC question and the DLC question. The ZCT and MGQT employ the comparison question technique; however, the formats (structure) are different, yet they both use PLC questions. The TES also employs the comparison question technique; however its format is unique and it uses DLC questions.

Comparison test format
An umbrella term for standard testing formats that use a variation of the modified general question test.

Conductance
Capacity of a material to permit the flow of electrical current. In electrical terms, conductance equals the current flow between two points divided by the voltage difference between those same two points. A related measure, resistance, is the reciprocal of conductance. Skin conductance is a common measure used in PDD.

Countermeasure
Any action(s) taken to affect a PDD examination outcome by tactical employment of behaviors, movements, medication, or cognitive processes.

Computerized polygraph
A computerized diagnostic instrument capable of monitoring, recording, storing, and analyzing respiratory, electrodermal, and cardiovascular activity.

Data collection phase
This is the second phase of a PDD examination and begins with the collection of the first chart. When a conclusive series is conducted, the data collection phase ends when test data analysis (the third phase) begins.

Deception Indicated (DI)
An opinion which indicates that an analysis of the PDD charts revealed the physiological responses to the relevant question(s) is indicative of deception.

Dicrotic notch
A regular feature of the pulse wave. It is generated by the closure of the aortic valve and marks the end of systole and the beginning of diastole. It has not been found to be a reliable diagnostic feature in PDD.

DoDPI (Army) Modified General Question Test (MGQT)
A modified version of the John Reid technique that falls within the category of comparison test formats. This particular technique was modified by the U.S. Army Military Police Polygraph School in the late 1960s and it was called the Army MGQT. It includes relevant, comparison, and irrelevant questions and addresses multiple facets of a specific issue. This polygraph technique incorporates a mixed chart.

Duration
Duration is the amount of time that elapses from response onset to when the response returns to the pre-stimulus tonic level or establishes a new tonic level in the ED or CV tracing, or recovery begins in the respiratory tracing.

Eccrine glands
One of two types of sweat glands, the eccrine glands influence electrodermal activity as monitored in PDD. They are found throughout the skin surface of the body, but in highest concentration on the palms, soles, and axillae (armpits). The primary function of the eccrine glands is thermoregulation; however, emotional stressors, mainly on the palms and soles, also produce eccrine sweat.

Electrodermal activity recovery phase
The physiological activity displayed in an electrodermal activity waveform that occurs between the highest peak and subsequent return to the pre-stimulus or newly established baseline.

Electrodermal activity rise
Physiological activity displayed in an electrodermal waveform beginning with response onset and ending at the peak.

Electrodermal Activity (EDA)
All exosomatic and endosomatic changes in the electrical properties of the skin.

Electrodermal Activity (EDA) Sensor. One of the three types of sensors routinely used in the conduct of a PDD examinations. The EDA sensor monitors skin resistance or skin conductance (instrument dependent) obtained through exosomatic recording with a galvanograph component. The standard EDA sensor is a set of finger electrodes with connecting wiring or silver-silver chloride pads with sensors.

Electrodermal Activity (EDA) Waveform
The display of physiological patterns of either skin resistance or skin conductance obtained through exosomatic recording with a galvanograph component.

Electrodermal Response (EDR)
Reaction of skin measured by changes in its electrical properties, including skin resistance (SR), skin conductance (SC), and skin potential (SP).

Endosomatic
Generated from within the body. An example of an endosomatic measure is skin potential because it reflects the voltage differences between two electrodes on the skin surface; bioelectricity is generated by the neurons of the dermis. Similarly, bioelectricity is generated by neurons in the brain and the heart resulting in the EEG and ECG signals, respectively.

Examination
A process that encompasses all activities that take place between a PDD examiner and an examinee during pretest, data collection, test data analysis, and posttest phases of a PDD examination.

Examiner
Someone who has successfully completed formal education and training in conducting PDD examinations and is either authorized or formally certified, by the examiner's agency, to conduct such examinations.

Excessive noise
Noise in a physiologic tracing that reaches a level that disrupts or prevents the data from being used for diagnostic purposes. Excessive noise may be isolated to a single recording channel or all channels.

Exclusionary comparison question
Comparison questions that attempt to achieve a clear line of demarcation, from events surrounding the relevant issue, by using time, place, or category separation.

Exosomatic
Generated from outside the body. Examples of exosomatic measures are skin conductance and skin resistance because they are determined by the application of external electrical current to the skin.

Fight, Flight, Freeze (F3)
Three stereotypic behavioral responses to threat; sometimes called simply F3. The physiological responses concomitant to these behaviors are involved in mobilizing the body's resources for an expenditure of energy and narrowing attentional focus to the features of the threat. This preparation activity of the body explains the pattern of arousal responses that are recorded during PDD. Some researchers also believe that the shift in attentional focus accounts for the differential responses elicited by different types of questions.

Forensic Psychophysiological Detection of Deception (PDD)
The science that deals with the relationship and applications of PDD tests within the legal system. It is the academic discipline that provides the student, the practitioner, and the researcher with the theoretical and applied psychological, physiological, and psychophysiological fundamentals for a thorough understanding of PDD tests, and the skills and qualifications for conducting PDD examinations. The modifier "forensic" delineates and delimits this discipline from the broader discipline of psychophysiology.

Galvanic Skin Response (GSR)
A superseded term replaced by the term electrodermal activity (EDA). GSR is an exosomatic measure of the changing electrical resistance of skin. GSR is sometimes erroneously called Galvanic Skin Resistance or Galvanic Skin Reflex. The current term is skin resistance.

Galvanograph
Polygraph component responsible for producing the graphic recording of skin resistance.

General Nervous Tension (GNT)
Recorded physiological patterns that suggest the examinee's baseline arousal is high. This arousal is not indicative of deception in itself. GNT is sometimes indicated by very fast heart rates, unusually labile electrodermal activity, and uneven respiration cycles.

Global test data analysis
A system of rendering an opinion by viewing the PDD chart as a whole, as opposed to making systematic comparisons among questions.

Heart rate
Rapidity of ventricular contractions, usually measured in beats per minute. It is one index of physiological arousal. Recent research indicates that after stimulus onset, cardiac arousal takes the form of an immediate decrease in heart rate. Heart rate and the interbeat interval are reciprocals of one another.

Holding
A pattern sometimes seen in the respiration waveform in which the examinee discontinues respiration at or near the respiratory peak. Holding is differentiated from a typical apnea in that apnea most often occurs near the end of the expiratory segment of the respiration cycle.

Homeostasis
Complex interactive regulatory system by which the body strives to maintain a state of internal equilibrium. The term resting state, pre-stimulus baseline, and homeostasis are used interchangeably.

Hyperventilation
Increase in rate and depth of respiration. Physiologic consequences include increased pulmonary ventilation and decreased carbon dioxide concentrations. Hyperventilation is not a diagnostic feature used in the evaluation of the respiration waveform.

Inhalation/exhalation ratio
The duration of inhalation segment of the respiratory cycle compared with that of exhalation segment. Normally the ratio is about 1:2 in a resting human and changes during stress. Changes in I/E ratio are a diagnostic feature or criterion in PDD and were first reported by Benussi in 1914.

Irrelevant question (in comparison question formats)
A question that is designed to be a non-emotion invoking question used to absorb orienting responses and assist in establishing an examinee's physiological baseline. They should be neutral questions and must be unrelated to the matter under primary investigation.

Latency
Refers to the period of time from stimulus onset to response onset. An examinee may respond within the prescribed response onset window for each recording channel or outside of those windows.

Law of initial values
The extent to which an individual is able to respond physiologically is determined by his/her body's physiological state at stimulus onset. An individual's potential response range is greater when in a state of homeostasis than when in a heightened state of arousal.

Modified General Question Test (MGQT)
A category of comparison test formats that: 1) includes relevant, comparison, and irrelevant questions, 2) may include a sacrifice relevant question, 3) addresses multiple facets of a specific issue, and 4) incorporates a mixed chart. Various DoD and federal agencies utilize selected modified versions of the MGQT in specific issue testing. Variations of the MGQT may also be used to test multiple issues for personnel screening and source validation.

No Deception Indicated (NDI)
An opinion that indicates that an analysis of the PDD charts revealed the physiological responses to the relevant question(s) were not indicative of deception.

No Opinion (NO)
An evaluation that indicates the examiner cannot render a conclusive opinion of DI or NDI based upon the evaluation of physiological data on a given set of charts.

Non-specific response
A response that occurs during the collection of PDD data that is not attributable to an applied stimulus. The term random response is also used interchangeably with non-specific response.

No Significant Response (NSR)
This is one of three diagnostic opinions used in various screening contexts. It is equivalent to the term NDI, which is the term of reference in criminal specific issue testing.

Numerical Test Data Analysis (TDA)
Systematic assignment of numerical values to physiological responses, and decision rules that are based on the sums of those numerical values. The DoDPI Numerical Evaluation Scoring System uses two numerical evaluation scales: The three- and seven-position scale.

Orienting response
The type of response that is expected to occur as a result of a novel stimulus or the type of response expected at the beginning of a polygraph chart when the examinee is orienting to the verbal stimulus during the data collection process.

Overall vertical spot total
The sum of all subtotals for a specific relevant question spot in one series of a comparison question examination.

Parameter
Term used in PDD to denote a single physiological data channel (e.g., pneumograph). The term parameter and channel are used interchangeably.

Peak
Refers to the highest point a waveform achieves following response onset.

Phasic response
A short-term change in physiological activity following question presentation. Typically, this response has a relatively rapid onset and may return to the pre-stimulus baseline or establish a new baseline within a period characteristic of the response system.

Plethysmograph
Device that measures changes in blood volume in a part of the body. Two common types of plethysmographs are occlusion (use of inflatable cuff to restrict venous return while measuring volume changes indirectly via pressure or resistance) and photoelectric (use of infrared light emitter-collector diode pair that measures volume changes indirectly by directing light into the skin and detecting its reflection back).

Polygraph
A diagnostic instrument used during a PDD examination that is capable of monitoring and recording, at a minimum, respiratory, electrodermal, and cardiovascular activity as a response to verbal or visual stimuli.

Premature Ventricle Contraction (PVC)
Term loosely applied to any premature heart contraction, but more precisely, it is a ventricular contraction initiated by an ectopic focus in the ventricles and not the atria. During a PVC, the normal sinus rhythm is interrupted and a compensatory pause results. Sometimes referred to as extra-systolic beat.

Psychophysiological Detection of Deception (PDD)
The academic discipline that provides the student, the practitioner, and the researcher with the theoretical and applied psychological, physiological, and psychophysiological fundamentals for a thorough understanding of PDD tests, the skills and qualifications for conducting PDD examinations.

Pulse pressure
The arithmetic difference between the systolic and diastolic blood pressures.

Question string
All of the questions that appear on a PDD chart between test commencement (i.e., X) and test termination (i.e., XX).

Rebound
A recovery that drops below the pre-stimulus baseline line and subsequently returns to the pre-stimulus baseline. Rebound may be attributable to physiology and instrumentation.

Recovery
A deviation in a PDD waveform attributable to a physiological phenomenon occurring as a compensatory action after a response or an artifact (i.e., return to homeostasis or pre-stimulus baseline).

Relevant question
A relevant question pertaining directly to the matter under investigation or to the issue(s) for which the examinee is being tested. Relevant questions consist of primary, secondary, evidence connecting, and guilty knowledge questions.

Relevant question (primary)
This question tests the possible direct involvement of the examinee. In PDD screening questioning formats, all relevant questions are considered primary relevant questions.

Relevant question (secondary)
This question tests the examinee's indirect or collateral involvement in the offense or matter under investigation. Secondary relevant questions address involvement (i.e., help, plan, or participate), an element (e.g., see, hear, or know), nature or location of evidence (i.e., Do you know where. . .), and physical acts (e.g., cut, break, splice, tear) that support the primary issue.

Respiration apnea
A temporary disruption of the respiratory cycle (cessation of breathing). If this temporary cessation of breathing occurs during or near the end of the respiratory cycle, it is defined as blocking. Apnea is the ultimate manifestation of respiratory suppression.

Respiration Line Length (RLL)
A means of evaluation introduced by Howard Timm. RLL refers to the linear measurement of the respiration waveform over a specified period of time.

Respiratory sensor
One of the three types of sensors routinely used in the conduct of PDD examinations. Normally two respiratory or pneumograph chest assembly sensors monitor the mechanics of abdominal and thoracic breathing or ventilation. The standard pneumograph chest assembly is comprised of a convoluted rubber tube, connecting tubing, and a beaded chain or other type of fastener that allows placement on the examinee.

Respiratory Sinus Arrhythmia (RSA)
A cyclical rising and falling in the cardiograph waveform that is synchronous with respiratory activity. Although this same pattern may be created by physical movement contamination (i.e., if the arm with the blood pressure cuff is placed too close to the body and consequently moves in synchrony with chest wall expansion), a vagus effect is distinct. Parasympathetic innervation (through branches of the vagus nerve) driving both respiratory and heart rate activity may be so prominent as to induce this characteristic synchronous wave in the cardiograph tracing.

Respiratory waveform
The display of physiological patterns reflective of an examinee's breathing activity. The respiratory waveform consists of inhalation and exhalation cycles.

Response
A physiological change to an applied stimulus that may be a diagnostic trend or phasic response.

     --Diagnostic trend response
A response that refers to a change in physiological activity during data collection procedures generally requiring a significant period of time for completion. This response is typically the type utilized in evaluating peak-of-tension physiological data and similar formats.

     --Phasic response
A response that refers to a short-term change in physiological activity following question presentation. Typically, this response has a relatively rapid onset and may return to the pre-stimulus baseline or establish a new baseline within a period characteristic of the response system.

Response onset
The first indication of physiological change from the pre-stimulus level to an applied stimulus. For a response to be considered timely, response onset must occur within the respective response onset windows designated for each recording channel.

Response onset window
Refers to the traditional time period, from stimulus onset, where one would predict a physiological response to occur in order for that response to be deemed timely. Response occurring beyond the designated response onset window for each recording channel, although not generally considered timely, may nevertheless be evaluated if consistency (latency) is demonstrated.

Resting state
An informal term that refers to an individual's homeostatic state. This term is often used interchangeably with tonic level, homeostasis, and state of equilibrium.

Rise time
The period of time from response onset to the peak of a waveform.

Sacrifice relevant
A sacrifice relevant question is the first question in a question string, involving certain testing formats, that is related to the relevant issue(s). The purpose of the sacrifice relevant question is to prepare the examinee for introduction of the relevant questions. Sacrifice relevant questions are not scored.

Serial position
The position of a question within a question string.

Seven-position scale
One of two semi-objective numerical evaluation scales taught by DoDPI. The seven-position scale enables assigning any of the following values based upon comparisons between relevant and comparison questions: -3, -2, -1, 0, +1, +2, +3. By convention, negative values represent greater physiological response to relevant questions, while positive values indicate greater response to comparison questions. A zero usually indicates equal or no responses to either the relevant or comparison questions, or that the evaluation spot does not meet minimum standards for interpretation. Each testing format has an assigned numerical threshold that results in one of three decision outcomes.

Signal value
The perceived salience or extent to which an examinee is affected by a stimulus. External significance is assigned to a question when it appears to differ from others based on appearance (i.e., is much longer or is read in a louder tone of voice). Internal significance is assigned to a question because of the examinee's perception of the question's scope or content. The objective of a CQT examination is to make the external significance of relevant and comparison questions appear equal, and for their internal significance to vary. An innocent examinee would be expected to generate higher internal significance for the comparison questions, whereas the relevant questions would hold higher internal significance for the deceptive individual.

Significant Response (SR)
This is one of three diagnostic opinions used in various screening contexts. It is equivalent to the term DI in criminal specific issue testing.

Skin Conductance (SC)
General term for skin conductance level and skin conductance response. Both are recorded exosomatically. In recent years, some PDD instrumentation has moved away from skin resistance measures toward skin conductance because skin conductance measurements are linearly related to the number of active sweat glands at the recording site. Sweat gland activity is controlled, in part, by the sympathetic nervous system.

Skin Resistance (SR)
General term for skin resistance level and skin resistance response. Both are recorded exosomatically. Skin resistance was the primary means of detecting electrodermal activity throughout much of PDD history until the introduction of computerized instrumentation. Skin conductance is now the preferred measure.

Sphygmomanometer
A device consisting of a pressure cuff connected to a manometer (pressure sensor) that is used for the indirect measurement of blood pressure. The pressure cuff is placed around a large artery (i.e., brachial artery) and then inflated until the artery is completely occluded. Cuff pressure is gradually released while sounds (Korotkoff sounds) caused by blood passing through the partially occluded artery are monitored. The manometer is also monitored to determine the pressures at which these sounds occurred. The pressure at which sound is first heard is termed systolic pressure, while the pressure at which sound is last heard is termed diastolic pressure. Typically, a stethoscope is placed distal to the occluded artery to enable a person to hear the Korotkoff sounds. This is the ausculatory method since blood pressure is determined while listening to sounds produced within the body.

Spot
A specific location, or applicable relevant question, within a question string where the spot analysis concept is applied.

Spot analysis
A fundamental concept for assigning values, by individual recording channel, based upon comparisons between a relevant question and the applicable comparison questions. The test data analysis rules, for a particular testing format, dictate which relevant and comparison question(s) to use for analysis.

Stimulus
Any oral stimulus presented by the examiner to the examinee during test data collection. Typically refers to a reviewed question that is presented to the examinee during a test.

Stimulus (stim) identifier
A stimulus or stim identifier is a test data notation, usually consisting of Arabic numbers, letters, or alphanumeric characters, which is applied directly on the PDD chart. The stimulus identifier indicates the specific stimulus applied by the examiner during the data collection phase.

Stimulus (stim) mark

A stimulus or stim mark is a test data notation indicated by a vertical mark on PDD charts. A pair of stim marks denotes the exact location on the PDD chart of a specific applied stimulus onset and stimulus end.

Stimulus end

During data collection, stimulus end is the last syllable spoken by the examiner when a stimulus is presented.

Stimulus onset

During data collection, stimulus onset is the first syllable spoken by the examiner when a stimulus is presented.

Symptomatic question

A question designed to test for an outside issue that could be more significant for an examinee than the issues being tested.

Test data

Physiologic recording of responses of the examinee in response to stimuli.

Test data analysis

Test data analysis is the systematic process by which a particular set of decision rules is applied to the evaluation of diagnostic features and other physiological data resulting in one of three outcome decisions.

Test data notations

Notations used to indicate events that occur during the collection of a chart.

Test for Espionage and Sabotage (TES)

Multiple-issue testing format employed by some U.S.Government agencies for screening purposes. The TES uses a repeated series of relevant and directed-lie comparison questions, and the conventional 7-position scoring system.

Three-position scale

Abbreviated application of the seven-position scale for PDD test data analysis. The major difference is that the range of values for each question pairing comparison is from minus one (-1) to plus one (+1), rather than the range of minus three (-3) to plus three (+3) in the seven-position scoring system.

Tonic level change

A relatively slow adjustment in the tonic (baseline) level that may occur over a significant period of time.

Tonic level
An examinee's level of physiological activity occurring prior to stimulus onset. This is sometimes referred to as the resting or baseline activity level. Tonic level describes a person's physiological activity when resting.

Vagus roll
Undulations in the pulse wave amplitude that are 2-4 seconds after the corresponding respiratory activity.

Window-of-evaluation
A term that refers to the onset and period in which data is used for evaluation purposes when applying RLL. Comparative responses, in the respiration channel, are evaluated using identical time windows. The default time window is predicated on the comparative response displaying the most significant response duration. For example, if a comparison question has an RLL response of five seconds, and the relevant question has eight seconds of response, the window-of-evaluation for both comparative questions defaults to eight seconds.

Waveform
A particular physiological pattern that is studied for its diagnostic value. A waveform is also a mathematical representation of a wave, especially a graph of deviation at a fixed point versus time. The terms waveform and tracing are used interchangeably in PDD.

You-Phase Zone Comparison Test
A standardized specific issue test that addresses a single issue and uses only two relevant questions.

Zone Comparison Test (ZCT)
A ZCT is a PLC question technique designed to resolve a specific incident. The ZCT uses a sacrifice relevant question, irrelevant questions and symptomatic questions in designated positions. Relevant questions are compared in spots to designated comparison questions.

APPENDIX I

REFERENCES

Air Force Modified General Question Test (2005). Fort Jackson, SC: Department of Defense
    Polygraph Institute

Abrams, S. (1989). *The complete polygraph handbook*. Lexington, MA: Lexington Books.

Bevan, J. (1996). *A pictoral handbook of anatomy and physiology*. NY: Barnes and Nobel
    Books.

Brownley, K. A., Hurwitz, B.E., & Schneiderman N., (2000). Cardiovascular psychophysiology.
    In J.T. Cacioppo, L.G. Tassinary & G.G. Berntson (Ed), *Handbook of psychophysiology*
    (pp. 224-264). NY: Cambridge University Press.

Comroe, J. H. (1974). *Physiology of respiration*, 2nd ed. Chicago: Year Book Medical
    Publishers.

Dawson, M., Schell, A. & Filion, D. (2000). The electrodermal system. In J.T. Cacioppo,
    L.G. Tassinary & G. G. Berntson (Ed), *Handbook of psychophysiology* (pp. 200-223). NY:
    Cambridge University Press.

Darrow, C.W. (1927). Sensory, secretory, and electrical changes in the skin following bodily
    excitation. *Journal of experimental psychology*, 10, 197-226.

Gantt, W. H. (1960). Cardiovascular component of the conditional reflex to pain, food and other
    stimuli. *Physiological Review*, 40, 266-291.

Holmes, D. S., Solomon, S., Frost, R. O. & Morrow, E. F. (1980). Influence of respiratory
    patterns on the increases and decreases in heart rates in heart rate biofeedback training.
    Journal of Psychosomatic Research, 24, 147-53.

Kircher, J.C. & Raskin, D.C. (1988). Human versus computerized evaluations of polygraph data
    in a laboratory setting. *Journal of Applied Psychology*, 73(2), 291-301.

Krapohl, D. J. & Dutton, D. W. (2001). Respiration line length. *Polygraph*, 30(1), 58-59.

Krapohl, D. J. & Sturm, S. (2002). Terminology reference for the science of
    psychophysiological detection of deception. *Polygraph* 31(3), 198.

Larsen, P. B., Schneiderman, N. & Pasin, R. D. (1986). Physiological basis of cardiovascular
    psychophysiology. *Psychophysiology: Systems, processes, and applications,* (pp.122-65)
    NY: The Guilford Press.

Leavenson, R. W. (1979). Cardiac-respiratory-somatic relationships and feedback effects in a multiple session heart rate control experiment. *Psychophysiology,* 16, 367-373.

Levitzky, M.G. (1986). *Pulmonary physiology*, 2nd ed. NY: McGraw-Hill.

Martini, F. H., & Bartholomew, E. F. (2000). *Essentials of anatomy and physiology*. Upper Saddle River, NJ: Prentice Hall.

Modified General Question Test (2004). Fort Jackson, SC: Department of Defense Polygraph Institute

Obrist, P. A., (1981). *Cardiovascular psychophysiology: A perspective*. NY: Plenum Press.

Pack, P. E. (1997). The cardiovascular system. *Cliffs quick review: Anatomy and physiology* (pp. 189-225). Lincoln, NE: Cliffs Notes.

Podlesny, J. A. & Kircher, J. C. (1999). The Finapres (volume clamp) recording in psychophysiological detection of deception examinations. *Forensic Science Communications*, 1(3).

Richards, D.W. (1953). Respiration. In J.T. Cacioppo, L.G. Tassinary & G.G. Berntson (Ed), *Handbook of psychophysiology* (pp. 265). NY: Cambridge University Press.

Sroufe, L. A. (1971). Effects of depth and rate of breathing on heart rate and heart rate variability. *Psychophysiology, 8,* 648-645.

Sticker, A. (1897). Uber *Versuche einer objectiven Darstellung von Sensibilitatsstorungen*. In Jung, C.G. (1918), *Studies in word Association*, 448-449. London: Heinermann and (1919) New York: Moffat, Yard & Co.

Tarchanoff, J. (1890). *Uber de galvanischen Erscheinungen an der Haut des Menschen bei Reizung der Sinnesorgane and Dei verscheidenen Formen der Psychiscen Tatigkeit, Pfugers Arch. Ges, Physiol*. In J.T. Cacioppo, L.G. Tassinary & G. G. Berntson (Ed), *Handbook of psychophysiology* (pp. 201). NY: Cambridge University Press.

Test for Espionage and Sabotage (2004). Fort Jackson, SC: Department of Defense Polygraph Institute.

Timm, H.W. (1981). *An objective procedure for quantifying respiration patters contained on field polygraph charts: A validation study*. Paper presented at the annual meeting of the Academy for Criminal Justice Sciences, Philadelphia, PA.

Tobin, M. J., Mador, M. J., Guenther, S. M., Lodato, R. F. & Sackner M. A.(1988). Variability of resting respiration drive and timing in healthy subjects. *Journal of Applied Physiology,* 65(1).

Veraguth S. (1907). *Das Psychogalvanische Reflexphanomen.* In Trovillo, Paul Y. (1939). A history of lie detection. *Journal of Criminal law, Criminology and Police Science*, 29, 848-881 & March-April, 30, 104-119.

Weinstein, D. A. (1994). *Anatomy and Physiology for the Forensic Psychophysiologist*. Fort McClellan, AL: Department of Defense Polygraph Institute.

West, J. B. (1985). *Best and Taylor's Physiological Basis of Medical Practice*, 11 ed. Baltimore: Williams and Wilkins.