

Introduction to Anatomy and Physiology for Students of Polygraph Science

Joel M. Reicherter

Professor Emeritus, SUNY, Farmingdale

Adjunct Instructor, National Center for Credibility Assessment

INTRODUCTION

Students entering the science of polygraph come from a variety of disciplines, most often from the criminal justice professions but rarely from a biology or life science background. Criminal justice educated students typically bring interview skills and interrogation expertise to the polygraph setting. However, the actual polygraph data recorded and evaluated require a substantial understanding of physiology, neurobiology and psychology. In recent years, the concept of psychophysiological detection of deception (PDD) has been adopted to more precisely describe the mission of polygraph science.

Before you begin your formal education in the application of the physiological principles to PDD, particularly, if you don't have a life science background which most students don't, I would like to encourage you to introduce yourself to the most significant building blocks of physiology in preparation for your experiences at the National Center for Credibility Assessment (NCCA). Because of the foundation principles in PDD, physiology will be the first course you will take at NCCA.

There are many sources of internet sites and published texts on the subject of anatomy and physiology (A&P). We will be using the text *Fundamentals of Anatomy & Physiology* by Frederic Martini. Although updated revised editions are published every few years, any recent edition you can access will be helpful. Other well-known A&P authors, such as Elaine Marieb or Gerald Tortora, are also good resources. Your local or nearby college libraries are likely to stock these publications and other related anatomy and physiology texts. Naturally, you can go to the Internet to explore any of the suggested key words and phrases I highlighted in this introduction. These boldface terms are core to the understanding of anatomy and physiology as they pertain to PDD.

There are eleven body systems that interrelate with each other coordinated by the nervous system, particularly the brain. Of these systems, neurobiologists, physiologists, psychologists, and polygraph examiners have come to a widely agreed understanding that certain systems can be recorded, evaluated and assessed which best reflect the brain's perception of environmental events. These systems are the Cardiovascular, Respiratory,

and Integument (skin). As a polygraph student, you will need to have some basic fundamental understanding of these systems and their interrelationship so that you can perform at a high level of assessment as a practicing PDD examiner.

BACKGROUND

The body systems work together in a balanced internal physiological environment, described as **homeostasis**. Because systemic interaction takes place over many changing environmental conditions, homeostatic conditions for optimal body function can be altered to meet the presiding environmental conditions. Mark Handler (Handler, Rovner & Nelson, 2008) introduced the concept of **allostasis** to the polygraph community to address that matter.

Since all physiological activity occurs at the molecular and atomic level, you will need to introduce yourself to at least an elementary understanding of **molecule, atom, ion, electron, covalent bonding, and ionic bonding**. I realize these may be forgotten terms or maybe never understood but there are many resources available to introduce them to you.

As you know, all living things are made up of cells. It would be helpful for you to get a brief recall of your high school or college biology course about the characteristics of a cell. One of the most important parts of a cell in PDD is its membrane which is typically described as **selectively or semi permeable**. Because of the cell membrane design it can establish a separation of charged particles between the cell and its internal environment (interstitial fluid). Like a battery, nerve cells can separate charges and use them to form a current and create coordinating interaction among the systems. This concept will be described in class. In nerve cells, the two most important ions are **potassium ion (K) and sodium (Na) ions**. They play a key role in developing **resting and action potentials** which is the core basis of nervous system function.

NERVOUS SYSTEM

The nervous system is composed of a central division, the brain and spinal cord, and a peripheral division, the nerves (bundles of nerve cells). The brain generates original information, such as thoughts, ideas, etc. and can evaluate environmental stimuli coming to it by the five basic senses (sight, hearing, smell, taste, and touch). It can also process information presented to it by nerve cells coming from the organ systems and send nerve cell signals back to the systems for a response.

Nerve cells, (**neurons**), communicate with each other or to other cells at specially designed connections known as **synapses** by releasing **chemicals known as neurotransmitters**. There are many different kinds of neurotransmitters but two of the

most important to know about in polygraph science is **norepinephrine and acetylcholine**.

BRAIN: In class we will study the architectural design of the brain from three functional perspectives: **Cognition, Emotion, and Organ System Management**. It would be helpful for you to become familiar with the basic structural organization of the brain. The overwhelming largest region of the brain is the **cerebrum** separated into **right and left hemispheres** and further divided into four lobes, **Frontal, Parietal, Temporal and Occipital**. Review the general function of these lobes. Note that the surface of the brain is composed of many bumps and indentations (gyri and sulci) and described as gray matter. The pre frontal cortex of the frontal lobe is most involved in cognitive decision-making and coordinating many other brain divisions.

Deeper into the brain is a group of structures collectively known as the **Limbic System** which generates emotional perception of events and is involved in creating and retrieving memory. Many of our likes and dislikes of circumstances are recorded in this area which will provoke a sense of emotion. The emotion of fear, for example, is generated in the limbic system area known as the **amygdala**. In class we will explore the coordinating activity of emotion and cognition interplay which lead to the decisions we make. This neurological interplay, particularly the sense of fear and pleasure and the interaction with the prefrontal cortex, lead to decision-making which reflects the human condition. It often takes many years of nurturing and learning before the behavior output is widely beneficial, a conditional state in neuroscience commonly described as **maturity**.

Based on levels of maturity and social experiences, the cognitive/emotional interplay lead to organ system response, otherwise viewed as a **vegetative response**. The brain division which coordinates the brain assessment of environmental stimuli to the organ systems is the **Autonomic Nervous System (ANS)** and the **brain stem**. The ANS is composed of two divisions, the **Sympathetic and Parasympathetic**. These two divisions manage the organ systems when the brain perceives the environment as stressful or in a state of rest and repose.

There are 12 pair of cranial nerves and 31 pair of spinal nerves that communicate the brain and spinal cord with the body organs directly. Two nerves that are of particular importance in PDD understanding are the **Vagus nerve** in the parasympathetic division, and the **Cardiac nerve** in the sympathetic division.

In polygraph science you will learn to evaluate the signal values generated by the vegetative organ responses to the greater or lesser provoking questions presented to the examinee. In physiology class you will be introduced to those organ systems which generate the most significant signal values evaluated in PDD.

CARDIOVASCULAR SYSTEM

The cardiovascular system is composed of **blood, heart, and blood vessels (arteries, capillaries and veins)**. The overall concept is that the blood, which is capable of delivering nutrients, oxygen, hormones, and removal of cellular waste products, will be pumped by the heart through the blood vessels to and from the organ systems.

In your preparation for the physiology course, it would be helpful for you to review the basic structure of the heart. Pay special attention to the **chambers, valves and internal conductive system**. The drawings in the text are often excellent and very helpful.

Note the major arteries and veins. Although there are thousands of named vessels, we will only focus on about 25. The **aorta** is the largest artery and the **superior and inferior vena cavae** are the largest veins. Make note of the major branches that arise from the aorta and the major veins which join each other to form the largest veins, particularly in the arm.

The heart goes through continuous cycles of contracting and relaxing. These cardiac cycles pump blood into the arteries which lead to the capillaries where a dynamic exchange of nutrients and waste products occur between the blood and cells. The veins are vessels that bring the blood back to the heart. We will have a somewhat brief study of blood circulation dynamics and the role the ANS has on blood pressure changes. These pressure change dynamics reflect the examinee's perception of the consequences of the questions the polygraph examiner has presented. They are significant signal values in the polygraph chart evaluation.

It is likely you have heard of the "fight or flight" response. It may be wise for you to revisit that expression in the published literature. Keep in mind, the examinee is advised not to move during the recording of these vegetative body organ responses as the brain assesses the questions presented. The stationary position of the examinee will modify the organ responses that would otherwise occur in a more natural environment. We will have a detailed discussion in class about the body's response to polygraph questions when the subject is directed not to move. Stay tuned.

INTEGUMENTARY SYSTEM

The skin is composed of a **dermis** and an **epidermis** with several layers of cells. The details of skin structure and function will be reviewed in class. In your preparation, you should review the basic functions of the skin and the role of sweat glands. Briefly, the sweat gland secretions in the hand and fingers promote better grasping ability. Scientists in the various fields of human behavior study have come to an understanding

that sweat gland activity is directly responsive to the cognitive and emotional mix of the brain's assessment of the environment circumstance.

The PDD application of sweat gland described as electro-dermal activity (**EDA**) provides a very significant signal value of the brain's cognitive and emotional assessment of the polygraph questions presented during the examination. The ANS sympathetic division has direct management control of the sweat glands. You should do a little review of that relationship before class starts.

REPIRATORY SYSTEM

Like the previous two systems introduced, behavioral scientist have studied the role of breathing dynamics as the brain perceives the environmental condition. I suggest you review the location and structure of lungs and their anatomical relationship to the heart. Ventilation (breathing) dynamics can have significant effect upon the cardiovascular system and consequently its effect on polygraph recordings.

In class we will address this interplay and the concerns it generates in assessing PDD outcomes. It would be helpful for you to review the anatomical pathway of airflow from the **nose through the larynx, trachea, bronchi, and alveoli** before class starts.

Breathing dynamics can be modified. You can hold your breath, or make shallow inhalations and exhalations which can affect voice tone, loudness, and even effect blood pressure changes. The ability to modify breathing dynamics is a serious concern for the polygraph examiner. In class, we will explore these matters.

CONCLUSION

As you may now realize, the polygraph examiner is recording the vegetative function of three organ systems regulated by the cognitive and emotional assessment of the brain. Through many years of research by several human behavior disciplines such as physiology, neurobiology, psychology and other specialized scientific disciplines, PDD has evolved into a respected science. For it to continue to advance, future students and practitioners need to become as knowledgeable as possible about the human body's response to cognitive and emotional stimuli.

The instructors and staff at NCCA will lead you in a very scholarly approach in the study of PDD.

See you soon.

Joel Reicherter

REFERENCES

- Handler, M., Rovner, L., and Nelson, R. The concept of allostasis in polygraph testing. *Polygraph*, 37(3), 228-233.
- Marieb, E. N. *Human anatomy and physiology*. San Francisco: Pearson Benjamin Cummings: USA. Any recent edition is useful, but latest edition best if available.
- Martini, F. H. *Fundamentals of Anatomy and Physiology*. Pearson Benjamin Cummings: USA. Any recent edition is useful, but latest edition best if available.
- Tortora, G.J. and Derrickson, B. *Principles of Anatomy and Physiology*. Wiley: Hoboken, NJ. Any recent edition is useful, but latest edition best if available.