



**PSYCHOPHYSIOLOGY
OF RESPIRATION
IN HEALTH
AND DISEASE**

DONALD L. DUDLEY, M. D.

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PREFACE

Psychophysiology is generally defined as the study of psychologic and physiologic components and their interrelationships in biologic functions. As such, it represents a bridge between medicine and psychiatry. This monograph is an attempt to integrate psychologic, medical, and physiologic data into a unique view of the respiratory system. To call it the psychophysiology of respiration is an oversimplification, but, perhaps best communicates the contents. Both the clinical and basic scientific approaches are utilized and are integrated as closely as possible.

This monograph is a product of the combined efforts of five investigators who have an average of over 20 years of experience in applying their particular approach to research. The material was gathered over a ten-year period of continued work on the respiratory system which utilized all of the biases inherent in each investigator's particular field. More data are continuing to develop and hopefully, will continue to do so for another ten years.

Division of the monograph into five sections was done to facilitate its use. Each section is relatively independent of the others. A reader is thereby able to follow his own interests in selecting parts of the monograph which are of particular interest without having to read the preceding material.

We are appreciative of the many patients and supportive personnel who have contributed time and effort, but who are too numerous to mention individually. There are many who are omitted in the bibliographies who have contributed significantly to the general field of study. We wish to extend our appreciation to the Departments of Medical Illustration and Medical Photography for the illustrations.

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Section I

Background Information

This section provides an introduction to the monograph. Contained in it are the historical, medical, psychologic, anatomic, and physiologic data necessary for a basic understanding of the psychophysiology of respiration in health and disease. In addition to providing an introduction to the monograph, however, this section can also be used as a general introduction to pulmonary anatomy and physiology and to the diffuse obstructive pulmonary syndromes. The last chapter provides pertinent details regarding the various experimental studies which make up the monograph.

I

Introduction

The often repeated adage to “treat the whole man” is exceedingly difficult to apply and even more difficult to understand. What is the whole man—and, even if we knew, how would we treat him? Medical knowledge is complex in breadth and depth and yet it is evident that the surface has barely been scratched. This monograph is intended to be a *small* scratch on the surface of knowledge aimed at the evaluation and treatment of patients with psychophysiologic respiratory reactions, clinical emphysema, and, to a lesser degree, other chronic lung disease entities. As such it tells a story.

The story begins with the normal physiology and psychophysiology of respiration and extends to respiratory disease as seen through the eyes of psychiatrists, physiologists, and internists. The diseased individual is one who has developed—for largely unknown reasons—a condition of undetermined or questionable etiology which decreases the function of the pulmonary system and poses a threat to life and productivity. Once the disability and insufficiency appear, the person struggles to adjust his behavior to the failing system in order to retain some degree of comfort. It is soon evident to the patient that the experts have little of lasting value to offer: it dawns on him that, indeed, no one has any answers and that he is incapacitated for life. The patient then has increasingly severe emotional problems. He may become angry and self-destructive, accepting, or overwhelmed and depressed. He may decide the struggle to breathe is not worth it and wish to die, or he may live in constant fear of death. Regardless of his response, he pays a psychologic and physiologic price.

The development and progression of a disease obviously have some psychophysiologic effect on the patient. Personality changes may be caused by the physical or mental limitations imposed by the disease, by the realization that he is failing, or by direct effects on the central nervous system.

However, they represent only a portion of the toll exacted by chronic lung diseases. As lung function deteriorates, the patient's respiratory system becomes less and less able to respond to environmental inputs. Emotions which previously had little or no effect now produce disability. The patient has little understanding of this and his physician is ill-equipped to help him. At this point the patient may become a "problem patient" or a "hypochondriac." There may be a flood of telephone calls from the frightened, angry, anxious, or depressed and dyspneic patient. The physician may have little to offer, and the situation seems hopeless and overwhelming. Because of the chronic, seemingly hopeless, time-consuming and expensive nature of the problem, the patient may end up without a doctor. He may then go to emergency rooms and public hospitals, or he may learn to adapt to his disease without professional care. If he is lucky, he may be directed to one of the few hospital units which are designed to care for chronic lung disease.

The above represents the predicament for the majority of patients with emphysema. However, the treatment of these people does not seem quite so hopeless with a combined medical, physiologic, and psychologic approach.

The theoretical approach utilized in the studies to be outlined is based on work first published in the 1800s by Bell and by Darwin. Examples of their observations illustrate their point of view and the point of view finally adopted by current investigators.

According to Charles Darwin, during grief "The breathing becomes slow and feeble, and is often interrupted by deep sighs," and during anger "the chest heaves, and the dilated nostrils quiver." Sir Charles Bell, in work published in 1806, arrives at similar observations:

In the expression of the passions, there is a compound influence in operation. Let us contemplate the appearance of terror. We can readily conceive why a man stands with eyes intently fixed on the object of his fears, the eyebrows elevated to the utmost, and the eye largely uncovered; or why, with hesitating and bewildered steps, his eyes are rapidly and wildly in search of something. In this, we only perceive the intent application of his mind to the object of his apprehensions—its direct influence on the outward organ. But observe him further; there is a spasm on his breast, he cannot breathe freely, the chest is elevated, the muscles of his neck and shoulders are in action, his breathing is short and rapid, there is a gasping and a convulsive motion of his lips, a tremor on his hollow cheek, a gulping and catching of his throat; and why does his heart knock at his ribs, while yet there is no force of circulation?—for his lips and cheeks are ashy pale.

So in grief, if we attend to the class of phenomena, we shall be able to draw an exact picture. Let us imagine to ourselves the overwhelming influence of grief on woman. The object in her mind has absorbed all the powers of the frame, the body is no more regarded, the spirits have left it, it reclines, and the limbs gravitate; they are nerveless and relaxed and she scarcely breathes; but

why comes at intervals the long-drawn sigh?—or why is the hand so pale and earthy cold;—and why, at intervals, as the agony returns, does the convulsion spread over the frame like a paroxysm of suffocation?

Henry found that the basal metabolic rate was elevated with elated, overactive, overtalkative, apprehensive, tense or agitated states, and was lowered by depressed, underactive, undertalkative, or apathetic states.

From the observations of the above-mentioned three investigators, it is suggested that if the individual is preparing or prepared for some type of physical activity, then ventilation and oxygen consumption increase. If no action is called for, or if, in fact, the individual is withdrawing from action, ventilation and oxygen consumption decrease. These situations point to two general types of emotional response to stimuli; this type of approach is suggested in Bell's writings. If the following quotation is integrated with the preceding one, these two types stand out clearly:

In pain, the body is exerted to violent tension, and all the emotions and passions allied to pain, or having their origin and foundation in painful sensations, have this general distinction of character, that there is an energetic action or tremor, the effect of universal excitement. . . .

On the other hand, as pleasure is characterized by languor, tranquility, and relaxation, all the emotions related to it, or deducible from pleasurable sensations, are felt in the prevailing state of the system—a degree of inaction, and as it were forgetfulness of bodily exertion, and an indulgence of mental contemplation. The contemplation of beauty, or the admiration of soft music, produces a sense of languor; the body reclines; the lips are half-opened; the eyes have a softened lustre from the falling of the eyelids; the breathing is slow; and from the absolute neglect of bodily sensation, and the temporary interruption of respiration, there is a frequent low-drawn sigh.

The above data indicate that there is biologic utility in psychologically induced ventilatory and metabolic changes. The effects upon the respiratory system of naturally occurring environmental stimuli, experimental head pain, and hypnotic and nonhypnotic suggestion of these stimuli were investigated and provided the framework for this monograph. Psychologic aspects of respiration have been reported from clinical, x-ray, bronchoscopic, spirographic, and pneumonographic observations. Until recently, no psychophysiology study has directly measured the ventilation and gas-exchange variables concerned with respiration.

The study of the psychophysiology of respiration has progressed significantly since the studies of Sir Charles Bell and Sir Charles Darwin, who simply observed breathing patterns and recorded their impressions of the psychologic state. Despite their lack of equipment they made fundamental observations which were instrumental in the development of the particular psychologic approach used in this monograph. The current electronic

sophistication in physiology provides us with elegant tools to document and extend concepts which are otherwise unacceptable because of our current insistence on statistical maneuvers and quantification of observations. Thus, although the following chapters are filled with scientific information largely unobtainable in the 19th century, most of the conclusions drawn are similar to those observed by workers such as Bell and Darwin. However, psychologic evaluation has not progressed to the degree of quantification manifested by the physiologic sciences and we still depend upon clinical evaluations derived from interviews. These types of data are also amenable to statistical treatment, which adds to the degree of comfort we experience in accepting it.

In addition to the normal psychophysiology of respiration, there will also be emphasis on psychophysiologic changes in the diseased pulmonary system. For example, emotions associated with physiologic change similar to that found in exercise might produce pulmonary disability by the same mechanisms as exercise. On the other hand, emotions which produce physiologic change similar to that found during sleep might produce disability by the same mechanism operating during sleeplike states.

The primary focus of attention will be on ventilation and metabolism. However, it should be kept in mind that there are simultaneous changes occurring in the nasal mucus membrane, tracheobronchial tree, chest, and diaphragmatic musculature.

The action-orientation/nonaction-orientation approach to the investigation of respiration is consistent with the integrative approach to emotions and behavior utilized by Gellhorn with neurophysiologic techniques. He found that direct or indirect stimulation of the parasympathetic or sympathetic divisions of the hypothalamus on hypothalamic reactivity led to a predictable responsiveness of these divisions. He used the term "tuning" for these reversible changes. A state of sympathetic tuning was said to exist when the sympathetic division of the hypothalamus was augmented and the parasympathetic division attenuated. The opposite was found to occur in states of parasympathetic tuning. The changes consequent to hypothalamic tuning were not confined to the autonomic nervous system.

To designate the autonomic plus somatic changes occurring, Hess's terminology was adopted. Thus states of ergotropic and trophotropic tuning were distinguished. Ergotropic tuning is characterized by increased sympathetic and somatic discharges and reciprocally attenuated trophotropic activity. Trophotropic tuning is characterized by increased parasympathetic discharges and reciprocally attenuated sympathetic and somatic activity.

Gellhorn's conceptualization of the integrative functioning of the nervous system is based on a considerable body of psychologic and physiologic data. His observations in the laboratory confirm and expand the