

## The Hypothetical Secondary Brain of the Respiratory Apparatus

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### ABSTRACT

We are focusing on the function of the respiratory system, which is the exchange of oxygen and carbon dioxide between the environment and the cells of the body. Set of differential equations systems of the respiratory apparatus is developed based on Bertalanffy's systems theory, considering that the respiratory apparatus is a so-called hierarchical system. This hierarchical order is broken down into sub-levels because the breathing apparatus also has further subsystems. The respiratory apparatus is working under the control of two levels. Block diagram is developed to demonstrate the kind of goal orientation we want to make effective because this always depends on the current needs of the given organism. A block diagram of the brain-controlled breathing apparatus in case of normal functioning is demonstrated here. A block diagram of the part directed by the hypothetical secondary brain was also recorded. It is also demonstrated that this part of the organization is functioning also under normal circumstances, only the brain activity obscures (masks) the everyday activity of the hypothetical brain. We have emphasized that the breathing apparatus is the first priority for people.

**Keywords:** *Respiratory apparatus, hypothetical secondary brain, biophysical modelling, rhythmic breathing.*

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### INTRODUCTION:

Breathing, more specifically the breathing of the lungs is the exchange of gas in the lungs. The airway entrance is the nostril, followed by the nasal cavity, oropharyngeal, larynx, trachea, and bronchial system. [1] Air can get into the airways orally as well, though this is the way to take in food, but the two meet in the pharynx and cross each other. The airways are not involved in the exchange of gas, and for this reason they are called "dead spaces". Breathing of the skin also plays a secondary role in breathing, through the pores of the skin, the gases pass directly into the capillaries[2].

The essential condition for breathing is that the composition of the air surrounding the human body is adequate (oxygen 20.94%, carbon dioxide 0.03%, other nitrogen, noble gases and water vapor), the air pressure is around  $1.3 \cdot 10^5$  N/m<sup>2</sup> and there should be minimal contamination of the air. The frequency of human respiration every 16–18 minutes.

The living organism sets many boundaries for its respiratory processes. [3] Gas exchange can only take place at certain speed, the amount of air inhaled and exhaled can vary within certain limits, and the level of contamination in the air must not exceed certain critical values. The presence of CO in the air is extremely dangerous because it creates an irreversible bond between CO and the hemoglobin of the red blood cells that carry the gases.

It is extremely important for the possibility of constant breathing, because for the average person, if you do not breathe for more than 5 minutes, brain death and then death will occur. This is documented in Table 1.

Some infectious respiratory diseases are listed in Table 2 [4].

Respiratory diseases are greatly influenced by a very common bad habit of a certain group of humankind: smoking [4], which is responsible for 95% of respiratory cancers. [5] The results of imaging procedures (X-ray, CT, MRI, ultrasound, etc.) are not used in this section because they are used in the diagnosis that is not the subject of this section.

### THE RESPIRATORY APPARATUS IS SUBSYSTEM OF ORGANISM:

Starting from Bertalanffy's systems theory, we wrote the differential equation systems of the respiratory tract. We need to consider the respiratory system as a so-called hierarchical system, because it has many subsystems. Let us examine the respiratory tract from the point of view of systems theory. We have to assume that the respiratory tract as a system is an integrated whole, even though it derives from various structures and subfunctions. [6] The other starting point should be that as a system it has a certain objective, and that the balance of these can vary greatly. The processes taking place in the respiratory tract aim to optimize the functions of the system as a whole according to the objective, and to achieve maximum compatibility of the respiratory subsystems. The main goal is to make the whole system work, not

for a subset to operate optimally. A given system, with its core inputs and outputs, is a subset of a larger “super system”, the human organism. If we look at all this at system level, it can be illustrated in the form of a block diagram (Fig.1.):

The respiratory system has a two-level control. Block diagrams can be used to examine the kind of goal orientation we want to make effective because this always depends on the current needs of the given organism. A block diagram of the brain-controlled respiratory respiration tract in case of normal functioning was recorded.

**MODELING OF RHYTHMIC BREATHING:**

Recognizing the sequence of events led to the development of the concept of time. Our statements regarding events taking place in the past, present, future, later or simultaneously used in everyday life all refer to the sequence of events that occur independently or are related to each other. To quantify time, we use a scalar quantity, which will be denoted as **t** in the following. 1 and 2 are two consecutive events. In this case, **t<sub>1</sub><t<sub>2</sub>** can be used if the events follow in sequence 1, 2, respectively. For order 2, 1, inequality **t<sub>2</sub><t<sub>1</sub>** applies. For events occurring simultaneously **t<sub>1</sub>=t<sub>2</sub>** should be used.

By introducing the concept of time, the characterization of the event becomes more complete: we can specify the “place” and “time” of the event. At the same time, there is an opportunity to describe movements – changes [7].

In this case, the rhythmic changes are modeled as follows: There is given a periodic function of discrete value (**F**): **F(t) = F(t+T)** in the following format:

$$F(t) = \left\{ \begin{array}{ll} Z_1 & n.T < t \leq n.T + t_1 \\ Z_2 & n.T + t_1 < t \leq n.T + t_2 \\ \dots & \dots \\ Z_k & n.T + t_{k-1} < t \leq (n+1).T \end{array} \right.$$

$$t_1 < t_2 < \dots < t_{k-1} < T$$

where: **T** – the period; **t** – time, **k** – number of qualitatively possible states.

Consider human deep breathing: contraction of the respiratory muscles (inhalation – **Z<sub>1</sub>**), relaxation (exhalation – **Z<sub>3</sub>**) and two interruptions (**Z<sub>2</sub>**) and (**Z<sub>4</sub>**). In this case there are 4 states. Note the rhythmic change function (**F<sub>1</sub>**). Consider a period of deep breathing as 20 s.

$$F_1(t) = \left\{ \begin{array}{ll} Z_1 & n.20 < t \leq n.20 + 4 \\ Z_2 & n.20 + 4 < t \leq n.20 + 11 \\ Z_3 & n.20 + 11 < t \leq n.20 + 17 \\ Z_4 & n.20 + 17 < t \leq (n+1).20 \end{array} \right.$$

Any change that results in a continuously changing value of a biophysical parameter in the living system and can be characterized by an average value is called a “quantitative” rhythmic change. The fluctuation is around the average value, which does not necessarily show a symmetric change.

This can develop in any living system where, contrary to evolving from equilibrium, the system seeks to restore its original state through so-called negative feedback [11]. Let’s denote with **o(t)** the exit output and the mean value of the characteristic parameter on the system is **o\*(t)**; after the adjustment, the values of the outputs obtained shall be denoted with

$$o(t_1), o(t_2) o(t_3), \dots, o(t_n) = o^*(t);$$

$$\text{if } t_1 < t_2 < t_3 < \dots < t_n.$$

We talk about a negative inverse value, if the following two conditions are satisfied:

$$|o^*(t) - o(t_1)| > |o^*(t) - o(t_2)| > |o^*(t) - o(t_3)| > \dots > |o^*(t) - o(t_n)|$$

$$\frac{d|o(t_i) - o^*(t)|}{dt} \leq 0.$$

In order for the biophysical parameter characteristic of the living system to be returned by negative feedback mechanisms, the system requires generalized forces  $\mathbf{f}(\mathbf{x})$ , which is considered to be proportional to the displacement  $\mathbf{x}$ .

Such a linear force produces a “quantitative” change in rhythm, in which the deviation of the respiratory rate  $\mathbf{x}$  from the average is a sinusoidal function of time:

$$x = A \cdot \sin(B \cdot t + \varphi)$$

where:  $A$  – the maximum deviation of the biophysical parameter from the average;  $B$  – constant that determines the rhythmicity of the biophysical parameter;  $\varphi$  – the value of the phase difference at the moment of initial observation.

### **THE BIOPHYSICAL MODELING OF THE MOBILITY OF RESPIRATORY GASES:**

Medical biophysics requires that medical science utilizes and creatively applies all the knowledge discovered on the basis of theoretical research and the physical methods developed and accepted for their applicability to living systems. Medical biophysics is an interdisciplinary science that requires scientific versatility, the use of the interdisciplinary approaches, and the compatibility of all theoretical steps with the living system [8].

The concentration and partial pressure of oxygen in the lungs is higher than that of oxygen in the blood, so it is transferred into the blood through osmosis. The concentration of  $\text{CO}_2$  and the partial pressure is higher in the blood than in the air, so it is released from the blood through the wall of the pulmonary alveoli, also by osmosis. Blood carries oxygen to the tissues, where it transmits and picks up  $\text{CO}_2$ . Both phenomena also occur through osmosis. Nitrogen plays a passive role and does not change its concentration during respiration. See Table 3.

The forces applied in the pulmonary system (expressed in pressure term) generates according to the third law of dynamics opposing forces equal to them which – for simplification – are presented as elastic refraction pressure (elastic rebound,  $P_r$ ) and dynamic pressure ( $P_d$ ) this last one sums the viscous or resistive ( $P_v$ ) and inertial ( $P_i$ ) pressures.

The first one depends on the elastic refraction force of the pulmonary tissues, which tends to reduce the system volume. The second one is generated mainly by the rubbing of the gas molecules at the passing of the air through the air ducts, to a lesser extent of the rubbing of the non elastic tissues in the lung structure caused by the mobilising of the system both of them summed up represent the resistive pressure and to a technically negligible extent, the acceleration of the air flow (inertial pressure). The relation between the movement of the pulmonary system and the forces applied to it is given by the following equation:

$$P_o - P_s = P_r + P_v + P_i$$

where  $P_o - P_s$  the pressure difference which takes place between the oral orifice and the pleural space represent the applied pressure and the other – the opposing pressure. In words, the equation of the movement of the pulmonary system is translated as follows: the pressures applied on the system generate opposing pressures which form in the system; their sum equals the applied pressure. The opposing pressure depends on the system’s physical properties: elasticity, flow resistance, inertia. The opposing pressures, being dependent on these properties, become functions of the pulmonary volume, the volume variation rate and, respectively, the volume variation acceleration [9].

The evaluation of the lungs elasticity requires the analysis of the relation between the pulmonary volume and the transpulmonary pressure, this last one being the difference between the alveoli pressure and the one in the pleural space. In order to obtain the required information, the two parameters – volume and transpulmonary pressure – they must be measured in static condition, hence in moments of apnoea (when in the air ways there is no air flow); in this condition it measured exclusively the elastic pulmonary pressure, the other components of the transpulmonary pressure depending on speed and, respectively the air flow acceleration being null when the flow is null. The value of this determination lies in the fact that it allows the diagnosis of the chronic obstructive bronchitis in an initial phase, when the clinic panel is not well contoured and, at the same time it offers more chances to control or cure the process.

In the lungs, gases pass into the blood, which, through the heart (systemic circulation), deliver gases back and forth to the cells at the capillary level, also in accordance with the law of osmosis [9]. This work is performed by the heart. So, in the exchange of gas ( $\text{O}_2$  and  $\text{CO}_2$ ) between the environment and the human body, all the work is done by the respiratory muscles and the heart.

The main function of the lungs is to supply the blood with oxygen and to remove the carbon dioxide produced by metabolism from the cells, at the level of the capillaries, also through the bloodstream [10]. To measure function, it is sufficient to measure the partial pressure of arterial blood oxygen and carbon dioxide. The alveolar partial pressure of oxygen is calculated by the following formula, which is called the alveolar gas equation:

$$P_AO_2 = P_I O_2 - P_A CO_2 \left[ F_I O_2 + \frac{1 - F_I O_2}{R} \right]$$

where:  $P_AO_2$  – alveolar partial oxygen pressure;  $P_I O_2$  – partial pressure of inhaled oxygen at body temperature;  $P_A CO_2$  – partial pressure of carbon dioxide in arterial blood;  $F_I O_2$  – fractional oxygen concentration of the inhaled gas;  $R$  – the respiratory quotient.

### THE BLOCK DIAGRAM OF THE BREATHING APPARATUS:

In our opinion, the respiratory device should have individual control associated with its own structure, which is likely to consist of neurons with hyper or donated spatial structure, called the “hypothetical secondary brain”, which performs certain control functions [11]. This “hypothetical secondary brain” of the respiratory tract, in humans, functions continuously throughout their life. It is only so poorly controlled that it has not yet been detected and discovered by scientific research, in addition, to the dominant role of the central nervous system. This statement is just a hypothesis, but the block diagram (Fig. 1.) clearly indicates the existence of a hypothetical secondary brain.

Important respiratory diseases such as those resulting from smoking, regular use of drugs, environmental contamination or respiratory tumors are not shown in the block diagram. Thus, the block diagram is a control scheme of the normal state of the breathing apparatus, and it provides a general outline thereof. It can also be expanded, especially to cover specific respiratory disease states. Medication is not included either.

The biological function of respiration is not simply ventilating the lungs. Additionally it secures normal gas tensions for the alveolar air and consequently for the arterial plasma through the aid of ventilation [12]. When the oxygen-need of the tissues changes the circulation, and consequently the pulmonary perfusion is altered, and ventilation must adapt in a way to secure normal gas tensions in the increased amount of perfusing plasma.

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Table 1. The priority of the apparatus in the human organism

Apparatus	Priority
Respiratory apparatus	I.
Circulatory apparatus	II.
Excretory apparatus	III.
Digestive apparatus	IV.
Reproductive apparatus	xxx

Table 2. Some infectious respiratory diseases

Pathogen	Disease(s)
Adenovirus	Infections of the lower and upper respiratory tract, conjunctivitis
Rhinovirus	Infections of the upper respiratory tract
Influenza A, B virus	Influenza
Respiratory syncytial virus	Bronchiolitis, pneumonia

Table 3. The breath concentrations

	Parameters	Air in inhalation	Air in exhalation	Air in alveolus	Arterial blood	Venous blood
O <sub>2</sub>	pressure (Hgmm)	158,25	116	100	95	37
	concent. (%)	20,97	16	14		
CO <sub>2</sub>	pressure (Hgmm)	0,3	28	40	40	46
	concent. (%)	0,03	3-4	5-7		
N <sub>2</sub>	pressure (Hgmm)	596	568	573	573	573
	concent. (%)	79	78,8	78,8		
Wa- ter	pressure (Hgmm)	5,00	47	47	47	47
	vapour					

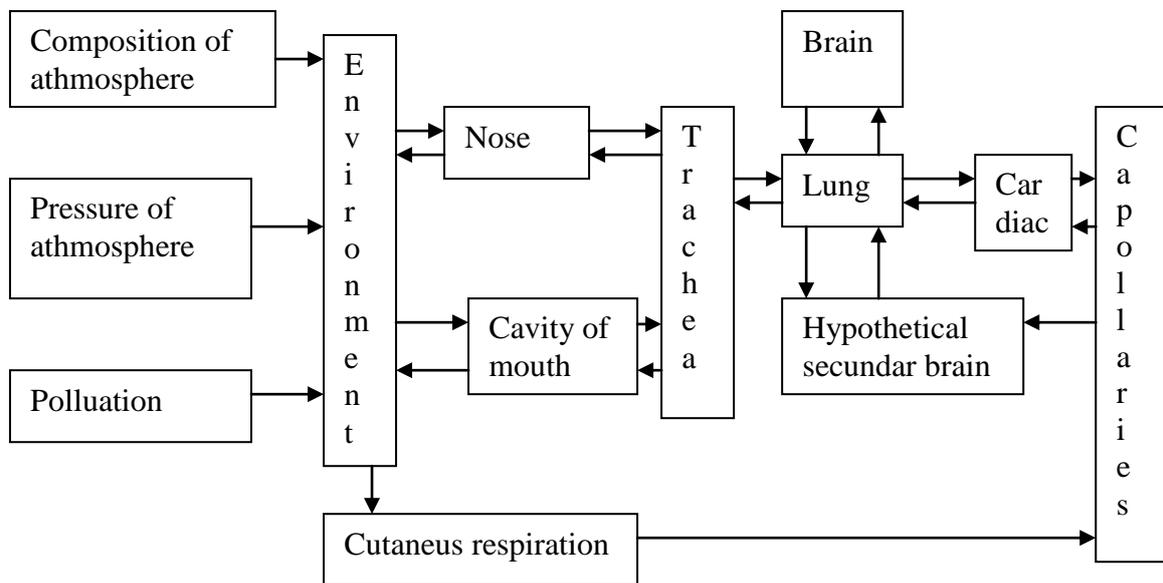


Fig. 1. The block diagram of the respiratory apparatus in the human organism