**International Journal of Medical Science and Clinical Invention 7(5): 4822-4828, 2020**
**DOI:10.18535/ijmsci/v7i05.05** **ICV: 77.2**
**e-ISSN:2348-991X, p-ISSN: 2454-9576**


**Review Article,**

# Biophysical Modeling of External Physiological Manifestations of Humans

**Janos Vincze, Gabriella Vincze-Tiszay**

Health Human International Environment Foundation, Budapest, Hungary

## Abstract:

We consider physiological processes that arise within the human body but do also manifest themselves to an outside observer. The most important of these are: belching, coughing, defecation, eyeball movement, fart, gape, laughing, sneeze, snoring, stomach growling, urination. We deal with the movement and modeling of the striated muscles involved in these processes. Modeling is always just an approximate system of reality. The topic of our study is not the pathology of these physiological processes. Ultimately, we establish an empirical intensity sequence based on muscle contraction. The energies used on the contraction of these muscles are not perfectly measurable, and therefore the sequence allows only the noting of an empirical series. To conclude the article, we present a block diagram of the muscular system.

**Keywords:** biophysical modeling, external physiological manifestations, muscular system, sneeze, traffic accident

## Introduction:

The equilibrium state of a living system is called normal homeostasis if the parameters that characterize the system are in static or dynamic equilibrium. The state of a parameter reflects static equilibrium if its value does not change over time; while a dynamic equilibrium state can be observed if its value changes as a function of time, but the measured values oscillate around a constant value.

The dynamic equilibrium state can be thought of mathematically as a sinusoidal oscillation at a certain time (t), characterized by the amplitude (A), angular velocity (ω), period (T), frequency (ν) and phase (φ) of intensity:

$$\mathbf{X = A.\ Sin\ (\omega t + \varphi).}$$

If a bio psychological system responds specifically to an external stimulus, it means that the value of some of its parameters changes and then returns to its original state of homeostasis when the response is complete. Parameters characterized by static equilibrium and is involved in the response return their values over time to their original value such that its envelope is an exponential (ascending or descending) curve. The parameter that is characterized by a state of dynamic equilibrium and is involved in the response returns to its original value with attenuated harmonic oscillation after its completion. The duration of the return is different for each parameter, and the normal state of homeostasis is determined by the parameter with the slowest finish. [1] A bio psychological system is in a state of strong equilibrium if, after responses to the stimulus, it returns to its original homeostatic state without permanent perturbations. If the perturbations are permanent but do not compromise the essential operation of the system, then we are talking about a stressed state. If the perturbations permanently add up in such a way that the values of certain parameters of the system change, temporarily or temporally enter a new homeostatic state, then a pathological state of the bio psychological system occurs.

## The role of striated muscles:

Muscles are tissues capable of contracting. During their contraction, they convert chemical energy

(ATP, glycogen, glucose) into mechanical energy. Striated muscles (skeletal muscles) as active motivators have an effect primarily on the bones. Living muscles, even if they are not functioning, are in constant active tension, which is called muscle tone. Smooth muscles form spiral and longitudinal layers in the wall of the internal visceral organs and in the layers of the vessel wall. The so-called myocardial tissue with a special structure is in the heart. In terms of muscle function, one type of exertion is isotonic (**T**), during which the points of origin and adhesion of the muscles get closer to each other, and the muscle is shortened. There is an inverse relationship between muscle strength and shortening rate. The contraction can be fast (**R**) or slow (**S**). Contraction summation: in the period corresponding to the ascending branch of the contraction wave caused by the previous stimulus, another stimulus is given; the amplitude of the obtained contraction will be larger than that of the contraction following the single stimulus. [2]

Another type of exertion is the isometric (**M**) one. The points of origin and adhesion of the muscle do not approach each other, only the muscle is tense. *Notes:* In general, the Latin names of muscles are used. Static work depends directly on the strength of the muscles, a greater force is needed to lift or carry a greater weight; in dynamic work, muscle strength is also an important factor, but in addition to a certain intensity, work is also determined by the body's ability to absorb oxygen. The exertion of the stimulated muscle always depends on the external resistance that prevents its free shortening. Normal muscle function consists of simultaneous shortening and exertion. All three were based on experimental results. If we denote the effort by **P**, the greatest shortening by **R**, and the intermediate values by **p** and **r**, we obtain the following mathematical relations for the three different cases (Fig. 1. /a. /, /b/ and /c/):

**A.** Case: $\frac{p}{P}=1-\frac{r}{R}$;

**B.** Case: $\frac{p}{P}=1-\sin\left(\frac{\pi}{2}\cdot\frac{r}{R}\right)$;

**C.** Case: $\frac{p}{P}=\cos\left(\frac{\pi}{2}.\frac{r}{R}\right)$

So, based on the type of work carried out, the muscle may be: **a, b** and **c**, but this is determined by the state of muscle fibers. Characteristics data of muscle fibers (Table 1.)

The block diagram of the muscular system. [3] Fig. 2.

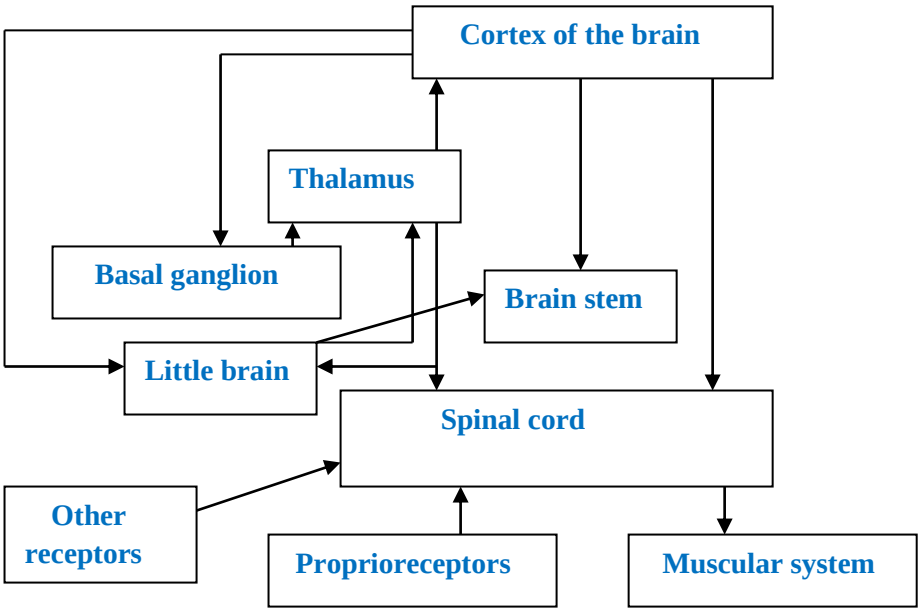


***Fig. 2. The block diagram of the muscular system***

## External Physiological Manifestations :

### (1) Belch, éructation :

Belching is the involuntary or forced flow of air from the stomach or esophagus through the mouth, sometimes accompanied by noise. [4] The gases causing belching are normal by-products of the food we eat. As the digestive system breaks down food, it produces gases that are mainly made up of carbon dioxide, oxygen, nitrogen, hydrogen and methane. We produce gases in two ways: when we swallow air and when the bacteria in the colon help digest the food we eat. We also swallow a certain amount of air when consuming fluids. Muscles involved in belching: the circular muscles of the stomach and the smooth and striated muscles of the esophagus. Biophysical characteristics of belching: **tsa**.

### (2) Coughing:

Coughing is a kind of defense mechanism, a reflex. Its purpose is to sweep out irritants that have entered the airways. [5] The condition for normal airway function is the presence of the secretion covering the bronchial mucus. Its formation and clearing play an important role in the optimal function of the lungs, primarily in its defense mechanism. One of the simplest reasons is the blocking of the airways by a foreign body. [6] The cough reflex is also activated when any foreign body enters the airways, be it a swallowed bite of food or a small object, toy parts in the case of children causing choking. In addition, pollen or smoke can cause irritation resulting in coughing. Muscles involved in coughing: m. Pectoralis major. M. Pectoralis minor, m. Serratus anterior. Biophysical characteristics of coughing: **tsa**.

### (3) Defecation:

The food consumed during eating passes through different sections of the gastrointestinal tract. [4] After mechanical and chemical digestion, the unabsorbed waste product is excreted via the rectum in stages in the form of faeces. The rectum has two sphincters, the inner smooth muscle, the contraction of which is involuntary, but the outer rectal sphincter has a striated structure, with a voluntary or reflex innervation. For most of us, defecation does not represent a particular problem: we get rid of waste products every day or at most every two days. Natural, calm, easy elimination requires a stress-free, relaxed state – so it is understandable that very often there are psychological problems and cramps behind the bowel movements. Muscles of defecation: m. Sphincter ani internus, m. Sphincter ani externus. Biophysical characteristics of defecation: **tsc**.

### (4) Eyeball movement:

Vision captures 85% of the stimuli coming from our environment. People see with two eyes, their q field of vision is at least 150° in the horizontal direction, which is at least of 50° to the left and right, and at least of 20° up and down. The human eye can increase this by the movement of the eyeballs. We have four straight and two oblique eye muscles, which are controlled by cranial nerves (III), (IV) and (VI). One well-known stage of sleep is called the REM phase. This is when we dream most intensely. The body is at rest, the muscles of the limbs are temporarily blocked, but the eyes move quickly in all directions. [7] While reading, it can be observed that the eyes do not move along the rows constantly, but in small jumps (per saccade), and intermediate fixations can be observed during the jumps. Our eyes make small jumps even if the eye movement is not used to change the direction of the gaze, but is fixed at a particular point. These constant, tiny jumps, invisible to the naked eye, are called micro saccades. Micro saccades play an extremely important role in vision, as they serve to refresh the image on the retina. This means that if micro saccades did not exist, objects would fade or even disappear in a short time if our gaze were fixed. Muscles regulating eyeball movement: m. Rectus bulbi superior, m. Rectus bulbi medialis, m. Rectus bulbi lateralis, m. Rectus bulbi inferior, m. Obliquus bulbi superior, m. Obliquus bulbi inferior. Biophysical characteristics of eyeball movement: **trc**.

### (5) Fart

Farting can be related to the gas content of the intestines. How does it get there? On the one hand, during swallowing. [8] Here we should not think of diseases in the first place, even with normal eating, chewing and smoking, there is plenty of air in the gastrointestinal tract. [9] Most of the swallowed air is eliminated in the form of a belch, but some may progress to the colon. The other option is to be found in the body, as gas is also formed during the digestive process. Half-digested food is further broken down and fermented by bacteria living in the colon. As a result of chemical reactions, gas is formed.

Hippocrates already shared the view that farting is necessary for health, and the Roman emperor Claudius assured everyone in a decree that at any time they felt the need, they could get rid of the gases. Muscles of farting: peristaltic movement of the colon, m. Sphincter ani internus, m. Sphincter ani externus. Biophysical characteristics of farting: **trb**.

### (6) Gape:

Gape is a common and natural phenomenon, we hardly notice it when it happens. It is a reflex that is indeed contagious. [10] Gape is nothing but an extremely ancient and instinctive reaction. Gape can help us stay alert, and our bodies keep us ready for action. We yawn a lot not only when we are tired, but also when we are very bored of something or start to lose our attention. And the reason why we cannot hear during yawning is that the Eustachian tube closes and creates a vacuum in the middle ear, which tightens and retracts the eardrum, thus not being able to receive the incoming vibrations. In the winter we yawn more often because moving the jaw can increase the blood supply to our brain and make it easier to control its temperature. A deep inhalation can cool and refresh our gray matter. Research on this suggests that yawning, especially contagious psychological yawning may have evolved to keep certain groups of animals alert. Muscles of gape: m. Digastricus, m. Mylohyoideus, m. Geniohyoideus. Biophysical characteristics of gape: **tsa-msa**.

### (7) Laughter

Laughter is a physical and physiological reaction that testifies to lived happiness, enjoyment and positivity. Many factors influence its frequency and expression, such as age, culture, mother tongue and the development of a given situation, as well as individual experience. [2] It belongs to the part of human behavior that is controlled by the brain and has a role in clarifying a person's intentions, translating them into a mimic reaction that facilitates human communication thus contributing to the construction of certain psycho-socialization processes. Although psychological background and significance are attributed to it, the process can also be triggered by tickling, chemicals (e.g. Laughing gas). Researchers associate laughter closely with a genetic background. Laughter is also slightly contagious, it is related mainly to empathy, the individual adapts to the group. The muscle of laughter: m. Risorius. Biophysical characteristics of laughter: **tsc**.

### (8) Sneeze:

We all sneeze, especially when we have a cold or are allergic to something. Sneezing is a natural reflex that allows us to eliminate pollens or other contaminants that could cause damage to the lungs. Our nasal sensory receptors recognize the substance and, by transmitting the information to our brains, activate the mechanism responsible for sneezing. The rate of sneezing may vary from individual to individual. According to some research, it can reach up to 160 kilometers/hour. [11] During sneezing, substances squirted from our noses and mouths into the air can reach up to 6 meters away from us. However, once we have inhaled the given pathogens, there is no way back: the mechanism starts, so we will have to sneeze. Muscles involved in sneezing: m. Pectoralis major. M. Pectoralis minor, m. Serratus anterior, m. Intercostales externi, m. Intercostal interni, m. Levatores costarum, m. Latissimus dorsi, m. Rhombiodes major et minor, m. Levator scapulae, m. Serrantes posterior, superior, and inferior, m. Spleicus. Biophysical characteristics of sneezing: **trc**.

### (9) Snoring:

During sleep, the air encounters obstacles in the partially or completely blocked airways. The vibrations that occur at this time, which usually come from around the soft palate and uvula, are called snoring. Snoring itself is not a disease; it is a harmless sound phenomenon in itself. An increase in the number of extra pounds proportionally increases the severity of snoring. As we age, snoring becomes more common as the elasticity of the soft palate tissue decreases. The cause of snoring is the collapse of the airways, which occurs when the muscles relax during sleep. In the case of simple snoring, breathing is not exposed to any danger. [5] The reason for the collapse of the airways is that the muscles of the pharynx and soft palate are too loose; there is too little space in the throat. Snoring is usually stronger when lying on the back. Snoring is a common phenomenon, with 20 to 40 percent of the population snores. It is more common in men than in women (this ratio is 10: 1), in men, the anatomical structure of the throat is different due to the Adam's apple. Muscles of snoring: m.

Levator veli palatini, m. Tensor veli palatini, m. Uvulae, m. Pharyngopalatinus, m. Glossopalatinus. Biophysical characteristics of snoring: **tsb**.

### (10) Stomach growling:

Stomach growling caused by hunger is a natural phenomenon. As the empty stomach contracts, air is squeezed out of it, straight into the intestinal tract - essentially, the sound of this is the stomach growling. [4] The stomach often growls after eating, although it is certainly not empty at this time. This sound is the sound of digestion. The growling sound comes from the encounter of gas and liquid during digestion. The interaction of gastric gas and gastric fluid can also lead to noise. Sounds in the small intestine are therefore beyond human control. The movement of the muscles surrounding the digestive tract is called peristalsis. The rhythmic contraction of the muscles moves the contents of the digestive tract forward; the average number of contractions is 3 per minute in the stomach and 12 in the small intestine. Muscles of stomach growling: smooth muscles of the stomach wall. Biophysical characteristics of stomach growling: **tsb**.

### (11) Twinkling:

A healthy adult blinks an average of 10 to 15 times per minute. The function of twinkling is well known: it covers the surface of the eye with a thin layer of tears to protect it and cleans up any dirt, dust particles and similar matters that may have gotten there. In young children, we reach the adult blinking frequency at roughly 13–14 years of age. [7] Twinkling is regulated by our nervous system with a neurotransmitter called dopamine. There is a theory according to which twinkling helps the eye focus. And another theory says it has a role in synchronizing brain function, allowing a little rest for the areas of the brain that deal with visual stimuli during tenth of a second blink breaks. Twinkling, like mimicry, has a role in nonverbal communication. It has been observed that people twinkle more often when they are exposed to mental stimulation and most when they are just communicating with another person. The following muscle is involved in twinkling: m. Orbicularis oculi. Biophysical characteristics of twinkling: **trc.**

The biophysical modeling of twinkling. Twinkling is a periodically repetitive process and we can write the following periodic function:

$$F(t) = \begin{cases} Z_1 & n.6 < t \le n.6 + 0.5 \\ Z_2 & n.6 + 0.5 < t \le (n+1).6 \end{cases}$$

Where: twinkling period is 6 s, the duration of closing the eyelid is 0.5 s; the duration of opening the eyelid is 5.5 s. This is specified for cases when we twinkle 10 times per minute.

### (12) Urination, micturation:

A urge to urinate occurs when the bladder signals, through the nervous system to the brain, that it is slowly filling up. Men, when they feel the need, get rid of more urine at the same time, while women excrete more often and less. The reason for all this is that men have a much higher bladder capacity. Women fill their bladder faster and have a much shorter urethra. [12] Detoxification by urine excretion is a complex process that is the result of the coordinated work of several organs (kidney, bladder, urethra, and certain muscle groups). Urine is produced in the kidneys and then stored by the bladder. A urinary stimulus occurs when the bladder fills with urine. This can be controlled until the bladder is overfilled. When this happens, urine starts flowing involuntarily. When the bladder reaches its maximum saturation capacity, it informs the brain through nerve transmission, from which the urinary stimulus returns to the bladder in response. The elimination of urine requires the contraction of the bladder muscles and the relaxation of the outer and inner rings. Muscles of urination: m. Detrusor urinae, sphinchter vesicae. Biophysical characteristics of urination: **tsa-msa**.

**Table 1. Characteristic data of muscle fibers:**

| | A. | B. | C. |
|---|---|---|---|
| Mechanism | Slow motion | Faster | Fast |
| Type of activation | Aerobic | Aerobic | Anaerobic |
| Protoplasm volume | Big | Small | Small |
| Drowsiness | Small | Medium | Big |
| Thickness | Small | Big | Big |
| Lipid content | High | Medium | Low |
| Glycogen content | Low | Medium | High |
| Sarcoplasmic reticulum | Small | Medium | Big |
| Number of mitochondria | Many | Few | Few |
| Color of the muscle fiber | Red | Pale red | Pale red |
| The force exerted | Moderate | Medium | Major |

## The strength order of physiological processes:

In general, the strength of the muscles of a given process and the work they do per unit of time allow an empirical order of strength to be established. Clearly, when we sneeze, we close our eyes. Thus, for instance, when we snore, we do not yawn or laugh. In general, the completion of fast processes hinders the course of slow processes. This is an empirical sequence for normal human homeostasis:

Sneeze trc > eyeball movement trc > twinkling trc > coughing tra > defecation tsc > fart tsb > urination tsa-msa > snoring tsb > belch tsa > stomach growling tsb > gape tsa-msa > laughing tsc.

In the case of pathological processes of some physiological processes, the order may change significantly and, depending on which process the pathological condition occurs in, it requires much more exertion; thus, for example, in case of constipation. Epilogue. It is of utmost importance that sneezing is the strongest manifestation, and the subsequent ones will be subject to the inhibitory effect of the nervous system. With this statement, we can easily understand that sneezing stops, for example, defecation or urination. The question arises as to whether this could lead to an accident for people. Unfortunately, our answer is yes. An employee working on a belt line may produce a defective product due to sneezing. It is much more severe if, in the meantime, the belt line grabs the hand and crashes it. But there is a much more common accident due to sneezing. When sneezing, the muscles of the chest are involved in this biophysical-physiological process and due to the strong contraction of the muscles, the upper body and head move. There is another extremely dangerous phenomenon that becomes understandable from the order of power. Sneezing has a stronger effect than twinkling, and the eyelids are closed when sneezing. Consider this situation in the case of drivers who have to drive the car with their eyes closed. Probably in the case of hundreds of accidents, drivers caused accidents while driving with eyes closed because of sneezing. The chances are minimal to avoid this accident, the most the driver can do is to take their foot off the accelerator, when they feel the need to sneeze, and automatically hit the brake with their other foot. Unfortunately, sneezing cannot be stopped and due to allergic diseases, it has become an extremely common physiological process.

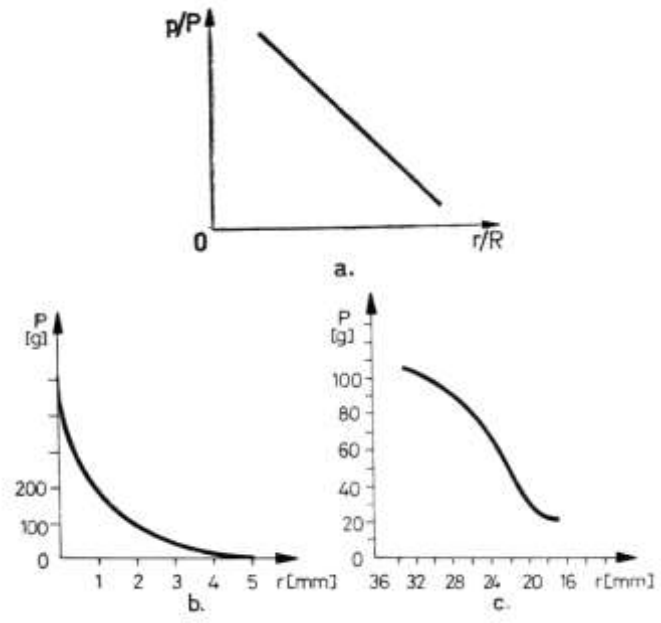


***Fig. 1. A. B. And c. The exertion of the stimulated muscle***

## References:


[1.] Paumgatner G. M.: Biliary physiology and disease reflections of a physician-scientist. Hepatology, 2010; 51: 1095.

[2.] Vincze, J: Medical Biophysics. NDP P., Budapest, 2018

[3.] Vincze, J.: The Biophysical Modeling of the Human Apparatuses in the Human Organism. NDP P., Budapest, 2020

[4.] Vincze, J.: Biophysics of the Digestive Apparatus. NDP P., Budapest, 2017

[5.] Vincze, J.: Biophysics of the Respiratory Apparatus. NDP P., Budapest, 2018

[6.] Ashley, V., Harris, C. C.: Biomarker development in the precision medicine era: lung cancer as a case study. Nat. Rev. Cancer, 2016; 16:525.

[7.] Vincze, J.: The Biophysics of Eyesight. NDP P., Budapest, 2007

[8.] Vincze, J., Vincze-Tiszay, G.: The Biophysical Modeling of Digestive Apparatus in the Human Organism. Biomed. J. Scient. Tech. Research, 2020; 26(4):19592–19597

[9.] Mathis, D., Benoist, C.: Microbiota and autoimmune disease: the hosted self. Cell Host. Microbe, 2011; 10: 297–301.

[10.] Vincze, J.: Biophysics of the Sleep. NDP P., Budapest, 2009

[11.] Vincze J., Vincze-Tiszay, G.: The biophysical modeling of the respiratory apparatus in the human organism. Frontiers in Medal Case Reports, 2020; 1(2):1–6.

[12.] Vincze, J.: Biophysics of the Excretory Apparatus. NDP P., Budapest, 2001