TECHNIUM
SOCIAL SCIENCES JOURNAL

Vol. 7, 2020

# A new decade for social changes

ISSN 2668-7798

www.techniumscience.com

Technium Social Sciences Journal
Vol. 7, 201-208, May 2020
ISSN: 2668-7798
www.techniumscience.com

# The Psycho-biophysical Modeling of the some Stress Parameters

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**Abstract**. The human organism is a biophysical system. Stress represents a normal reaction of the organism which appears as a response to an aggression situation which requires an unusual and quick adaptation effort from the organism. Stress is a state of putting in alert, of mobilizing the forces of the organism in the occasion of an event which requires, in order to be kept under control, a big amount of energy in a very short time. This alert state or action preparation translated through physical and psychological manifestations. In higher-level living organisms the following forms of regulation are known: biological, nervous, hormonal, humoral and immune regulation. In the case of humans, psychic regulation also appears due to the existence of psychic activity. We study only two forms of the stress: fear and death. We present different biophysical modeling aspects. The stress in the human organism is a perturbation. This perturbation is regulates by negative feedback.

**Keywords**. stress, psycho-biophysical modeling, negative feedback, fear, death

## The Biopsychical system

„Mens sana in corpore sano" – that is „*a sound mind in a sound body"* points to the inseparable unity of the biological and psychical nature of the man. Neither of them can subsist without the other. The psychic events, however, may be incomprehensible as they are, the organic substrate of these are provided by our individual biological structure. Thus the unity is composed of two parts: as separated they operate independently but they mutually determine the functionality of each other. If a function of a so balanced system breaks down it will burden the function of the connected organs which brings about disfunction in the organ itself as well as in the organism and these will react on each other. Anorexia and bulimia, e.g., both are based on psychical motives asserted themselves in somatic relation: the uncontrolled hunger and the nerve-centre (knot, ganglion) responsible for saturation-feeling generate organic injuries.

In this biopsychical system [1] there are, from the biophysical point of view, psychosomatic and somatopsychic, i.e. psychic alterations elicited by organic disfunction like renal diseases, brain tumour, gastric ulcer, etc. with their psychic alterations as concomitant signs. The emotional stress results in anguish having vegetative concomitants as sweating, change of temperature, flush-paleness, retching (nausea), flux (diarrhoea), micturition, etc. By recurrence of such vegetative phenomena organic changes can come into being. This is called psychosomatic symptom formation. [2]

Technium Social Sciences Journal
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www.techniumscience.com

The psychical emotion may influence also the effect of some hormones not only the function of some organs. The significant part of the psychosomatic disturbances is such reaction which exists also in normal state but it gets longer in time and its intensity increases. The repeated stimulus-answer reaction effects after a while from a quantitative to qualitative jump creating temporary or irreversible changes of lesser-greater extent. A stage of eternal rotation takes place in the closed system claimed to external intervention because of the balancing role of the homeostasis has got loosed. On the ground of all these, different arrangements can be pointed out: primary and secondary cause and effect, resp. or the symptom of neurotic or organic process resulting from endogenous or exogenous effect the inner pathomechanism of which one must intervene.

**General view about the stress**

The present approach is intended to submit a surway and at the same time a perspective for future research in the topic of stress.

The stress response is an essential component of the body's regulatory systems. Stress is nowadays a reality of the contemporary life which implies as well various categories of society as the entire population. [3]

The causes of this phenomenon are multiple:

– high incidence of stress symptoms;

– negative outcomes for health with increased morbidity and even cardiovascular or psychiatric mortality;

– pressure of the mass-media publicity offering many kind of medication proposed by traditional and complementary medicine.

During about fifty years we enjoyed the collaboration of many researchers apart physiology; psychologists, biologists, clinicians – therefore several of our papers have a multi or interdisciplinary nature. Our studies concerned particularly the exercise stress, investigated in the laboratory or in field conditions as well in animal as in human subjects, inclusively on athletes.

In the last decades the stress concept shifted from the biological doctrine founded by Selye to an integrative psychobiological theory, associated to a biopsychosocial model. Contemporary neuroscience, cognitive psychology and psychosomatics made major contributions to the elaboration of this construct. According to the interactive, transactional concept of stress it depends on the individual capacities to perceive adverse factors and on the cognitive evaluation of the relations between the subject and the physical and social environment. The psycho-biological and behavioral reactions to stressful events are therefore dependent on the balance/unbalance between the coping resources of the subject and his capacities to design strategies to lessen or avoid stress. [4]

Well known is the Cannon's notion of homeostasis – maintenance of constant or appropriate internal conditions and functioning in changing environmental demands. In contrast to homeostatic systems such as blood oxygen, blood pH, and body temperature allostatic adaptative systems have much broader boundaries. They enable to respond to our physiological states (e. g. awake, asleep, supine, standing, exercising, isolation, hunger, extremes of temperatures, danger, microbial infections). Allostasis is defined „as the organism's ability to active stabilizing through changing by expending energy toward challenges". „Allostatic load" is the cumulative cost of the organism on going to repeated cycles of adaptation, a long-term effect of the physiological response to stress with possible adverse outcomes on various systems leading to disease. Examples of allostatic load are the adverse effects of job strain on the cardiovascular system and the inhibition of cellular immunity resulting from chronic stress.

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www.techniumscience.com

„Allostatic support" refers to mechanisms that confer resistance to individuals making them more robust to PTSD, other kinds of stress and chronic illnesses. [5]

Moderators which influence long-term effects of stress.

– Coping – volitional management of stressful events and regulation of the reponses to stress.
– Resilience – related as well to cellular processes that protect cells and tissues against allostatic load as to psychological resistance.
– Hostility – a psychosocial variable mostly associated with higher incidence of CHD.

**Fear and Anguish**

Fear and is a regressive attitude of the bio-psychical system because with its accomplishment the self-control becomes weaker, informations from the environment (objective circumstance) as well as their treatment (subjective circumstance) become unreal appearance. Fear can happen under the influence of unconditional stimulus and on its recurrence or from some kind of reasoned situation as an information from previous experience. The more intelligent the person becomes the better he can distinguish between the real motive producing fear and the casual unknown. [6]

Let's list some few of the numerous types of fear. The material fear is attached to a definite thing (needle, fire, etc.) or occurrence (lightning, thunder, deep water, altitude, etc.) which can be essentially decreased by recognition, awareness and practical adaptation of the casual link. The symbolic fear has no concrete objective linkage but bound to an abstracted idea (nightmare, ghost, hell, witch) which can show decreasing tendency through enlarging the attained knowledges and their interference with the reality.

The separative fear is the person's own induced state that rises in it probably related to the negative reaction of the environment. We speak about isolational fear when the person shall effectively be frustrated by the society, excluded from one or more forms of the social activity (unemployment, prison, familiar loneliness, uncurable disease, etc.) The general fear is already not an actual state but permanent defending mechanism of the personality and unsuccesful (self~)defense to the environmental stimuli, response reaction to stressors, respectively. The general fear from punishment („the ignorance of the law excuses no man from the punishment") from which it follows that man undergoes fear having been endangered in the communal life, in the society, in every life situation. In consequence of this continuously many thousand times repeating state he comes so far to antecipate the fiasco of his activity, the unavoidable failures provoking distorted, incorrect interpretations from his environment, sustaining personal injury. The multiple relived failure experiences may bring about permanent change of the personality, create panic reaction in the course of decision dilemmas, so to say short-circuit actions.

It is difficult to differentiate between the fears of a healthy man and that of a patient because you hardly can take the measure of the circumstances of their subjective treatment, of the injuries accumulated before, of their intimate condition. Depending on the appearance, fear can be categorized according to exteriorized behaviour (emotional manifestation, depression, tension) and organic symptoms (dry throat, slow breathing, anxiety, weakness, retching, sweating, giddiness, etc.).

The state of anguish in the bio-psychical system can come about as accumulated previous experiences the aetiology of which, however, might have been considered easy, one cannot determine it unambiguously. According to Freud, it is an inner notice of the man to prepare the personality to take precautions for a future situation. With any person, the activity form to come may induce tension-anguish. The nurturing-education of man and his previous knowledges decide whether he will be followed by positive or negative anguish in his future activities. In

the well balanced man the positive anguish predominates even in the case if he has to carry out in the future such activity where his preliminary experiences are minimal or unadequate.
The anguish very often acts as hindrance which can considered normal (exam, stage appearance) and is typical for every person. The anguish turns into abnormal if it is shifted towards future activity and only the tension remains which in this way won't be bound to concrete action, and by dominating ever longer period, it becomes a psychical pathology. Anguish is after all a fearful disposition through which it turns into fear without reason and content. This state is reflected by the very true name hovering, as a matter of fact the person is living, namely, in hesitation.
The symptoms of anguish are: behavioural (negativism, unquietness, aggressivity, difficulty in accomodation), affective (lability, sensibility, phantom dream, startledness), somatic (headache, giddiness, vomiting, anorexy).
These regressive defense mechanisms are enlarging the clinical picture when also the emotional co-efficient appears, i.e. the emotion-based manifestation is associated with the behavioural component. The projected feeling of the anguish results troubles in conduct and serves primary reason for avoid failure, so every experience receives traumatic complexion. Just for this it is necessary to reduce the period of the anxious state in the evolution of the personality and that in the adult man to a minimum ; in its implementation immense responsibility rests upon the society, the laws and public functionaries (government officials) representing all those bodies the citizen gets in touch.

**The relationship of life and death**

Death shouldn't be contrasted to life but with the living capacity. The limited, irrevocable cessation of life cannot be reversed. It is the disintegration of that order according to which the parts in the living organism are working. This order won't be upset by freeze-drying, the process will stop only, but under more favourable conditions they can operate again co-ordinated. It is not even sure that by death these processes shall halt. Parts can work further just the harmony between them shall stop irrevocable, the co-operative order shall overturn irreversibly. [6]
Everybody comes into the world with some hereditary adaptive energy taken from the ancestors, parents. He may use it for a long life time with careful thrift or consume run through during a short period with a conduct full of stresses. The inherited quantity of energy is given but the rhythm of consumption shall be determined mainly by ourselves.
Death is the last symptom of life for every living organism. Its cause can be some outer effect (e.g. sickness), but the organism can perish without any outer cause, also as a result of inner causes, this being the so-called „natural" death. Inner causes should be found among the most essential living symptoms, in the metabolism. On its course more and more cells get destroyed and also the remainder, those who survive shall change disadvantageously. Natural death is frequent in low-grade animals, in higher grade we meet predominantly pathological death. „Natural" death has not been observed with man. Aging was never found to be the direct cause of death. Should anybody die of old age it would mean that all his organs would have been equally used up during the long activity. But without any exception everybody dies in a manner that a certain organ as compared with the others is disproportionately used up. The life keeping our organs together can be compared with a chain the durability of which depends upon the weakest link of the chain. Independently how important it is, if getting broken our organs can no longer unite to a living body.

Technium Social Sciences Journal
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www.techniumscience.com

**The biophysical aspects**

The inner life is a multidimensional and at the same time a uniform system. From the point of view of the human individual life the psyche (psychism) is a subsystem. If still we take it out of this relationship with investigational aim then we have to consider it a system.

In this respect the human psychism unifies in itself the attributes of integrity, the openness, the complexity of the synthetic character, the probabilisticity, the self-organization i.e. the (active and passive) homing guidance and the self-regulation so we can draw a picture of the highest grade cybernetic system. [7] This is to explain that in the course of searching the human psyche one have to use the general system theory, the internetics and the dimensions of the control regulation. Quite apart from our morphological, functional or spiritual approximation we have to emphasize first of all the internetical connections of its components and peculiar features, those of organization, information delivery, controllability, expediency. The psychology represents a non-substantial, essentially functional system the fundamental role of which is governing and control: referring to the internal conceptual world of the man and by the interest to insure mutual balance as well between the man's attitude and the outside world.

One can establish that the physical system is an isomorphic superstructure of material, energetical and informational cycles of events originating from the in- and outside of the organism and realized in the peculiar alphabet of the logical network of the nervous system. This superstructure evolves place through the self-organization of abstract codes created in the course of the juncture of the reflexion-rised imaginal and of the symbolic one. We can plainly say that the spiritual life in cybernetic respect is nothing else but an entropy device subjected to the preservation task of the human-specific psychophysiological homeostasis. [8]

The psychical system in organizational viewpoint is of developing character because it forms and develops within the frame of interaction between the man and his environment. It is, therefore, a self-organizing, developing system.

The organization of the psychical system is subordinated to the domination areas of the universal laws of the evolution and it is directed also by such particular principles which accentuate more concrete its organizational mechanisms and variants. Out of these let's mention some: the Le-Chatelier principle, the weakest chain-loop, the efficiency of the energy consumption, the ranking, avalanche-effect, the compensation, the principle of action.

In reference to the Le-Chatelier principle: if on a system in rest is operative such an external input which changes one of the conditions resulting the equilibrium state then the system evades in the direction reducing the outcome of the effect. The principle of the weakest chain-link declares that during a change-over from a given organization to the new one the modification determined by the effect of the directing factors take place mainly in the vulnerable points or chain-loops of the system. For the energy consumption an excellent example is the formation of dynamic stereotypes. Ranking happens when simultaneously more factors affect the living system. The avalanche-effect is well illustrated by the „it's hit or miss" law of the nervous system in the case of the stimulus-answer reaction. The compensation principle is realized in the living organism in every case of the negative feedback regulation. Action comes into being when it is threatened by an external factor or mediates such adequate, essential information towards the system that has to be replied.

According to the system theory, from the of viewpoint of the steering circumstances in the systems the process of the guiding communication takes its course in compliance with the divergency-convergency principle.

Creativity can be considered as the highest level of the expression of the operational polivalency of the human psyche. The distance between reality and model the effort and the possibility is such an indicator which determines the real selfimplementation level of the personality. Since

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these indicators determine the entity of the psychical organization by their help one can estimate the general development level of the personality which expresses the conformity of the behaviour towards the nature and sense of the external effects. [9] This can be estimated by completing the phase profile of the psychical system on the basis of the main psychical indicators which can be expressed in the form of the following relation:

$$S = \frac{\sum_{j=1}^{m} Y_j(t_k)}{\sum_{i=1}^{n} X_i(t_k)} \quad ; \quad k = 1,2,..., p$$

where $\sum_{j=1}^{m} Y_j(t_k)$ expresses the sum of the mean (value) of the adaptative answer answers, $\sum_{i=1}^{n} X_i(t_k)$ still the sum of their external effects and employments, $t_k$ *(k = 1,2, ..., p)* the consecutive moments of the examined period. If the value of **S** is near the zero then the personality is characterized by considerable absence of psychical organization, i.e. psychical inorganization; if the value of **S** is near the 1 it can be expected the individual should properly respond, show psychically balanced state and his psychical amplitudes should be minimal.

**The biophysical modelling**

With modelling we usually understand the reproduction of the behaviour of a system on an analogue one especially built on the basis of certain rules. Usually, the system is modelled either on a physical one, either on a mathematical one. The mathematic model has the advantage of comfort and economy. The mathematic dealing mode also eases significantly the discovery of the analogies between the various systems.

Generally, for the study mode of the biophysical systems, two methods are foreseen: the phenomenological methods and static methods. The phenomenological method studies the phenomena regarding a few fundamental principles, that result from various experiences, leaving aside the discreet internal structure of the matter.

The statistic method studies the phenomena starting from the discreet internal structure of the matter. For the study of the systems with an enormous number of particles the probability calculation is used. Hence, the measurable macroscopic properties appear like average statistic values of the properties of the individual elements.

The modelling method in biophysics consists of the creation of certain devices (models), with which processes analogue with those happening in living organism are studied. The biophysical model though abstract reasoning leads to models of the phenomena which by simplifying and isolating some aspects of the phenomena, discover laws and relationships which describe with a certain approximation the behaviour or functioning of bodies or biological ensembles.

The biophysical models offer a „language" of quantitative and qualitative processing of experimental data, being compatible and adequate to the laws of biology.

One of the types of modelling, the so called analogical modelling, consists of the study of a phenomena which respects certain mathematical laws, with the help of its resemblance with another simpler phenomenon, subject to the same mathematical laws. As an example of analogies, we can quote the oscillation processes with mechanical, acoustic, thermal, optic, electromagnetic, seismic, physiologic, even economic character or the analogy between the nervous impulses and the electric impulses.

Technium Social Sciences Journal
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Through the elaboration of models, one can achieve the prediction of normal answers of environment factors and in biophysical reactions and to detect the atypical abnormal responses. In the human organism, the stress is a perturbation. The existence of the perturbations imposes a permanent control of the way the exit size is realized, so that any deviation can be corrected. [10]

The negative inverse connection functions "constantly" and its main role is, to maintain certain functional parameters of the body to a relatively constant value. This is about a relative stability, since the adjustment involves oscillations around an abstract medium value with a tendency to minimize the deviation in respect of this mean value.

Let's denote with **o(t)** the exit output and the mean value of the characteristic parameter on the system is $\mathbf{o^*(t)}$; after the adjustment, the values of the outputs obtained shall be denoted with

$$\mathbf{o(t_1), o(t_2)\ o(t_3), \ldots, o(t_n) = o^*(t);}$$

$$\text{if} \qquad \mathbf{t_1 < t_2 < t_3 < \ldots < t_n.}$$

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

$$\mathbf{|o^*(t) - o(t_1)| > |\ o^*(t) - o(t_2)\ | > |\ o^*(t) - o(t_3)| > \ldots > |\ o^*(t) - o(t_n)|}$$

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

In the living organisms, all the mechanisms for maintaining a constant composition and internal environment function on the basis of on negative feedback.

**Summary**

Stress is the non-specific response of the living organism to a stressor. In 1936, Hans Selye published his article on stress in *Nature* [11], in which he discussed the close correlation between stress, and the endocrine and immune systems. The medical research of Selye found a connection between disease and stress. [12] The human body behaves like a morphofunctional unit in the continuous process of adaptation to the environment. The organism's unity is not given by its homogeneity, but on the contrary, by its highest heterogeneity. From the sub-cellular structural-functional levels, step after step, to the ultimate level – the organism – heterogeneity amplifies, which requires more and more complex adjustment mechanisms, with more and more complex interrelations.

By adjustment we understand the process through which a size is continuously measured and, by comparison with another reference value, it is influenced in the meaning of an equalization. This way, the regulated unit is based on two components: comparison and command.

Adjustment, with reference to the human body aims, within the biologically optimal limits of the structure and functionality, to all the steps of organization: maintaining the homeostasis of the internal environment, coordinated and unitary functionality of all its components, the adaptation of functionality to the requirements imposed by the environment. The adjustment also has an organization role in the growth and development of the organism, as well as in its reproduction. The organism is a system ensemble situated in a dynamic equilibrium permanently controlled through the adjustment loops. The optimal systems ensure the coincidence between the regulated size and the reference one through negative retroaction, compensating the perturbation. Extreme adjustment or automatic optimization systems also have a retroaction loop, but there is no comparison between the regulated size and a reference size, hence, by seeking for the extreme point, they elaborate adequate orders for maintaining the biophysical and physiological process in that point.

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Vol. 7, 201-208, May 2020
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