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Some Biophysical Aspects of the Stress

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Abstract: Selye published a short note about his findings in *Nature* in 1936. Selye applied his famous theory of stress to everyday life. A stress-free state is equivalent to being dead. In our paper we write about the some directions in stress research and the stress syndromes in clinical medicine. We show that eustress suits to situations when the psychoneuroendocrine stimulation of the organism and its behavior is temperate, maintaining at an optimal level the physical and mental resources and the health status and inducing a positive adaptation to the environment. We give a comparative analysis between the eustress and distress. Psychical stressors are those which come into being independently from the man's will and destroy–as social factors–psychic and organic components taking place in the response, the organism consequently get tired. During the harmonic life gradually all human psycho-organic components shall get exhausted. Forming a biophysical model is not the task of the biologist or physicist alone, a good model can successfully constructed only by common, collective-work. This is typically the task of the biophysicist and a problem which falls within the competence of this discipline. Model is always an approximation, the user of the model has to take into consideration that he can approach only the absolute truth just through the endless series of relative truths. We use the Le-Chatelier principle and determine the measure of psychical organization.
Keywords: Stress, biophysical modeling, psychical organization, Le-Chatelier principle.

Introduction

In 1936, Hans Selye published his article on stress in *Nature*, in which he discussed the close correlation between stress, and the endocrine and immune systems. [1] A review was published by Selye in 1946, [2] where he already gives a comprehensive theory of the general adaptation syndrome, which was supported by experimental facts.

What is stress? Stress is the non-specific response of the living organism to a stressor. Such stressors include effort, focused attention, pain, illness, failure, joy, success. Stress can be either pleasant or unpleasant, whereas distress always denotes something troubling and unpleasant. Although the natures of the stressors may differ, similar biophysical/physiological/biochemical changes are produced. Selye always emphasized in his writings and lectures, that stress is a necessary component of human life, which does not cease to exist even in our sleep. A stress-free state is equivalent to being dead. [3]

Severe and chronic stress, on the other hand, may lead to the development of chronic disease, and may severely damage the function of the immune system and the central nervous system. This depends on susceptibility, age and certain hormones.

Selye did not only present his findings in scientific journals, but also wrote popular books about the process of scientific research, about stress and related subjects. [4] These books have been translated into many languages.

Some Directions in Stress Research

Exploration of biophysical, physiological, endocrinological and emotional processes which involve several brain structures and various types of neurotransmitters. For instance intense stress causes alterations in the hippocampus induced by hypersecretion of glucocorticoids and of excitatory neurotransmitters leading to disturbances of memory and behavior. The hypothalamo-pituitary-adrenal axis and the sympatho-adrenomedulary system are key links of the central and peripheral parts of the "stress system"; its activation accelerates motor reflexes, improves cognition and attention, influences cardiovascular and metabolic functions.

Stress implies several molecular, cellular and genetic circuits, which are prioritary areas of today research. The significance of oxidative stress, induced by free radicals of oxygen and nitrogen, has been proved but it remain many uncleared mechanisms and consequences for the organism. Had been reported bidirectional modulatory effects between stress and the immune system, severe stress having immunoinhibitory outcomes.

New neuroendocrine factors involved in stress comprise endorphins, arginine-vasopressine, prolactine, renin-angiotensine.

The molecular chaperones are parts of an antistress mechanism, having particularly protective roles against the alterations caused to the conformation of proteins by environmental stress factors. Numerous studies described the chaperones related to heat stress, named heat shock proteins. The genetical alteration of chaperones represent a new class of illnesses– chaperonopaties–associated to aging (Alzheimer disease) and to other neurodegenerative conditions.

An approach concerns the concept of allostasis, related to the biological mechanism of stress. A new approach concerns the concept of allostasis, related to the biological mechanism of stress. [5]

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) [6].

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.

Management of Stress

Stress prevention. The premorbid detection and prevention of stress–related reactions comprise several steps.

- ✓ Detection and monitoring of environmental stress factors.
- ✓ Identification of symptoms by questionnaires and objective methods.
- ✓ Reduction of the vulnerability to stress by bioactive substances.
- ✓ Periodical medical controls of risk groups.
- ✓ Increasing the resistance of the organism by appropriate nutrition, avoidance of noxious habits, healthy life style, physical exercise.

Treatment of Distress

- ✓ Combination of individual or group therapies, including various relaxation procedures and biofeedback, with behavioral cognitive therapies.

- ✓ Stress inoculation technique.
- ✓ Additional interventions: psychoanalysis, yoga, meditation.
- ✓ Pharmacological treatment necessary against severe distress including anxiolytics, antidepressive drugs, antioxidant substances, various combinations of nutrients, bioelements and vitamins.
- ✓ At the same time there exist non-scientific assertions which generate stereotypes and discutable practices frequently promoted by mass-media and vulgarization books focused on stress management.

Stress Syndromes

The biopsychosocial concept became a framework in psychosomatics, proving the reemergence of holistic systems theories. Horowitz published in 1976 a first book on stress response syndromes, a concept revisited in several of his publications where have been explored namely the subjective stress in response to psychosomatic life events. [7] Nowadays some specific stress syndromes have been identified. An example is the competitress the female athlete triad consisting of three interrelated disorders: osteopenia or osteoporosis, menstrual cycle disturbances, eating disorders.

Stress Syndromes in Clinical Medicine

Several researches deal with the impact of chronic distress on the cardiovascular conditions.

- ✓ Positive correlations between the stress vulnerable type A personality and the cardiovascular heart disease.
- ✓ Association between psychosocial stressors and high risks for myocardial infarction.
- ✓ Acute cardiomiopathy (Taco-Tsubo syndrome) occurring after severe emotional stress.
- ✓ Sudden cardiac death in young competitive athletes.

The controversies as concern the involvement of stress in the ulcerous disease prove the shortcoming of the view that the psychosomatic dimension and immune processes imply isolated reciprocally excluding mechanisms.

After the demonstration of the role of Helicobacter pylori on the genesis of ulcerous disease many clinicians have considered obsolete the hypothesis that this condition could be the result of psychological stress.

In the last time has been proved that psychosocial stress intervenes in the etiopathogenity of peptic ulcers by interacting with Helicobacter pylori and with other risk factors.

Among possible physiological mechanism stress may induce gastric hypersecretion, reduce acid buffering in stomach and the duodenum, impair gastroduodenal blood flow and affect healing through psychoneuroimmunological and psychoendocrinological factors.

The significance of stress in other diseases (asthma, rheumatoid arthritis, chronic fatigue syndrome, cancer, diabetes, psychiatric disorders, neurodegenerative diseases, etc.) is also underlined and widely explored.

On the whole, the vulnerability to acute stress could be associated mainly to functional psychosomatic disturbances, while the susceptibility to chronic stress is closer related to psychosomatic organic diseases.

Perspectives

Eustress suits to situations when the psychoneuroendocrine stimulation of the organism and its behavior is temperate, maintaining at an optimal level the physical and mental resources and the health status and inducing a positive adaptation to the environment. [8]

Table 1. Eustress and distress comparative analysis

Categories	Features	Eustress	Distress
Generalities	Main effects	Benefic	Noxious
	SGA Selye	Alarm stage	Exhaustion stage
	Homeostasis/ Allostasis	Maintened	Disturbed
Causes	Critical life events	Positive>negative	Negative>posit.
	Stressors	Moderate	Intense, Long-acting
Physiological mechanism	Neuroendocrine Endocrine	Prevail Sympathoadrenal Activation Hipothal. Pituit. Corticoadrenal Activation Opiodes	Inhibition/hyper-Activation Hipothal. Pituit. Adrenocort. Axis Inhibition/hyper-Action Sympathoadrenal Activation Interleukine G
Physiological background	Social support Transactional basis Emotions Coping Resilience/ Recovery Anxiety/hostility	Present Equilibrium Resources > Demands Functional Active problem solv. Present, fast Reduced	Poor/Absent Disbalance Demands > resour. Nonfunctional Passiv, emotion. Reduced/delated Intense
Reactions	Long acting effects	Adaptative	Maladaptative
Health correlations	Outcomes Immunity Interventions	Sanogenetic Mainly activated Unnecessary	Pathogenetic Inhibited/suppres Psychoterapy Medication

The Correlation between the Psychic System and the Stress

Of the measure of the psychological stressor-effect a subjective conclusion can be drawn only from the extent of the produced reaction. Both the experience and his reactions are subjective. A few aspects can be taken into consideration to try the assessment the effect of stress on the individum. Such questions among others are: did his attitude change, what is the depth of the appearing sentiments like, can he/she narrate the bygone events, do arise defensive mechanisms, what time is needed to treat the stress, did somatic concomitant signs appear? By all means we must get answer how deep the event has occupied his/her psyche, has the function of mind (cogitation, memory) restricted and what kind of fantasy world has set off. [9]

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. [10] 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. [11]

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.

The Biophysical Modeling

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. [12] 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.

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. [13]

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. [14] 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. [15]

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 self-implementation level of the personality. Since 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. 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 adaptive 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.

Conclusions

- ✓ Stress can act as a triggering factor leading to stress syndromes or intervene as a precursor cofactor of a disease.
- ✓ Allostatic systems respond to stress by initiating adaptative reactions and accelerating recovery.
- ✓ The translational concept proposes new approaches to explore and to manage stress-related disorders and syndromes by bidirectional transfer of knowledge.
- ✓ A number of systemic or psychiatric conditions suppose disregulation of mechanisms responding to stress and maladaptation to the environment.
- ✓ A crucial challenge for stress researches is to integrate the mental level with the cellular, molecular and genetic factors and to develop the biopsychosocial model in medicine.
- ✓ Eustress, with its positive dimensions, can be interpreted in terms of the posttraumatic growth theory.

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.

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.

At the main entrance of the Institut de Medecine et de Chirurgie Experimentales at the French Universite de Montreal–where Hans Selye was leader–the following inscription could be read: *"Neither the prestige of your subject, and the power of your instruments, nor the extent of your learnedness and the precision of your pianning, can substitute for the originality of your approach and the keenness of your observation."*

Conflict of Interest: The authors did not have any conflict of interest.

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