

The Eustress Concept: Problems and Outlooks

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Abstract: The concepts of eustress and allostasis are discussed in terms of their inter-relationship and penetration. Historical research on general adaptation syndrome is examined from the standpoint of an interdisciplinary approach in which the effects of stress are manifested in four areas: physiology, behaviour, subjective experience and cognitive functions. This article provides a review of eustress concepts. The key problems and contradictions of eustress concept are disclosed and discussed. The authors propose an approach to eustress from the position of the adaptation process. The definition of eustress is substantiated as a form of stress after which a person's adaptive capacity increases. The ways and mechanisms of eustress are described. The role of eustress is reviewed in the context of allostasis, a form of adaptation more complex than homeostasis. The authors propose the working hypothesis of allostatic states to describe the phenomena of distress and eustress.

Key words: Stress • Adaptation • Eustress • Allostasis • Allostatic Load • Adaptive Capacity

INTRODUCTION

Nowadays stress is an attribute of modern life. This problem hasn't professional, territorial and cultural boundaries [1-5]. Although some researchers emphasize the adaptive features of stress, the destructive effects of stress ("distress") are far better discussed in scientific literature. Hans Selye (1936) speaks of the dual nature of general adaptation syndrome (GAS), which can both cause physical illness and death and improve the body's resistance to unfavourable conditions [6, 7]. In 1976, Selye introduced the concepts of eustress and distress to indicate different types of responses to stress. The physiological mechanism of stress progress that he described only explains the negative effects of adaptation syndrome. As some authors assert, the theme of eustress is simply ignored in the literature [8, 9]. According to S. Levine, the number of references to term "stress" in the PubMed system in 2005 was 209,744 [10]. In 2014, there are already 563,117 such references. There are 83,779 references devoted to distress and only 51 devoted

to eustress. Similarly, a search for synonyms of eustress, "positive stress" and "good stress," yields 461 and 19 references, respectively. In addition to these figures, M. Le Fevre points to the semantic shift from understanding the term "stress" as an inevitable consequence of life to its contemporary use as a synonym for distress [8]. The purpose of this article is to differentiate eustress from other types of stress and to examine its contribution to the process of adaptation and improvements in health.

Conception of Eustress: According to Nelson and Simmons, the conception of eustress is incomplete [9]. Indeed, eustress is an insufficiently explored phenomenon. As the examination of the PubMed database illustrates, very few analyses of stress attend to the concept of eustress. It is our position that the lack of research on eustress is due to a lack of clear criteria for differentiating this type of stress from others. Furthermore, the absence of such criteria is a consequence of insufficient development of the

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conceptual basis of eustress. Under these circumstances, there is significant variation among scientists in their understanding of eustress. For example, in some models of stress, eustress is included only as a lack of negative effects. Milsum considers eustress as an ideal condition of the well-functioning homeostatic system [11]. The concept of eustress was introduced into the scientific lexicon by H. Selye, who is not known to be precise with terminology. Selye's scholarly works themselves further confound an understanding of the phenomenon of eustress. At times, he used the terms "eustress" and "distress" to distinguish different types of stress and in other instances, he identified them as stimuli that cause stress [9].

Today, there are two dominant approaches to understanding eustress. The first is connected to H. Selye's work. In his formulation of general adaptation syndrome, Selye emphasised the adaptive nature of the reaction to the stress [6, 7]. The terms "distress" and "eustress" were subsequently introduced by Selye in 1974 to distinguish the non-adaptive and adaptive effects to stress reactions [12]. Quick et al. considered eustress in a similar light [13]. They identified eustress as "healthy, positive, constructive results of stressful events and stress response." Thus, eustress is considered the result of the body's response to a stressor.

Lazarus proposed a second approach to understanding eustress in his stress model. From this point of view, eustress is a positive cognitive response to a stressor. This type of stress is associated with positive feelings and a healthy physical state, while distress is a severe stress associated with negative feelings and physical impairments [14]. Harris correlates eustress with a joyful response to a stressor [15] and Edwards and Cooper identified eustress as a positive discrepancy between perception and wishes (provided the discrepancy bears direct relation to the individual) [16]. According to Le Fevre et al. [17], the main factor that determines whether a stressor will cause distress or eustress is the perception and interpretation of the situation by the individual. Le Fevre believes that a particular stress is distinguished as eustress or distress not only based on the individual's perception of the intensity of the stimulus (stressor) but also based on the perception of its other characteristics, such as its source, duration, controllability and desirability [17].

There is an opinion that eustress and distress may occur simultaneously. For example, Nelson and Simmons also supposed that eustress and distress represent separate and independent aspects of the overall response

to stress [9]. They consider eustress and distress as two different reactions to the stress, which can occur simultaneously [9]. Lundberg and Frankenhauser also believe that eustress (positive emotions) and distress (negative emotions) can occur in response to the requirements of the environment, either separately or in combination [18]. These variants differ from one another in the ratio of catecholamines and cortisol found in the blood. The researchers concluded that the neuroendocrine responses to the psychosocial situation are determined by the individual's cognitive evaluation of the situation and by the emotional impact of the stimuli but not by their objective characteristics [18]. Lovallo [19] also believes that the influence of stress is largely dependent on how a person interprets the situation. He asserts that two situations in which the physical load is identical may have different consequences for the person based on the interpretation of the situation and the accompanying emotions. Lazarus and Folkman noted that the immediate psychological consequences of the evaluation of the situation are revealed in positive or negative feelings [20]. Thus, a person may react to any stressor with both positive and negative feelings and judgments [20].

Associating eustress with emotional state or cognitive evaluation alone presents the risk of stepping on "shaky ground" and losing direction in the search to identify this phenomenon. This is because emotions and cognitive evaluation of a situation can change during the period in which the stressor is acting upon the individual. In such cases, it would be difficult to distinguish eustress and distress from one another. In terms of an integral approach to human physiology, we cannot speak of two or more reactions occurring simultaneously. Physiologically, there is only one reaction in the organism, although the ratio and number of structural elements involved in the reaction may differ. Thus, we may speak of a variety of reactions to a stressor. An example of such an interpretation of eustress is a theory of nonspecific adaptive reactions of the organism (NARO) [21-24]. According to Garkavi et al. [22], adaptations to strong stimuli vary significantly from adaptations to weak stimuli. Adaptation to a strong stimulus occurs not only through over-stimulation of some subsystems of the organism but also through inhibition of the activity of others, known as defensive subsystems. According to these authors, this is a classic reaction to stress. While adapting to a weak stimulus, neither inhibition nor significant stimulation of protective subsystems takes place. This adaptive reaction, which Garkavi et al called

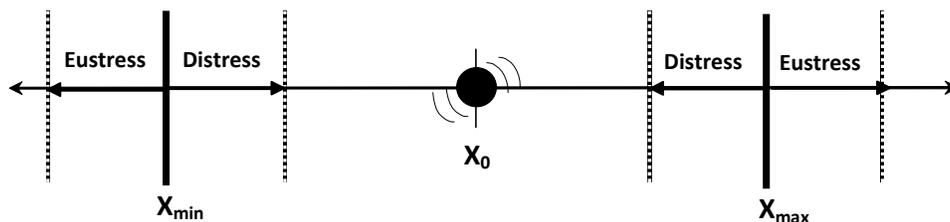


Fig. 1: Homeostasis and eustress. X_0 - some biological property of an organism; X_{min} , X_{max} - limits of adaptive capabilities of an organism.

“the training reaction,” increases the activity of protective subsystems and causes the organism to become resistant to harmful actions [22]. These authors also identified the commonly occurring “activation reaction,” which occurs in response to the action of medium-strength stimuli of varying quality. This reaction is characterised by a rapid, though not excessive, increase in activity of the protective and regulatory subsystems of the organism. If we consider this theory in terms of eustress, both training and activation reactions would be classified as eustress. Identification of different types of non-specific adaptive reactions enabled the authors to suggest the technique of “activational therapy” [24]. Their basic idea is to provoke the necessary adaptive immune reaction in human organisms through controlled external action or medicine (i.e., by stressor). For positive therapeutic effects, it is possible to use two non-specific reactions. The training reaction is necessary to induce prophylaxis of diseases and the activation reaction should be used for therapeutic treatment of diseases [24].

Distress is a type of stress that leads to deterioration of the adaptive capabilities of the organism and eustress is a stress that initiates an increase in adaptive capabilities [25]. This approach makes it possible to clearly identify the phenomenon of eustress, affording new opportunities for its study. Graphically, eustress can be shown in the form of increased limitations of the organism’s adaptive capabilities (Fig. 1). Adaptation and stress phenomena have a causal relationship wherein the onset of stress initiates adaptation. The evolutionary history of all life forms may be treated as a history of organisms combating stressors, thus bringing about destruction (distress) and gains (eustress). When using the term “eustress”, we want to emphasise the positive, constructive value of the stress response. The initial purpose of the body’s reaction to stress and stressors is to overcome the adverse impact of the external environment. Nature created a mechanism that allows the body to

activate all of its resources to survive in adverse conditions. Therefore, most anti-stress programs aimed at decreasing stress levels are misguided; they intend to reduce stress levels rather than to control the stress response by converting the response to a eustress reaction. Several studies confirm the viability of this point. A. Sih reviewed theories claiming that “early stress” prepares the body for more effective resistance to stressors in later life [26]. It has been argued that “early stress” may play an adaptive role, as “vaccination against stress,” in training animals to endure environmental conditions after birth [27, 28]. According to this argument, there is a bell-shaped correlation between the level of stress at an early age and subsequent resilience [29-31].

Ways to Create Eustress: Although Selye described eustress as a positive effect of uncertain physiological responses and strain, neither he nor his adherents have described how this positive effect arises.

One of the most common points of view on the cause of eustress is the intensity of the stressor’s impact, a position exemplified by the theory of NARO [22, 23]. Other theories assert a nonlinear relationship between eustress and the intensity of the impact, as often illustrated in the form of a U-shaped diagram, where the relationship exists between the intensity of stress and health or productivity [32-35]. In the latter case, the researchers rely on the law of Yerkes-Dodson [36]. Within a quantitative approach, the phenomenon of hormesis may also be considered. “Hormesis describes any process in which a cell, organism, or group of organisms exhibits a biphasic response to an exposure of increasing amounts of a substance or condition (e.g., chemical, sensory stimulus, or metabolic stress). Typically, low dose exposures elicit a stimulation or beneficial response, whereas high doses cause inhibition or toxicity” [37]. For example, there is evidence that low doses of radiation stimulate cell proliferation [38]. Furthermore, caloric restriction prolongs life in a variety of

organisms from yeast to mammals, protecting them from deterioration of biological function [39]. From the data discussed above, it may be concluded that the intensity of exposure to stressors is a key factor in determining the development of either the eustress or the distress response.

Intensity of exposure to a stressor depends not only on the power of the stressor impact but also on the duration of exposure to the stressor. The duration of the stressor impact may also play a significant role in the development of various effects of stress. According to S. McEwen [40], the short-term impact of major hormonal mediators of stress is essential for adaptation, homeostasis maintenance, and survival. However, at longer time intervals, the stressor impact can accelerate the pathogenic process, which can be considered a variant of distress.

In addition to studying the characteristics of the stimuli that cause eustress, there are a number of studies aimed at identifying the internal conditions and factors that are beneficial to people in stressful situations. In the field of psychology, several studies on the relationship between psychological traits and health and wellbeing have been carried out. Some of the traits investigated include positive affect [41], optimism [42], self-determination [43] and hope [44]. Other researchers have focused on individuals who remain healthy in stressful situations [45]. Studies have shown that individuals who face distressing situations can achieve positive results and traits such as hardiness may facilitate this process. In such cases, hardiness is defined as an aspiration to discern the meaning of events, especially those that cause stress. Other traits cited as promoting health and wellbeing include self-reliance [46], the character [47] and sense of vocation [48]. It was also shown that eustress is connected with total life satisfaction [49].

Eustress and a Theory of Allostasis: Approximately 25 years ago, a new term, "allostasis" (from the Greek words *allos*, meaning "other, another" and *stasis*, meaning "state, stability"), was proposed, which literally means "to remain stable, changing" or "remaining stable by being variable" [50]. Authors working within this paradigm understand allostasis as a process by which an organism maintains its internal environment within parameters necessary for survival by changing its state and its behaviour [40, 50-52].

The notion of allostasis broadens and supplements the concept of homeostasis, introduced by C. Bernard

and W. Cannon [53, 54]. It is understood as a more complex form of adaptation than homeostasis. According to the latter theory, environmental or life events cause a stress reaction, which enables the organism to maintain homeostatic balance; however, once the stimulus has disappeared, an organism returns to its original state, although it may not restore balance at the original level. In such a situation, a human organism tries to restore balance at another level, causing a new stable state, rather than returning to the former. This new level is called the "allostatic state" [55]. Expanding on this concept is the notion of "allostatic load," which refers to the price the body pays for being forced to adapt to unfavourable psychosocial or physical situations. Physiologically, it signals either the presence of excessively strong stress or an ineffective reaction of the hormonal system to the stressor [40].

Allostasis occurs when the homeostatic balance is upset, whether due to damage or a change in the parameters of the human organism's functioning (e.g., in the normal growth and development of the organism). A cause and indicator of allostasis is intense activation of regulatory systems, which manifests itself in excessive production of cortisol and adrenaline. Allostasis is further characterised by intensive and unstable functioning, including behavioural and psychological activity, attributed to an emergence of new neuro-humoural regulation mechanisms and new forms of behaviour that are more adaptive to new conditions. As a norm, an allostatic state is in flux until homeostasis is achieved at another level, within new parameters of the internal environment, due to the formation of new neuroendocrine regulation systems and the development of new adaptive behaviours and strategies. However, if an allostatic load is too high, or if the environment is constantly changing and unpredictable, it is impossible to achieve balance because the emerging structural elements of a regulatory system have no time to develop into a new effective system and conditions for pathological changes in an organism appear, including those that are behavioural.

Allostasis theory can be applied to explain the eustress phenomenon. For example, Li G. introduces the concept of "allostatic buffering capacity" (ABC), which, according to the author, supports dynamic stability [56]. This capacity is equal to the change in physiological parameters from normal to peak level (i.e., the maximal possible change). In terms of ABC, eustress is regarded as an increase in the buffer zone that results in health improvement and reduction in morbidity and mortality [56].

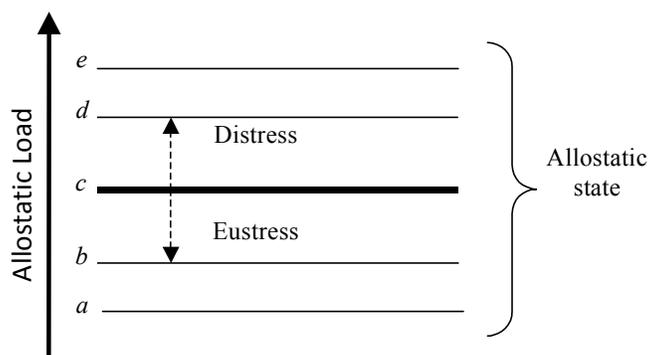


Fig. 2: The model of allostatic states: a, b, c, d, e - allostatic states; c - the current state of homeostasis. Transfer from allostatic state c to b or a one might be considered as eustress; transfer from allostatic state c to d or e one might be considered as distress development.

Eustress harmoniously fits into the modern theory of allostasis [57] in that the latter concept suggests the presence of many states. These states can, in our view, be ordered according to the allostatic load on the body (Fig. 2). Therefore, within the framework of allostasis, we can consider the possibility of moving not only with high levels of allostatic load but also with reduced levels of allostatic load. This allows use of the concept of eustress to explain the positive effects of stress on the body, such as increasing resistance to adverse factors, survival in extreme conditions, etc. We propose a schematic model of the "allostatic state," which takes into account the existence of stable physiological states of the body that differ in terms of allostatic load. The transition from one state to another is possible if certain external actions or mobilisation of internal reserves occurs. We are not proposing the existence of certain predefined conditions in which the body can endure stress influences because individual characteristics associated with the levels and states in each case may be different. Thus, in this model, eustress is the transition of the system to a lower level of allostatic load and distress is the transition to a higher level (Fig. 2). It can be argued that the concept of allostasis provides a new viewpoint on the phenomenon of eustress and new opportunities for understanding and investigating it. Our approach facilitates a clear identification of the phenomenon of eustress, thus opening new possibilities for its further study.

CONCLUSIONS

This article discusses the inter-relationship and penetration of the concepts of eustress and allostasis. Despite the proliferation of research on stress, it tends to be studied in an irregular and often one-sided manner.

Although most researchers attend to problems of pathogenesis, stress is a protective reaction that helps the organism to survive in difficult conditions and environments and it is the positive, constructive role of stress that very few have studied. It is necessary to move beyond the pathological model and turn to positive conceptions and cognitive research that can elucidate the mechanisms of eustress. From a perception of stress as a reaction to strong negative environmental impacts, researchers now recognise distinctions within the stress phenomenon, seeing distress as a non-specific basis of disease and eustress as a favourable factor affecting health and longevity. We propose to consider eustress as an adaptation process. In this context, eustress is a type of stress that increases an organism's adaptive capacity. We further propose a working hypothesis of allostatic states to describe the phenomena of distress and eustress. Eustress results in the transition of the organism to a lower level of allostatic load and distress is the transition to a higher. Although some well-known models of stress provide the grounds for eustress mechanisms, experimental studies are necessary to confirm the model of eustress.

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