
The Stress Reaction: A Historical Perspective

Oren Rom and Abraham Z. Reznick

Abstract

The history of stress research – milestones and people. Definitions and modern concepts of stress as well as the conflict between Hans Selye and the psychologists are described in this review. The molecular and physiological mechanisms of stress and their possible pharmacological intervention are introduced. The cycle of stress is presented as a new concept of the stress reaction, trying to bridge the gap between physiology and psychology. The cycle is a circular event in life, composed of 4 phases: (1) the resting ground phase, (2) the tension phase, (3) the response phase, and (4) the relief phase. In each phase, both physiological and psychological components can be assessed. These components are the basis for the proper handling of each phase and provide a unified model for the psychological response to stress. In addition, parameters of the cycle such as frequency, duration, and intensity can be measured, providing an effective tool for stress management. Finally, modern techniques and mechanisms for coping with stress are discussed like the Norwegian Gate Theory and Lazarus Dichotomy Model for the Stress Reaction. In the above models, specific examples of how people respond to the first time encounter of stressful events and how soldiers cope with stress are presented.

Keywords

Stress history • Stress research • Coping mechanisms • Gate theory • Stress physiology

O. Rom
Rappaport Faculty of Medicine, Technion, Israel Institute of Technology, Haifa, Israel

A.Z. Reznick (✉)
Department of Anatomy and Cell Biology, Rappaport Faculty of Medicine, Technion; Efron St., P.O. Box: 9649, Bat Galim, Haifa 31096, Israel
e-mail: reznick@tx.technion.ac.il

1 Historical Introduction

1.1 Research Before Hans Selye

Several scientific giants have contributed to the foundations of stress research in the 19th century. Charles Darwin (1809–1892) in his monumental

book “The origin of species” had written that only those organisms that are capable of adapting to a changing environment will survive. Thus, what really Darwin was saying is that survival is the interaction of the biological world with the harsh and stressful environment. Claude Bernard (1813–1878) had stated that adaptation of an organism to a changing environment is possible by keeping the internal environment (*milieu interieur*) stable and constant. Walter B. Cannon (1871–1945), was the first to formulate some detailed concepts of the stress response and possible biological mechanisms involving emergency hormones (Cannon 1932). In addition, Cannon was the first to introduce some psychological aspects of stress by formulating the Fight or Flight model of the stress response. Finally, Cannon was the one who presented the concept of homeostasis as a basic mechanism of response to stress based on Bernard’s idea of ‘*milieu interieur*’.

1.2 Hans Selye (1907–1982)

Hans Selye is considered the founder of modern stress research. In the 1930s Selye advanced the concept of the General Adaptation Syndrome known also as the “GAS” Theory (Selye 1936). In his paper, Selye observed that in many long term exposures to various stressors the physiological responses followed a similar consistent pattern of three stages:

1. Alarm reaction (AR Stage)
2. Stage of resistance (SR Stage)
3. Stage of exhaustion (SE Stage)

These stages were further elaborated by Selye as based on neural and hormonal processes that are taking place in the body. Thus, the fast AR stage involves a neural response of the autonomic sympathetic nervous system which leads to rapid secretion of adrenaline followed by a slower SR stage which leads to increased levels of cortisol and other corticosteroids changing the body metabolism. Long term exposure to SE stage will eventually result in a damage to body

systems such as the digestive, immune, or kidney systems. Altogether, two important ideas have been put forward by Selye: (i) stress is basically a physiological response and (ii) stress is a non-specific response of the body to any need or threat that it encounters (Selye 1974).

1.3 Controversy Between Selye and Psychologists

Selye’s ideas were not accepted favorably by psychologists working in the stress field. J.W. Mason wrote in 1975: “In the psychological stress field it has been observed repeatedly that responses to any given psychological stimulus may vary widely from one individual to another or from one time to another in the same individual” (Mason 1975a, b). In a response paper, H. Selye tried to rebuttal this criticism by writing: “The fact that stressors or even the same stressor can cause different lesions in different individuals has been traced to what I have called ‘conditioning factors’ that can selectively enhance or inhibit one or the other stress effects” (Selye 1975). In addition, in his controversy with psychologists, Selye described a very famous experiment in animals in which he disconnected the brain cortex from the hypothalamus and avoided any emotional and psychological stimuli and still obtained the same physiological response to different stresses. Another psychologist, Susan R. Burchfield, wrote in 1979: “The research literature on failure to adapt to chronic stress suggests that maladaptation results from psychological not physiological exhaustion as was suggested by Selye” (Burchfield 1979). Despite the controversy, until his death in 1982, Selye strongly believed in his concepts of the stress reaction.

2 The Cycle of Stress

The above controversy emphasizes the diverse definitions, notions, and ideas that prevail in the stress field. Therefore, the concept of the stress cycle has been developed in order to try to

integrate many of the ideas that exist in this area into a unified model that would combine both physiological and psychological ingredients of stress and provide a comprehensive definition of the concept of stress (Reznick 1989). The cycle is a circular event in life, composed of four phases:

1. Resting ground phase
2. Tension phase
3. Response phase
4. Relief phase

In each phase, both physiological and psychological components can be assessed. These components are the basis for the proper handling of each phase and provide a unified model for the psycho-biological response to stress. In addition, parameters of the cycle such as frequency, duration, and intensity can be measured; providing an effective tool for stress management. In summary, the idea of the stress cycle is that it tries to define the stress response as a physiological and a psychological reaction at every stage of the cycle and integrates these into a cohesive definition of the stress reaction (Reznick 1989).

3 Coping with Stress: Modern Approaches to Stress Management

Finally, in the last section, we would like to discuss two relatively less known ideas how to cope with stress. The following models are elaborated.

3.1 The Norwegian Experiment

The group of Ursin et al. (1978) have performed a series of studies on young paratroopers that joined the Norwegian army. Prior to jumping from airplanes, the young men were trained on ground facilities which gave them some feelings and experience of sky jumping. The men were taken to a Norwegian army base where they exercised jumping from a tower of 12 m height.

Before the first jump, some biochemical parameters of stress were measured in their blood, including the levels of adrenaline, insulin, glucose, and fatty acids and were designated as resting levels. Afterwards, the soldiers were asked to climb to the top of the tower to be hooked to special ropes and jump from the tower to the ground. Most of the fall is a free fall but as they approach the surface, the ropes slow down preventing them from hitting the ground. Immediately after the jump the above stress parameters were assessed again in their blood. They were jumping for 11 consecutive days and being assessed similarly every day. It was found that in the first 3 days, especially in the second day, the levels of the above parameters increased by 200–300 % above the resting levels. However, beginning after the fourth day of jumping and all the way to the last jump on day 11, the biochemical parameters of stress were gradually reduced, but did not return back to the resting levels of the pre-jumping period. The conclusion of the researchers was that by repeating the stressful experience of jumping over and over again, the soldiers were “getting used to” and by that they had developed coping mechanisms based on what is known in the literature as the gating mechanism. Accordingly, overcoming the initial fear means closing or narrowing the psychological gate in the brain which is followed by closing the physiological gate which, in turn, manifests by a milder or reduced biological reaction to stress, as shown in the Norwegian experiment.

3.2 The Dichotomy Model of Lazarus

Fear and threat are considered usually strong negative stressors. By overcoming them, the soldiers in the experiment outlined above have turned the negative stress into a positive reaction, and by that creating the psychobiological gate in the brain. However, most encounters of stress are such that the individual meets those events for the first time and does not have the opportunity to “practice” or repeat those situations many times.

Fig. 1 Dichotomy scheme of Lazarus



How does one react positively and create this gate when encounters, for the first time, a stressful situation? The dichotomy model of Lazarus (Lazarus et al. 1974) is a scheme that tries to provide such a mechanism by claiming that stress can be conceived in two different ways:

1. Conceived as a threat
2. Conceived as a challenge

When stress is conceived as a threat, one reacts strongly with an emotional response which dominates his reaction. Only after some time he may eventually refer to a logical response. Under such conditions he would have difficulties to create a positive psychobiological gate, needed for a mild logical response. On the other hand, if from the very first seconds he conceives the stress as a challenge, his emotional stage will be relatively short, while his logical response will be much longer; thus creating a positive psychobiological gate in the brain. The dichotomy scheme of Lazarus is shown in Fig. 1.

4 Summary and Conclusions

In this short review, a historical perspective on the long lasting scientific research into the stress field has been attempted. It is by no means comprehensive or complete, but it does emphasize that stress is a very complicated area of research with diverse definitions, concepts, and controversies. Nonetheless, the cycle of stress, elaborated in this paper, tries to bridge the gap between the physiologists and the psychologists by integrating many of the concepts, ideas, and discoveries into a cohesive model of the reaction

to stress. Hopefully, the concept of the stress cycle will contribute to the proper handling of stress by human beings, having in mind that a disease, a hardly escapable encounter in everybody's life, is the most common form of stress as well.

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References

- Burchfield SR (1979) The stress response: a new perspective. *Psychosom Med* 41:661–672
- Cannon WB (1932) *The wisdom of the body*. W.W. Norton & Company, New York
- Lazarus RS, Averill JR, Opton EM Jr (1974) The psychology of coping: Issues of research and assessment. In: Coelho GV, Hamburg DA, Adams JE (eds) *Coping and adaptation*. Basic Books, New York
- Mason JW (1975a) A historical view of the stress field. *J Human Stress* 1(1):6–12
- Mason JW (1975b) A historical view of the stress field. *J Human Stress* 1(2):22–36
- Reznick AZ (1989) The cycle of stress—a circular model for the psychobiological response to strain and stress. *Med Hypotheses* 30:217–222
- Selye H (1936) A syndrome produced by diverse nocuous agents. *Nature* 138(3479):32
- Selye H (1974) *Stress without distress*, 1st edn. Lippincott Williams & Wilkin, Philadelphia
- Selye H (1975) Confusion and controversy in the stress field. *J Human Stress* 1(2):37–44
- Ursin H, Baade E, Levin S (1978) *The psychobiology of stress – a study of coping men*. Academic, New York/San Francisco/London