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Short Commentary Open Access

Stress in Biological Research

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Every system, non-living or living, may remain in a static (non-dynamic) or a dynamic (non-static) state, which may be reversible or irreversible. It is possible that a system may be in one of the states at the time when observed, but may temporarily transit into the other state in between two observed time points. Another possibility is that the time spent by an object or a system in one of the states may be within the perceptible limit and hence could be observed; while the time spent by the system in the other state may be transient so that effectively it does not reach the threshold of our perception avoiding detection and therefore, for all practical purposes it is considered to be remaining in one state only. Thus, the duration spent in each condition by the system may vary in all possible ways including in a rhythmic, arrhythmic, progressive, regressive, linear, non-linear and/or exponential manner. In either condition, static or dynamic, a system generally exists in a sort of equilibrium with the surrounding. However, in a dynamic state the stability of the equilibrium persists only very briefly i.e. that of another kind, if we may say so, as compared to that in the static state. Because of this stability or un-stability of the equilibrium a system is referred as biased to be drifting (dynamic) towards a particular direction or biased to be non-drifting (static) from its position. Thus, essentially the equilibrium state of a system, which again may depend on the threshold of perception, suggests its existence in a static or a dynamic state.

Every living individual indeed has needs of various kinds, which however, may vary under various conditions and situations. Although the need may be of an individual, its source of supply for fulfilment may directly or indirectly originate from external or internal to the boundaries of the needy individual. The questions are how does an individual or a system recognize its need, how it would decide how and/or by whom (which source) the need would be met? The natural follow up question then comes up is even if there is/are source(s) to compensate or supply the necessary need(s) of an individual, how would the former know which system is in need and how much to deliver/supply? At the same time it is equally important to understand how a system in need would know which source(s) to be approached, who would deliver the right kind and right quantity of product to satisfy the need.

The basic understanding from the narration in earlier paragraphs may be summarized as demand and supply, the fundamental guiding principle in economics studies. Here we would not discuss those basic issues, which have expanded into subject categories as such. Nevertheless, in brief, demand would arise from within the body and that would depend on the psycho-somato-patho-physiological conditions of the living system, which in turn may have a component of interaction of the body with the surrounding. The source(s) of the supply in response to the demand may be from within or from outside of the body. But the fact remains, as has been raised above, how does the system know the quality and quantity of the demand to be ordered, on whom (which source) the demand should be ordered, how to evaluate if the desired quantity and quality of the demanded input(s) have been either delivered or received. It is also important to stop if excess has been received, excess is being pumped in or different quality is being pushed in than the quality demanded for. Similarly, the source of supply also needs to have the ability to receive the correct demand, deliver adequate supply and also the supply should be to the correct demander on right time. There are various factors on which the supply may be affected, which will not be discussed here in detail. However, for convenience of our understanding at least limited to this write-up, it would suffice to know that it would depend on the source, surrounding as well as the state of the receiver. It is also possible that although the supply is expected by an individual, some of the supply might non-specifically reach other surrounding systems/individuals which might not have demanded the specific supply.

Thus, for an optimum functioning it is necessary to strike an effective working equilibrium between the demand and the supply; which naturally will be a dynamic (non-static) process. It would depend on many intrinsic and extrinsic factors affecting both the demander as well as the supplier. As a consequence this equilibrium cannot be rigid and must have some play (flexibility) to accommodate the disturbance. Therefore, for such system(s) an optimal level of functioning or equilibrium cannot be a rigid fixed value for ever rather it has to be condition specific flexibility. In such an eventuality, the demander, the living system for this article, would behave within a range of limits. The altered behavior and expression when crosses the limits, are considered symptoms, manifestations of disorders or diseases, although many a times they may not be identified as full blown disease as such. In the absence of specific and adequate definition or explanation often some such expressions have been broadly termed as stress or response to stress.

The word stress has been used by many, in more than one ways; it has been used in explanation and interpretation of results in theoretical, experimental, physical, chemical, social and biological science studies. As we can find in the following site http://en.wikipedia.org/wiki/Stress_(biology), the word (stress) was not used until around 1920s, at least in relation to biological studies in particular. Initially it was used in physics to explain internal disturbance of a force and later found its use in biology. In biology, by and large the word stress has generally been used to convey the meaning that there is a challenge or threat to the maintenance of homeostasis of the living system. In generic term, if I may say so, this essentially means that stress is disturbance in maintenance of equilibrium but may not reach the level to be characterized as full blown disease i.e. to classify under a specific category to gain an identity by itself. Although the word has been widely used in relation to response(s) by a system, the stress(ful) response, generally we do not encounter a term as stressful stimulus to characterize a stimulus that would induce stress. This is possibly because to generate a response (by a system) which has its exclusive

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identity, a threshold of stimulus is necessary; however, often the intensity of stimulus to induce stress varies with the context, exposure, adaptation, etc.

As has been explained above, disturbance or shift in equilibrium may be due to one or many factor(s), intrinsic or extrinsic to the system. The word stress has been used quite broadly and as a consequence it is reasonably non-specific. Also, as the equilibrium is a dynamic state, any factor, at certain intensity, which may induce change in equilibrium at one point in time, may or may not be as effective or may be more effective depending on various internal conditions, various inputs on them and interaction of various components intrinsic and/ or extrinsic to the system. Thus, it would depend on the complexity of the system per se and the surroundings where the system exists and the point in time when the observations are made. All these factors must be taken into account while studying an effect and interpreting findings; however, these may not be significant if most experimental variable conditions can be controlled.

In experimental biological research, working with humans or animals (complex systems) poses a major problem of controlling all the intrinsic and extrinsic factors. Such difficulties are significantly reduced if the studies are performed on simpler model system(s) including in an anesthetized preparation, a slice preparation, anisolated tissue preparation or in cell cultures and so on. Therefore, naturally the stress response is an inbuilt associated experimental hazard that the experimenters have to deal with continuously. In behavioral research on living systems the experimenter can observe or apparently assumes to observe the so called behavior with relative ease, which is/ are reasonably crude as compared to observation at molecular level. Notwithstanding, in principle, stress may be experienced and stress response may be expressed by tissues, cells or more fundamentally by the molecules even in isolated studies as well, which often we do not take cognizance of. This is primarily because of lack of visible or other stress marker, if at all.

To be fair it must be mentioned that in some of the behaving animal studies level of serum cortisone [1-4], while in some of the cell culture studies morphology of cells [5] have been considered as marker for stress response. Although it may be argued that considering these signs and symptoms may be better than having no criteria, they are not the exclusive marker(s) of stress response because they are neither uniformly expressed in all experimental animals/cells, nor they are released/ expressed in a dose dependent manner [3,6] because of varieties of reasons discussed above. Further, often those changes, if any, may not be seen in long term chronic studies possibly due to adaptation, accommodation or simultaneous compensatory changes in other surrounding associated factor(s). It should also be considered that like most research the biological research is also carried out for the benefit of the humans as well as the animals. Most of the time the response of a living system is a reaction for the benefit of the body/ system, which has to be expressed even when one is diseased. However, when such reaction is in excess so that the body/system cannot withstand the reaction (e.g. anaphylactic shock, etc) or the body's defense cannot counter the effect of the external invader (whatever may it be, including the psychological factor), disease is expressed.

Therefore, instead of worrying much on some of the so called inevitable stress responses, which is essentially associated and may be a necessary evil, the emphasis should be on designing better control experiments, which would take care of the responses and also that of the background adaptation/accommodation effects [7,8]. Designing and conducting better and more control studies are more important because during most studies exposure of animals/subjects to certain test environment, chemicals, etc are likely to release/ secrete several bio-molecules. The quality and the quantity of these bio-molecules on one hand may not be consistently expressed in every experimental animals or subjects; on the other hand, even if expressed they may not reach the level of significance. Such expressions would be considered as non-specific changes, which in turn may bias the overall behavior of the living system.

In general, the living systems express primarily two fundamental behaviors. One is instinct behavior, which are inborn, while the other is learnt or acquired behavior, which one learns depending on the environment one lives in, with practice, experience, maturity and so on. Some such behaviors fall exclusively in either one of the categories, however, there are some behaviors which are instinct, but may get modulated by practice as well. Further, while some of the behaviors are autonomically regulated, others may be controlled by our will. In addition, the biological systems are so much interconnected that although a behavior may not be directly modulated by changes in a behavior, under conditions, it may get modulated or biased indirectly by changes in another behavior. Therefore, due to inherent properties of living systems, in behavioral studies, essentially often it would be difficult to predict which parameter may get affected or not while carrying out an experiment.

Sleep is one of the fundamental behaviors of all living higher order animals including humans. We do not yet know the precise and detail function(s) that sleep plays in our life [7,9]. Often sleep deprivation is used as an experimental paradigm to evaluate and understand the function of sleep as a model [8,10]. In addition, the effect of sleep loss needs to be studied to understand its influence on psycho-somato-patho-physiological conditions. Being a behavioral study it also suffers from similar consequences of so called stress (!) effect discussed above. Similarly, many such studies e.g. effect of exposure to high altitude, space, microgravity, microwave, psychological conditions, population pressure and so on, also may suffer similar stress related ambiguous criticism. It would be better that rather than ignoring the findings due to the so called (ghost) stress effect, emphasis should be on designing better and more number of control studies while collecting data for the advancement of knowledge for the ultimate benefit of science and society and service to the mankind at large.

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