ON THE CONTROL THEORETIC INTERPRETATION OF ANCIENT AND ALTERNATIVE MEDICAL SYSTEMS

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Abstract

The human body is viewed as a multivariable control system, with the brain as the supervisory controller. The five physical senses act as feed forward signals to the controller. It is shown that this system can obey the law of similars if the sensory organs exhibit a positive semi-sigmoidal or an exponential dose-response curve. Under this new light we see that most alternate therapies like the Homeopathy, Chromo therapy, Music therapy, Aroma therapy and Acu-therapies (puncture, pressure and touch) are but various special cases of a more general curing mode, namely the feed-forward compensation. It is also pointed out that the oldest medical systems of Siddha and Ayurveda use this principle as one of the modes of treatment.

Key words: MIMO system, Feed Forward Compensation, Cybernetics, Law of Similars, Homeopathy, Siddha, Ayurveda, Hormesis.

I. INTRODUCTION

In what follows we describe the problematic phenomena of Law of similars found in medical systems and Hormesis found in pharmacology. We also briefly present the modern scientific view of Physiology regarding the regulatory processes of the biological systems named as control systems.

A. The law of similars

It has been found since ancient times that drugs that elicit certain symptoms on a healthy person are in turn capable of curing diseases with similar symptoms. This observation is called the law of similars (LOS) which was formulated as *"Similia Similibus Curentur" by* Hippocrates. The LOS or the *"like cures like"* law is the basis of Homeopathic medical system. Contrary to the common belief, the LOS is one of the oldest principles to be discovered and recorded by human civilization. This is expressed as *"Vishaya Visham Aushadam" in* Ayurveda[2]. The Siddha system, an ancient medical system of south India, explicitly states three modes of treatment, namely, *"oppura, ethirura and kalappura"* which translate to "similars, opposites and mixed". However, the LOS continues to be a mystery mainly because it appears counter-intuitive at first sight and lacks a theoretical model to explain how it works. With scientists homeopathy has become unacceptable because of its second law. The second law states that with increasing dilution the curing effect increases. This means that after sufficient number of dilutions, the remedy still woks and works more powerfully, though it may not contain any atom (or molecule) of the original drug.

B. Hormesis

In the field of medical pharmacology and toxicology the relationship between the amount of a drug (or a poison) and its effect on a biological system (typically a lab animal) is usually measured experimentally and plotted as Dose-Response curve. As can be expected the response is slow in the beginning but increases rapidly with increasing doses before stopping the bio-activity completely (death). However on the near-zero doses the curve exhibits an unexpected phenomenon. As the dose approaches zero the activity is inhibited. But surprisingly, below some critical value the bio-activity is stimulated. This means that the drug, instead of harming the system, is actually found to help it. This non-monotonic behavior of the curve, which is called the 'Hormesis' [4], was first observed by Arndt & Schulz. This phenomenon continues to be a mystery even after 120 years after its discovery. Though it has been suggested as an evidence for Homeopathy, and hence the law of similars, the scientific community continues to be skeptical because again there is no supporting theory and in any case the second law of homeopathy can not be explained.

C. Human body as a Control System

It is established in modern physiology that human body possesses a control system to regulate its organs and processes to maintain all the variables of interest within normal limits (whole body auto regulation). More specifically the human body posses feed forward sensors which are the special sense organs of the human body, feedback sensing from various parts of the body through innumerous nerves, the central nerves system as the multivariable controller and the whole body as the complex system or plant being controlled.

In what follows we show how the LOS and Hormesis are the result of one and the same cause namely the feed forward mechanism present in human and other biological systems. In the same vein we also show that Hormesis

II. FEED FORWARD COMPENSATION

Plants in which variables of interest are kept within desired limits by the action of a controller and an actuator are called as a control system. The collection of all variables that are required to describe the system at any point of time is called the state. Systems deviate from their desired state because of the influence of the environment. The corrective action is computed as a function of the deviation of the variable (error). This method is called feedback control. Instead of correcting the system after allowing it to deviate in the first place, an adaptive method uses information of oncoming disturbance to correct the plant in advance. This approach is called as feed forward compensation. These concepts as applied in man made systems are collectively known as automatic control system theory. The study of flow of information and control is known as *cybernetics.* The feed forward mechanism as established through the five senses namely taste, smell, vision, hearing and touch actually act as information sources regarding any object of interest like food, danger etc. Taking this information, the brain triggers either preparatory or precautionary actions. In this premise we make the following assumptions: Human body is a system of many state and output variables each of which tend to be in a normal value. When all the variables are in their normal values the system is said to be in a healthy state.

Whenever one or more variables move away from their normal values due to an internal or an external action, the controller attempts to bring them back to their normal values. The "disease", for our purpose, may be defined as a permanent deviation from the normal state from which the system can not recover by itself. In the absence of correct therapy the system may continue to be in this undesirable state or diverge further away from normality which may lead to death. There may be more than one normal state. Transition from one normal state to another normal state occurs when correct inputs are given (e.g.: empty or full stomach).Every input of information, energy or material nature, affect the system in some way i.e. one or more variables move away from their normal values. With this back ground knowledge we propose the following assumptions.

i) All feed forward information trigger a compensatory response that tends to offset the change produced on the system by the input received. The sensitivities (rate of change) of the sense organs are high near low input and decreases with large values of input. This is a strictly increasing function with a concave downward curve. The nature of this curve is shown in figure1 by y_r (reaction). The reason for this intuitive judgment is that, a very high signal for a very large dose is not only impossible and unnecessary, its also dangerous if available. The mass and capacity of every organ and subsystem of the human body is obviously finite. Hence, its reaction in any form can only be finite. The boundary conditions are

ii) The ill-effect generated by the input (food, poison, inhaled gas, noise, a shocking scene or a traumatic external action) on the body is either linear or increases rapidly. The function here is strictly increasing but the corresponding curve is concave upwards. This is shown in figure1 by y_a. The reason for this judgment is the opposite of our previous argument. While the attributes and reaction of any human body can only be bounded, an external action on the body can, in principle, be unbounded. The result of such extreme action should only be terminal to the life. We model the strain produced on the system as an exponentially diverging measure.

With these assumptions, we show in the following section that recovery from the state of disease can happen using feed forward compensation.

III. MATHEMATICAL DESCRIPTION OF FFC

The output of sensors sluggishly increases with increasing values of stimulus. Thus the sensitivity of the sensor is the highest near zero and continuously decreases with increasing value of stimulus. This is so as to cover all possible range of the stimuli. The exponential (1) and the sigmoidal (2) equations, known to exhibit such behavior, are given below:

$$y_r = A(1-e^{-Bx}) \qquad \text{----- (1)}$$

$$y_{rs} = \frac{A1}{(B1+C1e^{-Dx})} - \frac{A1}{(B1 + C1)} \qquad \text{------ (2)}$$

Here, y_r is the response of the sensor, x is the stimulus strength, A, B, A1, B1, C1 and D are positive valued arbitrary constants. The boundary conditions for equation (1) are

$y_r(x = 0) = 0$

$y_r(x = \infty) = A$

$dy_r/dx = AB$ at $x=0$

$dy_r/dx = 0$ at $x = \infty$

The boundary conditions for equation (2) are

$y_r(x = 0) = 0$

$y_r(x = \infty) = AC$

$$\frac{AC}{B(B+C)}$$

$$dy_r/dx = \frac{ACD}{(B+C)^2}$$

$dy_r/dx = 0$ at $x = \infty$

$$\frac{AC}{B(B+C)} > dy_r/dx > 0 \text{ for } 0 < x < \infty$$

Note that exponential curve is first order approximation of the sigmoid curve. The direct action of the stimulus on the system is exponentially increasing with the dose. Because many variables inter connected in a multi input multi output system (MIMO) each stimulus can affect more than one output variable. The combined effect of many dimensions may be expressed using the following measure:

$$Y = \Sigma(c_i - \mu_i)^2 \quad \text{--------} (3)$$

which is sum of square of deviations of all controlled variables. The action of the dose is represented by the following equation:

$$y_a = p(e^{qx} - 1) \quad \text{-------} (4),$$

where y_a is the effect due to the direct action of the dose, x the dose and p & q are positive constants. The resultant response of the system which is the difference between action and reaction is represented by

$$y_{net} = y_a - y_r \quad \text{-------} (5)$$

Fig. 1. Sensory and System responses

The action of the dose on the system y_a is either linear or a rapidly increasing function. This is monotonically increasing like the reaction curve, but different in some ways. The rate of is small at the beginning but increases rapidly with increasing doses. Thus the shape of the action curve is concave upwards. Thus the net response of the system produces a J shaped curve. Because the reaction dominates at very low doses the net response initially grows negative and reaches a minimum. But as the action starts dominating the response gradually moves upwards and reaches zero (the zero point). There after the action is ever increasing. Thus with one and the same model we are able to completely explain two hitherto unconnected phenomena.

A. Condition for Hormesis

In the above system of equations, if $y_r > y_a$ for low doses then hormesis occurs. For this to happen the condition $dy_r/dx > dy_a/dx$ should be met. For the exponential sensor relation, this condition is AC > PQ at x=0.for this situation maximum hormetic effect occurs at $x = \log (AB/pq)^{1/(q+B)}$. The zero point can be found by solving $y_{net} = y_a - y_r = 0$.

B. The mechanism of LOS based medical systems

With this we also get a clearer picture about the mechanism of the homeopathic therapy. The patient due an external disturbance and/or an inherited deficiency undergoes a state change (a subset of symptoms gets deranged), from which he cannot recover by himself. This we call as the disease state. By collecting the complete pattern of symptoms of the patient, the physician recognizes the closest remedy (drug) which can elicit the same set of symptoms on a healthy person. Upon administering the same drug in a diluted form (chewing the pills longer in the tongue is recommended), due to the dominant reaction as explained above, every symptom is subjected to a reversal towards its normal value. After repeated applications this system returns to normal state.

Now we are able to find a pattern among the most ancient medical systems. Specifically, five different ways of treatment emerge, each depending on one sense organ. Medicines that act on the sense of taste.

1) Taste: Homeopathy, Siddha, and Ayurveda.
2) Smell: Homeopathy, sidda, Ayurveda, and Aroma therapy.
3) Sound: Music therapy
4) Colors:Chroma therapy
5) Touch: Oil bath, massage, Acupuncture, Acupressure, Acutouch

Thus these systems must be proved on healthy persons for the states they elicit before applying these therapies on patients with similar symptoms. This procedure is already in practice with the ayurveda, siddha and homeopathy. Here we make a suggestion for other perception based healing systems as well.

IV. Conclusion

The cybernetic model presented in the work is a novelty. Using this view we are able to explain the law of similars as well as the non-monotonic dose-response curve. Unlike the existing research reports which relate specific toxins applied to specific species with any one measure of damage, our work presents a very general

framework independent of the type of toxin, species, corrective process and the measure of damage. Further our interpretation is not statistical. The second law of homeopathy, according to our picture, has either a lower limit to the concentration or involves phenomena unknown to science hitherto.

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