



HYPOTHETICAL COMMUNICATION MODEL OF INTERACTING RHYTHMS IN LIVE COMPLEX OPEN SYSTEMS

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Abstract

(Key words: biological rhythm – BR; biological rhythm system – BRS; machine/human interaction; Emotion and Stress Screening – ESS*; Rhythmic Frequency Modulation – RFM*; Dynamic Bayesian Networks – DBN)

Problem: Communication between environment and human organism depends on the exchange of information in the interaction of fluctuating and oscillating systems. Fluctuation of a system is controlled by permanent changing stimuli and their oscillation. A fully functional live system is regulated by rhythms generated out of the communication of quasi-periodically repeated fluctuation and oscillation values, as for example concentration of hormones, temperature of skin, loudness/intensity, heart frequency. Each oscillator generates fluctuancy and analogue oscillation and is influenced itself by oscillation of fluctuant systems of the network. They are connected via negative/positive feedback mechanism. The quasi-periodical variations cause rhythms with “longitudinal wave” character, which work like “moving and structuring waves”.

In passive state biological and natural rhythms oscillate in their individual spontaneous or “rest rhythm”. Out of this position the organism is able to accommodate environmental stimuli (natural / technical rhythms) in an optimal way. Exceeding stimuli or accumulation of stimuli cause rhythmic disturbances throughout the system and may even generate general “insufficiency of accommodation”. The organism reacts with emotions, starts with physio-psychological-pathogenetic mechanisms, and means the beginning of a 7 – 10 year lasting structural pathogenetic development with “chronic diseases” at the end.

Solution: Special time series analysis like ESS demonstrates the biological rhythm system in its actual oscillation on the basis of voice analysis. Rest rhythms as well as stress rhythms are detected. Stress rhythms must regain “rest rhythm state”. A special method, RFM, modulates frequencies into rest rhythms. They are applied to organism for entrainment/resonance via sound and vibration with special vibrasound equipment.

Results: schematic diagram of hypothetical communication model; 50 probands with disturbances of their individual BRS and disturbed capability of accommodation – their analysis via voice before and after entrainment via sound and vibration

INTRODUCTION

It is well-known, that there is a complex network of interaction: the environment - nature as well as technique - and human beings communicate by sending out stimuli, receiving and answering them, influencing each other. The human organism reacts to stimuli by changing metabolism, immunsystem, emotions and vegetative parameters. The altered values are validated and defined at a fixed moment, excluding the observation of time and space. The explanation of those changings is given on the structural, chemical and electromagnetical level. The explanation of what is forcing and organizing the changes of this level is missing. These 'organizing forces' in the 'Black Box of human organism' are quite unknown.

The knowledge of what is going on principally, basically, in the "Black Box" would enable to solve problems, that are of vital importance for human's healthiness, existence and evolution and – of course for improvement of controlling the interaction "machine/human" and the development of new machines and technical equipment.

PROBLEM

To optimize the interaction of machines and humans up to now machines have been specified and optimized to highest degree: best function, easy handling and controlling, safety, comfort. It remains the task of optimizing humans.

It should exist an idea, a theory, about operating sequences in live complex organisms, and it should exist the technical equipment to evaluate and verify such theory and, in consequence, to regulate and balance a live organism. Up to now there is few theory about the inner organizing processes in the 'Black Box'. The most frequently explanations of 'energetic' or 'functional' proceedings are not precisely enough, to develop exact emplanted and working technical equipment.

Sound and vibration, of natural as well as of technical origin, are stimuli, that impinge live organism and disappear in that so-called 'Black Box'.

Only now the immense progress of informatics and physics, especially the development of a method like 'time series analysis' [1] enables to integrate the observation of time and space and therewith opens a wide field for research of live systems and their inner processes inside the 'Black Box'.

SOLUTION

Hypothetical communication model

On the basis of chronobiological knowledge and research: the interaction between environment and humans is based on the exchange of information. Information needs a medium, a 'universal language' for transportation: temperature, light, colour, smell, taste, sound, vibration. The human senses function as receiving station and transfer

the sensed frequencies. The perception happens partially ‘overcross’: subsets of frequencies are registered simultaneously by different sense organs. Time series analyses of different parameters prove the joint possession of frequencies/bands of frequencies representing the multitude of oscillating processes [2]. This is the precondition for the existence of DBN (Dynamic Bayesian Networks) [3]. The information of only few parameters allows prognoses for all remaining parameters.

The sensation of the organs skin and ear/equilibrium organ is of essential importance. Static and balance, orientation within the environment, all physiological, vegetative processes are connected with the right translation of sound and vibration.

All sorts of natural stimuli are characterized by the oscillation of a mixture of frequencies, dependent on the kind of stimulus (electromagnetic – radio, light; chemical – smell, taste; mechanic – sound, vibration) and the fluctuation of permanent changing values of concentration or intensity. Periodically repeated motives of fluctuation and oscillation values within defined time intervals generate characteristic ‘rhythms’. Natural rhythms are generated by quasi-periodically repetition and get ‘longitudinal character’, which enables them to work like “moving and structuring waves”; that means, they may cause structural changes of mass. The human organism as a live complex system is organized by regulative systems and their biological rhythms [2]. Hormones, enzymes, minerals, cells, organ’s functions, etc. are characterized by their own rhythm, that is generated through fluctuation and the analogue oscillation of connected rhythms.

‘Rhythm’ is the informativ factor, the universal language, that connects the environment with the live human organism. Rhythm regulates all functions in the ‘Black Box’.

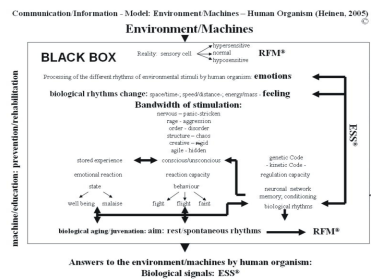


Figure 1 - ‘Black Box’ -Communicative flow of information between natural / technical environment and a live organism and the flow within the organism

The visible and measurable differences of effects caused by defined stimuli (rhythms) prove, that there must exist an inner self-regulation-mechanism. In passive state biological and natural rhythms oscillate in their ‘spontaneous’ or ‘rest rhythm’ state [2]. Out of this position the organism is able to accommodate environmental / technical stimuli (rhythms) in an optimal way. Rest rhythms react to stimuli with increasing amplitude and frequency and phase shifting to ‘stress rhythms’ and recover again to rest status within a short period (adaptation period). The organism reacts with archaic reflexes and emotions, electromagnetic and chemical alterations and

changes its perception of space/time, speed/distance, energy/mass. Exceed or accumulation of stimuli cause rhythmic disturbances throughout the living organism. If there is no sufficient reduction to rest rhythm periods, it may even generate general insufficiency of accommodation with prolonged stimulation/recovery intervals, hypo-/hypersensibility. A physio-psychological-pathogenic mechanism starts and means a 7 – 10 year lasting structural pathogenetic development with chronic diseases in the end [2].

Each organic / non-organic mote of environment and living organism is acting like an ‘exciter – E’ and an ‘oscillator – O’ at the same time. The direct interaction is regulated by a ‘3rd player’ for ‘fine tuning – FT’, especially in important regulation centers (e.g.hypothalamus). The combination of exciter, oscillator and fine tuner works like a ‘rhythm generator – RG’ with the character of a longitudinal wave to act like a ‘moving and structuring wave’ and to organize the mechanisms of catabolic/anabolic metabolism, of building up structures, of decompositing structures to generate energy, of building up new structures - even in the context of diseases - or longtermed - even evolution.

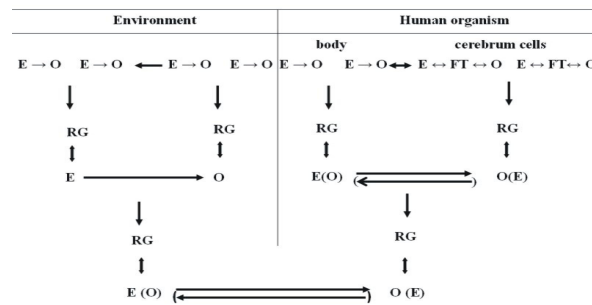


Figure 2 - Exciter- Oscillator- Rhythm- Model (Heinen, 2006); E = exciter; FT = fine tuner; O = oscillator; RG = rhythm generator

Optimal communication is based on the similarity of rhythms (variability of frequencies within the ‘critical bandwidth’) to approach resonance. A rhythm with a basic frequency beyond the scope, beyond the critical bandwidth, communicates via entrainment. The success, that means the take-over of the new rhythm depends on the intensity and duration of the rhythms application.

Chronobiology research found out many rhythms of organic and natural functions [2]. In passiv state all rhythms communicate within their rest rhythm frequency band. Inside the body rhythms show a trend to coherence. Rhythms of united cell structures are evolutionary assimilated to work as a whole. Special rhythms developed dominantly to act as pace-makers (e.g.sinu-atrial node). Quite different the brain works with ‘mathematical chaos’. Subsumed under low frequency bands (beta, alpha, theta, delta) each cell follows its own oscillation in a quite autarkic way, always ready to modulatr its rhythms to integrate in new teams, groups and formations and to recreate again, when the brain’s order is done and the

formation disintegrates. The brain works with a constant composition to similar oscillating groups on the basis of the incoming rhythmic exciters from the environment and the body and the following decomposition. The body's rhythms excite adequate brain cells' rhythms to cooperate in a special composition on the basis of actual values. This is why complex live systems need no absolute point of origin, to return to. The actual value always acts as a new 'zero-point'.

This is the reason why the brain does not need a high volume capacity of memory – there is only a basic set of rhythms (R_i). They are permanently involved in actual compositions and connections and the permanent decomposition. The possibilities of free and new combinations are endless: ($R_i!$).

Because of the fluctuation of values the brain is able to register differences between rhythms' amplitudes and frequencies. This makes humans get an individual sense of space/time, speed/distance, energy/mass (reversibly proportional relation). Stress rhythms generate actual changes in the individual experience and emotions, that means, not the world of experience and learning but the biological rhythms provoke aggression, panic, depression. [5].

To be aware of this fact is of great importance in the interaction of machines and humans. Security depends not only on the technical clean function of machines but on the clean balanced biological rhythmic system of the operators.

Method to verify and prove the model – ESS Emotion and Stress Screening

The splitting of separate oscillating systems via time series analysis shows, that in a complex live system the whole bandwidth of frequencies is defined as $1/f$ noise, the most important criterium for the existence of functional working self-organization [1]. The $1/f$ noise derives from the interaction of exciter, oscillator and fine tuner, which are connected by positive/negative feedback. The characteristic 'bounded input' and 'bounded output' secure the system not to exceed beyond the scope. A natural regulating structure is generated to build up and regulate structure under supply of energy with regard to the management of biological rhythm system (Figure 2).

White noise, produced by techniques or entrainment of 'false' rhythms, leads to the formation of closed loops (Selbstreferenzschleife), which inhibit the organism in its selfregulation and communication [4] (e.g. see paintings of Escher).

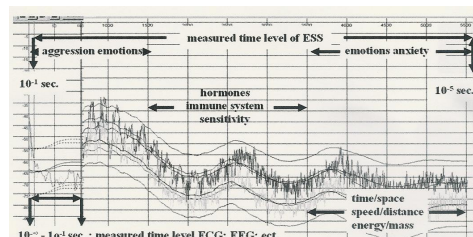


Figure 3 - Time series analysis via ESS, comparison of the analysing range of ESS; EEG; ECG; etc.

The human voice as a vivid, actual and individual moving bio signal is predestinated to provide an insight to the biological rhythm system. It is part of communication with the environment and with the own organism. Voice is made out of sound and vibration. It builds up a selfregulation loop, a direct feedback. The same moment voice is produced, skin and ear and equilibrium organ get the excitement of the immanent rhythms, interact with their oscillations and cause brain's cells' oscillations.

Voice research demands only for the development of non-invasive methods and promises easy handling. A special analysis of the voice has been developed, which opens a bandwidth of frequencies between 10 Hz and 5.5 kHz to represent the mainly used human frequency band (*Figure 3*). This enables an insight to biological rhythms in the range of 10^{-1} to 10^{-5} sec..

Up to now more than 2000 voices have been analysed and special kinds of interpretation modes according to the BRS have been found out. They enable to make statements to i.a. general disposition of energy; characteristic individual constitutional and conditional status; oxidation and reduction processes; acid – basic metabolism status; status of immune system; regulative status of the hormones insulin, cortisol, thyroid hormone; BRAC; emotional status of aggression, panic, depression analogue archaic reflexes of fight, flight and faint; tension, surge, relaxation, exhaustion; individual sense of time/space, speed/distance, energy/ mass. (*Figure 1*)

Method to regulate BRS via sound and vibration: RFM Rhythmic Frequency Modulation

Recognition and demonstration of a disordered BRS requires a method to re-regulate and re-organize to a status of optimal accommodation, to regain common rest rhythm status. On the basis of the knowledge of uptodate scientific research and the above introduced theory there has been developed a an easy operating tool, a method, combining all parameters, that are necessary to create rhythms analogue BRs. The basics 'frequency and amplitude' are modulated to a mono-sound with a variable amplitude of defined rest rhythmic character. The experience of the deep basic frequencies happens via the sense organs ear/equilibrium organ and skin, bone conduction, connective tissue. Harmonics and high frequencies are to be heard via ear. The simultaneous application of the vibroacoustic stimulus via ear and body enables the brain to calculate and interpret the differences between the incoming rhythms, to check the rythms as 'well-known' and to stimulate the organism's self-regulation system to go in resonance, to take over the rhythms and to swing back to rest rhythm state in order to regenerate.

ESS and RFM in practical use – exemplified with voices of 50 probands

Out of 2000 voices, that have been analysed with ESS, a subset of 50 probands' voices demonstrates

a) the ability of objective visual demonstration of individual BRS

- b) the manipulation by extern/environmental natural and technical rhythms (u.a. by sound and vibration, (*Figure 4*)
- c) the possibilities for regeneration via application of rest rhythms, created on the basis of sound and vibration

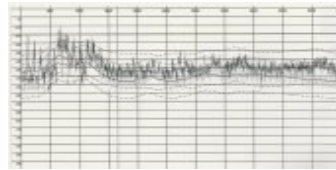


Figure 4 - voice curve: lost 1/f-noise character after long-termed car driving/radio

RESULTS

Probanden		before stimuli		under stimulation		post 1/f - tone	
ESS		m	w	m	w	m	w
time	slow	4	3	4	9	2	3
space	wide						
speed	slow	4	3	4	9	2	3
distance	long						
energy	low	4	3	4	9	2	3
mass	big				9		
time	quick	3	5	17	14	1	2
space	narrow						
speed	high	3	5	17	14	1	2
distance	short						
energy	high	3	5	17	14	1	2
mass	low						
oxidativ stress	high	5	3	21	12	4	2
reduktiv stress	high	7	5	3	9	3	3
white noise		0	0	24	26	3	2
acidosis	↑	5	11	19	21	2	5

Table 2 - ESS-Study with 50 probands (24 m; 26 f), who were stimulated by different environmental stimuli (vibration, noise, electromagnetic field, chemical substances)

1) Functional processes in live complex systems/organisms are regulated by a basic informative system: the Biological Rhythm System. 'Rhythm' is the fundamental and universal language in live complex systems.

2) Sound and vibration are to characterize as 'rhythms'. They are able to manipulate a live system/organism via resonance and entrainment.

3) The special methods of voice analysis and rhythmic frequency modulation (ESS and RFM) give an insight into BRS and support the reorganization of the system.

4) The individual perception of space/time, speed/distance, energy/mass, depends on the individual sufficiency of BRS. A disordered BRS produces different estimations compared to those given by machines and measurement apparatuses (watch, tachometer, distance-measure, assamby line,...) with the result of unexpected conflicts with sudden unexplainable emotional eruptions (aggression, panic,...) and somatic misfeelings (sweating, tachycardia, hyperventilation...), (*Table 2*)

5) The knowledge of the relevance of $1/f$ noise of BRS, (*Figure 3, 4*) gave the impulse to test the 'voice' of loudspeakers because of their function as transmitters of sound and vibration. Nowadays high performance loudspeakers are qualified by linearity of amplitudes - with the effect of causing 'white noise' status. New full-range loudspeakers have been developed, producing sound rendition analogue a natural $1/f$ noise with the aim of optimal regulation methods for living systems.

CONCLUSION

A message of basic importance has been published already in 1869 by Virchow [6] in Berlin. 'Diseases start at that moment, when the 'regulatory apparatuses' of the organism do not function sufficiently in order to balance disturbances. Not life under abnormal circumstances, not the disturbance itself, causes illness, but the insufficient working 'regulatory apparatuses'.'

The determination of perception by the individual regulation systems causes conflicts between machines and operators, if the external and internal rhythmic systems differ. Analogue the above definition of 'rhythm' the external rhythms are of acoustic and vibrational nature as well as of chemical, electromagnetical nature. Techniques, electronical equipments, which were originally thought to support and defend the human operator suddenly turn to rivals and force humans to sudden unexplainable reactions up to aggressiv or panic attacks.

The message for future developments in industrial as well as in social institutions is to recognize, that the interaction between environment (nature and technique) and the human being is characterized by permanent changing communication of rhythms. Humans have to regulate and vitalize themselves and their BRS regularly in order to adapt to their environment.

On the other hand the environment has to observe rhythmic variability to adapt humans' intervention. This demands for awareness, consciousness, fairness and responsibility in respect to both sides.

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