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THE EFFECTS OF SOUND AND VIBRATION TO BIOLOGICAL RHYHTM SYSTEM IN HUMAN ORGANISM NON-INVASIVE SCREENING, ANALYSIS AND MODULATION VIA VOICE FREQUENCIES WITH ESS (EMOTION AND STRESS SCREENING)* & RFM (RHYTHMIC FREQUENCY MODULATION)*

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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*; Basis-Rest-Activity-Cycle – BRAC)

Problem: Optimal interaction of humans and machines presupposes full capacity of the operating person in order to guarantee high quality perception, regulation and reaction. Lack of concentration, tiredness up to sudden faint (micro sleep) has to be prevented.
The disturbance of biological rhythms is of basic importance. Alterations in BRS produce modified perception, reaction and regulation in the emotional and the different metabolic and somatic systems. The result is “stress” up to “illness”.
Early warning and detection systems are needed to watch the different BRs and to interpret closely the analogue emotional and somatic reaction and regulation.
Solution: Time-series-analysis of voice frequencies, like ESS, is adapted for implementing analysis of BRS. The method is adapted for controlling and interpreting the functional behaviour of the living organism with its emotional and somatic regulation and reaction.
Result: We found out and could demonstrate that one’s individual experience of time/space, distance/speed, energy/mass often differs from the objective real-time measurement. The changed perception is caused by the changes in functional processes of the various coupled BRs. The “operability” of the BRS is directly influenced by stimuli - like sound and vibration - and further on influences and determines actively the organism’s ability to adapt the different surrounding stimuli, as for example natural/technical sound and/or vibration. That means for humans: their status of health and its tendency to diseases is determined by the individual functionality of their BRS.
Presentation of: Examples of time series analytic evaluation of voice with ESS, 50 probands stimulated by sound and/or vibration, special curves for standardized examination of the observed reactions in BRS, new method – RFM - in order to restore the deregulated BRs to their “spontaneous” or “rest form” (for example BRAC), demonstration of special developed high quality Hifi-equipment

INTRODUCTION

The essential importance of sound and vibration for human beings is already proved by embryonic development. The first formed sense organs are skin, equilibrium organ and ear in order to listen to the basic rhythms of life: the frequencies of mother's heart, blood flow, breathing, the vegetative system of Symphatikus and Parasymphatikus. The first neuronal networks are based on the perception of movements, of vibrating and sounding rhythmicity. The frequency band of sound and vibration covers the whole human physiological regulation system, which is coupled with the archaic reflexes of fight, flight and faint, coupled with the analogue emotions of aggression, panic and depression. These primal senses never 'sleep': the existentially required orientation of space and time, of speed and distance, of energy and mass, the essential security, static, the balance of movements – body's as well as brain's – depend on their ability to perceive natural/technical environmental rhythms and the sufficiency of the BRS to accommodate.

PROBLEM

It is fact, that increasing influence of rigid technical rhythms - especially of sound and vibration rhythms - disturb the sensitive natural BRS of humans causing symptoms like sudden, unexplainable emotional breakouts, hypersensitivity, weakness, tiredness up to sudden faint (micro sleep), exhaustion and a modified perception of time/space, distance/speed, energy/mass – contrary to the technical measuring instruments.[3] Persisting false rhythms of high intensity are able to overwhelm the human BRS and start a process of 7 – 10 year lasting psycho-somatic deregulation beginning with light feelings of 'un-wellness', ending with chronic diseases. [1]

One realizes the health disturbing effects and influences of technical stimuli only at the moment, if there are already visible signs respectable if there has already happened structural modification, that means: too late. The possibilities to actual monitoring or even controlling of what is going on inside the human organism are limited. In the consequence industry tries to optimize machines and their operating modus. For industrial purpose the easiest way to reduce disturbing effects is to lessen the intensity/amplitude by absorption and dampening and/or overlay with other stimuli, music for instance. The effect is: humans believe to feel well: their cars are running softly and silently; there is no feeling of the slippery ground, the sharp bends, the heavy drop of rain and hail, the machine's humming; the human feels safe in his – pretended - noiseless 'sitting room', his 'concert hall'. Thus his sensitive connection to his environment is cut dramatically. Technical comfort, technically induced soundlessness, uncouples the human from his environment and consequentially from adequate reactions. The influence of frequencies remains in the background. The sense organs are sensitive enough to feel them anyway. They stimulate the human's BRS further on, but the human cannot classify them in a correct way because of the missing 2nd factor.

Early warning and detection systems are needed, that enable easy-handling measurements of the effects of external rhythms to the self-regulation-system and the BRS of the complex live organism and – in consequence - methods to influence organism in a balancing way. In the past chronobiology and chronomedicine research found out the rhythms (frequency bands) of many natural organic functions by using invasive methods. [1] Only the development of new information technology and physical and mathematical methods like time series analysis enabled the design of first non-invasive methods to analyse comfortably the permanent changing fluctuation of values of bio signals like blood pressure, brain waves, heart-rate-variability, skin's temperature and resistance. [1, 2]

All these methods suffer from the lack of integration of the coupled emotional status and the individual perception of space/time, distance/speed, energy/mass. [3] Those factors are of significant importance for security and precision in operating machines. To get information about the communication and interaction of external and internal rhythms is of vital interest of medicine, pharmacology, informative technologies and industry - especially of automobile and aerospace industry. [3]

SOLUTION

Basics

The interaction between BRS and technical rhythms

A live complex organism always aims at a certain stability and balance of his regulative systems. This vivid balanced status is the basis for optimal adaptation to any external and internal stimulus. Self-organization happens on the level of BRS. [1]

Rhythm is the informative factor, the universal language, which connects the environment with a live organism. Rhythm is generated by the interaction of an exciter and an oscillator, performing periodical repetition of motives of fluctuating values and the analogue oscillation. They influence each other via permanent positive/negative feedback. In this vein most different parameters are able to communicate, independent of the kind of quality, whether of electromagnetical or chemical nature, whether pressure, temperature, resistance or concentration. [3, 4]

Rhythm is characterized by its amplitude/intensity and its frequency. Rhythm is characterized by the periodical (technique) respectively quasi-periodical (nature) repetition of a fluctuating motive within a defined interval.

Each cell, each function of metabolism, is working in its own rhythm. In passive state all rhythms work and communicate in rest rhythm status. [1] Incoming stimuli/rhythms generate changes of phase, frequency and amplitude, alterations in fluctuation and oscillation of rest rhythms into 'stress rhythm' state. [1, 4]

The BRS is the level, where movement takes place: regulation and manipulation are possible in a negative as well as in a positive way. [4]

The BRS' sufficiency of accommodation, sufficiency to re-regulate to rest rhythm state in time, is of vital, existential importance for humans and their fitness

for work and life. Persistent stress rhythm state provokes non-adequate interaction with natural and technical environment.

The rhythmic nature of sound and vibration

Sound and vibration are oscillating stimuli, with 'rhythmic' character. The interaction of technical sound/vibration with the human BRS via resonance or entrainment is based on the parameters 'variability', 'intensity' and time dependent 'progress'.

variability	**intensity**	**progress**
mixture of frequencies (harmonic/disharmonic: noise, bang, tone, band, beat frequency)	linear / changing	permanent/once/sometimes
sinus frequency	high / low / mute	periodical/non-periodical interruptions
rigid periodical / quasi-periodical repetition	varying periodically/non-periodically	in-phase/out of phase
Within/outside critical bandwidth		

Figure 1- Characteristics of rhythms

The less variability, the higher intensity, the longer progress of sound and vibration rhythms the higher is the danger of over-take of a strange rhythm and long-running disturbances of BRS and further on the coupled metabolic systems – neurotransmitter-, hormone-, immune systems, the balance of minerals and vitamins, of acid/basic metabolism, of emotions, of mental capacity like concentration, awareness.[4]

The human voice

The human voice is a permanently changing bio signal within a frequency band of about 16 Hz – 12 kHz with a mainly used band between about 100Hz and 6 kHz. This is a wide subset of sound and vibration frequency band. It is 'status of knowledge', that the sound of voice integrates the actual emotional status of a person. Based on the knowledge of the coupling of natural vegetative regulation, archaic reflexes and analogue emotions, voice becomes an object of interest for scientific and medical research.

The voice, a product out of sound and vibration itself, is able to represent and to reflect the high speed of organic impact sound and air transfer within fractions of seconds. The same moment voice is produced, skin, ear and equilibrium organ get the excitement of the immanent rhythms, and the whole organism interacts with their oscillations. It is built up a selfregulation loop, a direct feedback. Any dysbalance of oscillation between new incoming and inner working rhythms is registered and answered with psychic and metabolic/somatic reactions.

Voice analysis ESS (Emotion and Stress Screening)

A special developed method on the basis of time series analysis splits the voice into its frequencies up to 5.5 kHz. The frequencies are to interpret as representative for BRS.

The interpretation of voice always is related to the individual and demonstrates his actual state of accommodation in relation to the bandwidth of his potentiality. A series of voice analyses gives a review of the development of individual sufficiency within a defined time interval and allows a statement of trends regarding his future performance of accommodation and the tendency to health or illness. Voice analysis features by individuality, actuality, visualization of trends.

The 2 curves, established by the sound/vibration of voice over body and ear, show the actual status of the BRS. In balanced status of organism the two curves are running parallelly: the green one representing brain's BRs and capacity, the yellow one running below showing the metabolic/somatic suffiency. This is the state, when all rhythms interact and communicate in their rest rhythm status, when all functions are balanced, the immun system is strong, the human feels emotionally and somatically good. This is the status, that generates standarized values of medical parameters (EbM).

This is the status, when the environmental perception is approximately analogue the measurements of watch, metering rule, tachometer, weighing machine. This is the status to adapt stimuli in an optimal way, to enable peak performance in work, sport, life.

This ideal status is of vital importance for the human's regeneration. A live organism is organized to get back to this state regularly and therefore requires with signs of tiredness for pauses and sleep to swing back and regenerate. This is the task of a dominating immanent human rhythm - the 2 h lasting BRAC (Basis-Rest-Activity-Cycle). Voice analyses taken every 5 minutes over a period of 2 hours demonstrate the capacity of an organism to regulate and regenerate, respectable to detect problems.

Permant environmental stimulation causes permant modulating oscillation of BRS and permanent changing voice analysis' curves. Permanent false stimuli, lack of regeneration periods force the BRS to stress rhythm status. The curves show excessive amplitudes of frequencies out of scope, excessive or deminished positions and crossing points, the loss of 1/f – noise character.

Up to now more than 2000 voices have been analysed and special kinds of interpretation models 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.

Perception of time/space, distance/speed, energy/mass in relation to BRS

The individual and actual modifications of human BRS corresponde with an individual and actual modification of perception.

Crossing curves within the high frequency area between 3.5 and 5.5 kHz are significant for an altered environmental orientation by an altered perception of time/space, speed/distance and energy/mass. Each pairs's relation is of reciprocal proportion. The crossing curves correspond with the subjective feelings of 'Time is running too quick.', 'Minutes last forever.', with the manner of driving a car anxiously and slowly in the middle of a multilane road, of sudden slow down the engine, or on the contrary with the manner of raving with exceeding speed along the narrow track of road works or dangerously deminishing distances.

The perception of a fixed measured instrumental value depends on the actual individual regulation status of human BRS.

RFM Rhythmic Frequency Modulation

A new method to modulate frequencies analogue biological rest rhythms has been developed in order to re-regulate a stressed BRS, to balance and stabalize the organism, to prevent permanent stress and diseases .

Using basic, universally validated, musical parameters the basics 'frequency and amplitude' are modulated to a mono-sound with an amplitude swinging up and down with defined rest rhythmic character. The experience of the deep basic frequencies happens via the sense organs ear/equilibrium organ and skin, via bone conduction and connective tissue. Harmonics and high frequencies are to be heard via ear. The simultaneous application of the vibroacoustic rhythm 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 and reinforce and regain its original rest rhythm status.

RESULTS

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

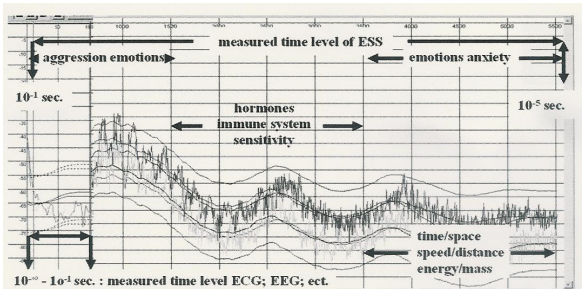
Study: 50 probands (27 male/23 female) were analysed: before stimulation – after stimulation by technical sound and vibration – after application of special vibrasound rest rhythms, which were modulated with RFM

The curves demonstrate the ability of objective visual demonstration of individual BRS and the corresponding emotional and metabolic/somatic status as well as the manipulation by extern/environmental technical rhythms of sound and vibration.

The validation was done by comparison of EbM related values and diagnosis, the subjective estimation of emotional and somatic status by the proband itself and the investigator's independant interpretation of curves without knowing any personal

details. There has been reached a specificity and sensitivity of about 93 - 97 % depending on parameter.

The same procedure was implemented to prove the influence of 'artifical' creations of rest rhythms on the basis of sound and vibration in order to regenerate the system via RFM.



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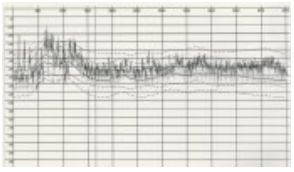

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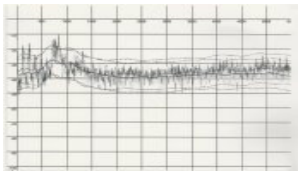

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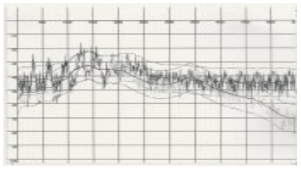

d)

Figure 2 - voices' curves – effects of external sound and vibration stimuli a) rest rhythm status b) stress rhythm status - car driving/radio c) noises of fair d) music listened to via earphones

The individual curve progression analogue a natural 1/f noise has been changed by entrainment of external stimuli like surrounding noises of fair, car driving and radio, gongs, music via earphones, machines' humming in a joiner's workshop. Some curves even show 'white noise' character. These persons lost their own rhythm totally for some time.

Probanden / ESS		before stimulation		under stimulation		post RFM	
		m	w	m	w	m	w
time	↓ slow	3	7	11	15	5	4
space	↑ wide						
speed	↓ slow	3	7	11	15	5	4
distance	↑ long						
time	↑ quick	5	4	13	7	4	2
space	↓ narrow						
speed	↑ high	5	4	13	7	4	2
distance	↓ short						
panic-stricken		6	5	9	17	2	3
aggressive		7	3	15	11	3	1
vertigo		5	5	9	12	2	3

Table 1- study - results

The study demonstrates the altered perception provoked by external/technical sound and vibration and the balanced perception after regulation with RFM modulated vibroacoustic rest rhythms.

High quality Hifi-equipment

The knowledge of the relevance of 1/f noise for the functionality of BRS 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 forcing the BRS to 'white noise'status. *(Figure 1)* New full-range loudspeakers have been developed producing sound renditon approximately analogue a natural 1/f noise with the aim to have an optimal equipment for living systems combining analysis and regulation methods with adaquate techique.

CONCLUSION

The voice analysis ESS is a non-invasiv method of easy handling and quick analysation. It gives insight into the human functional system on BRS level. ESS enables to watch and controll actual interaction between environment/machines and human organism. ESS proves to be a method of optimal controlling effects of sound and vibration. The method RFM enables re-regulation of BRS by application of rest rhythms via sound and vibration.

Loudspeakers, which support the approximation to the natural 1/f noise by their construction are favourable for application. Special equipment has been developed.

The consideration of the human's BRS is of vital importance for professional judgement and control of multimodale interaction between environment/machines and a live complex open system like human organism.

Studies proved, that the above introduced methods are particularly suitable tools for those projects.

An interesting question remains for future research about the influence of humans' rhythmic behaviour to machines' technical rhythms.

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