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STRESS DIAGNOSIS OF ACOUSTIC AND VIBRATION STRESSORS WITH A SPECIAL VOICE FREQUENCY ANALYSIS - VFA PRESENTATION OF A RHYTHMIC-FUNCTIONAL DIAGNOSTIC METHOD

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Abstract:

The industry's demand for diagnosis of the stress effects of sound and vibration within human-machine-interaction so far has not been matched sufficiently by an adequate development of medical equipment and methods. What is needed is an user-friendly, fundamental and reproducible diagnostic method to evaluate the essential emotional-functional stress systems in organism, considering the influences of the individual's constitution, condition and conditionings.

Based on experimental / practical / clinical research with thousands of voice graphs over the last years, it appeared that special interpretation modes of a new kind of voice-frequency-analysis VFA allow inferences about essential emotional-functional stress parameters (ESP). With the usage of an individual's timbre it is free of any influence of age, culture or gender. The handling is easy, safe, immediate and location-independent, without any sensors or belts attached to a proband.

The VFA is based on the models for living open systems with non-linear behaviour and connects the knowledge of chronobiology, functional medicine, physics, acoustics and stress research.

The results of many open studies brought off with the VFA revealed that sound and vibration rhythms cover all interfering biological rhythms. It allows to assess the emotional and functional stress parameters ESP: 'autonomous nervous system', 'redox system', 'acid-base-equilibrium', 'anabolic-catabolic-hormone-equilibrium', 'personality profile' (basic/stress behaviour), 'conditioning', 'experience of time and space – speed and distance', 'potentials', 'stress status', 'problem areas of 'columna vertebralis'. Stress thereby is defined as a communicative process of interfering environmental (technical, natural) rhythms and the biological rhythm system (BRS) of organism.

In summary, it can be stated, that VFA is a repeatable, emotional-functional diagnostic method for the human organism. VFA enables to control individual emotional and functional reactions of the human organism during an application of specified acoustic/vibration stressors. By means of an impartial controlling and mobilization of repeatedly intended interventions in order to develop an optimal prevention for the organism and to sustain health and manpower, VFA supports the process of optimizing the human-machine-interaction. VFA is an optimal enhancement to conventional morphological and chemical diagnosis and visual biometric methods.

Background:

The industry’s demand for diagnosis of the stress effects of sound and vibration within human-machine-interaction so far has not been matched sufficiently by an adequate development of medical equipment and methods ^{1, 2, 4}.

Existing metering methods may only detail the morphological and structural stress response in an adequate way but fail to depict the emotional and functional as the empathic processes of stress responses themselves, which result in this response. I.e. the actual stress processes, caused by a stressor, proceed secretly as in a "black box", as shown in Figure 1 ^{1, 2, 6}.

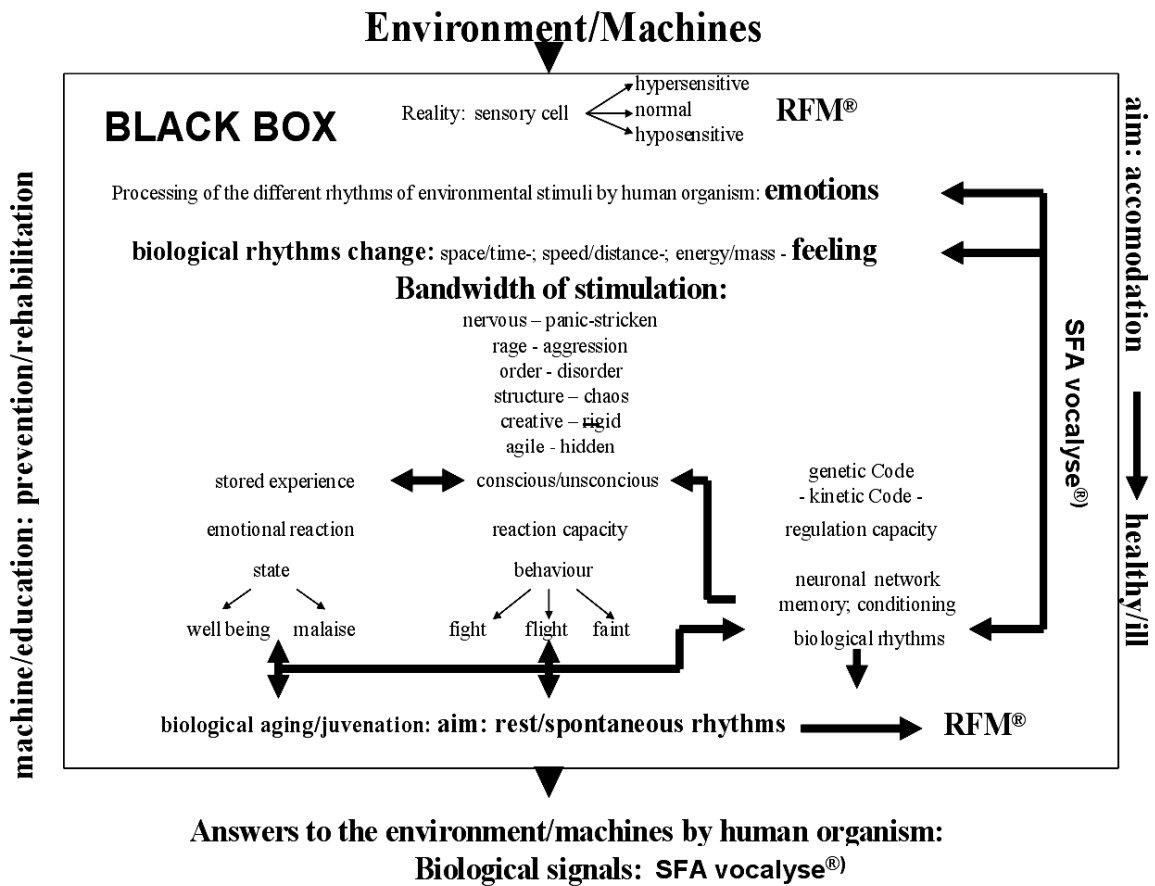


Figure 1. ‘Black Box’ - Communicative flow of information between natural / technical environment and a living organism and the stress response within the human organism in the sense of a receptor model

What is needed is an user-friendly, fundamental and reproducible diagnostic method to evaluate the essential emotional-functional stress systems in organism, considering the influences of the individual’s constitution, condition and conditionings ^{7, 8, 9, 10, 11, 12}.

Method:

Open practice studies with the voice-frequency-analysis VFA in recent years used for the diagnosis of stress reactions and chronic diseases, revealed that the VFA is a measuring method especially for the emotional-functional field of chronic diseases as well as for vibrational environmental stressors ^{5, 8, 10, 11, 13}.

Based on experimental / practical / clinical research with thousands of voice graphs over the last years, it appeared that special interpretation modes of a new kind of voice-frequency-analysis

VFA allow inferences about essential emotional-functional stress parameters (ESP) ¹¹. With the usage of an individual's timbre it is free of any influence of age, culture or gender. The handling is easy, safe, immediate and location-independent, without any sensors or belts to be attached to a proband.

The VFA is based on the models for living open systems with non-linear behaviour and connects the knowledge of chronobiology, functional medicine, physics, acoustics and stress research. Stress thereby is defined as a communicative process of interfering environmental (technical, natural) rhythms and the biological rhythm system (BRS) of organism ^{1, 2, 3, 6, 7}.

It allows to assess the emotional and functional stress parameters ESP:

- 'autonomous nervous system',
- 'redox system',
- 'acid-base-equilibrium',
- 'anabolic-katabolic-hormone-equilibrium',
- 'personality profile':
 - 'basic/stress behaviour',
 - 'conditioning',
 - 'experience of time and space – speed and distance',
 - 'potentials/resources',
 - 'stress status',
 - 'problem areas of columna vertebralis'

The using of the VFA method developed with specific time serial analytically algorithms is based on two universal natural principles for open and complex systems:

1. The biological rhythm system BRS, as shown in Figure 2.
2. The fact that four distinguishable phases, controlled by the biological rhythms in the human organism, repeat in a *motivesque* manner, as shown in Figure 3.

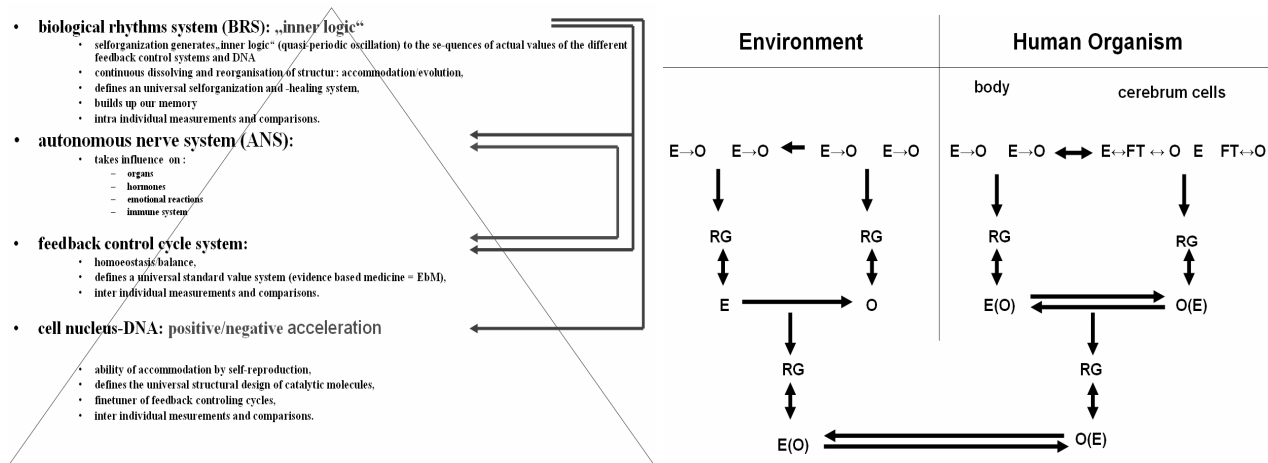


Figure 2. left: Hierarchical representation of the principle of self-regulation of the human organism, according to Heinen 2006

right: Notional information and communication model of human-environment, according to Heinen 2006, in the meaning of an Exciter- Oscillator- Rhythm model, whereby an universal logic is taken into account. E = exciter; FT = fine tuner; O = oscillator; RG = rhythm generator.

Ad 1.): The BRS is the level of:

- Self-organization
- Self-recovery
- adjustment (adaptation)
- Development / Evolution
- Memory

From the point of its oscillatory characteristic all rhythm contain an own immanent logic. The sum of all biological rhythms on a superior level forms a comprehensive system. It determines the organism's ability of self-regulation and self-recovery and in addition to it also combines the communicative and informative connection to the natural rhythm system NRS of the environment with the surrounding technological, unnatural rhythms through its oscillatory transmitter-receiver characteristic, see Figure 2.

The BRS is regarded as a homeo-dynamic and –kinetic force. It allows to observe the living under dynamic kinetic criteria.

This approach defines stress as a communication -, information - and regulatory problem. In terms of a regulatory circuit, stress as oscillating or rhythmic process will be schematized as follows:

→ Stressor → stress response → stress response →

Ad 2.): Rhythm is a universal principle and allows for every open, complex system:

- Adaptation to the present
- Conclusions about the past
- Prognosis for the Future
- Evolution / accommodation in terms of a redesign on the basis of previous structure forms, since rhythm connects the chaotic state of a structure with its cosmic condition
- an intrinsic logic, i.e. self-regulation-/self-recovery capability

The accommodation to a stressor proceeds inter- and intra-individually (induced by light) in a 2-hour rhythm, by day and by night following the same 4-phase motif:

- 1.as BRAC (see figure 3) with the corresponding quantities / intensities of a basic rest-activity of all systems of the human organism
- 2.as PASW (see figure 3) with the corresponding quantities / intensities of a post-aggression metabolism of all systems of the human organism

As figure 3 shows, the metabolism is always: in phase I: as purely catabolic (chaotic, i.e., resolving); phase II: as anabolic-catabolic (structural destructive); phase III: as purely anabolic (cosmic, i.e. structuring) and in phase IV: as anabolic-catabolic (structure preserving).

These characteristics of the rhythm allow a measurement of past and future in the here and now and (in that sense, on the understanding that no change in the motive / sound pattern of a system-specific rhythm and the BRS as a whole appears) to predict the future behavior of the system, i.e. at what time it will shape what specific quantity / intensity and quality. If the exogenous and / or endogenous stressors influencing the system are known, it is possible to predict, in which direction the change of quantity and the morphological change of the system under this influence will occur at a specific point of time. This could be used especially in the industry in communication between man - machine.

Phase of Postaggressions-Metabolism:		I (~·)	II (~~)	III (·~)	IV (··)
Hormones:					
Adrenalin/ Noradrenalin	E_n	↑ bis ↑↑↑	↑→	→	↓→
Acetylcholin		↓→	↑→	↑ - ↑↑↑	↑↑→
Cortison		↑↑↑	↑↑→	↑→	↓→
Glucagon		↑↑↑	↑↑→	↑→	↓→
Thyreoid hormone in activty	E_2	↑ bis ↑↑↑	↑↑→	↑→	↓→
Thyreoid hormone in deactivity					
ADH		↑ bis ↑↑↑	↑	↓→	↓
Aldosterone	E_1	↑ bis ↑↑↑	↑	↓→	↓
Growth hormones		↑→	↑→	↑ bis ↑↑↑	↑→
Insulin		↓	↓→	↓ bis ↑↑↑	↑↑→
Lipolyse		↑ bis ↑↑↑	↑↑→	↓	↓→
Triglyceride		↓	↓→	↑ bis ↑↑↑	↑→
Proteinolyse		↑↑↑	↑→	↓	↓→
Proteinsynthesis	E_n	↓	↓→	↑ bis ↑↑↑	↑↑→
T-Supressor-Cells		↑↑↑	↑↑→	↓→	↑→
Th ₁ -Helper-Cells		↑ bis ↑↑↑	↑↑→	↓	↓→
Th ₂ -Helper-Cells	E_{-1}	↓	↓→	↑ bis ↑↑↑	↑→
Oxitocin		↑ bis ↑↑↑	↑→	↓	↓→
Endorphines		↑ bis ↑↑↑	↑→	↓	↓→

Figure 3.: Presentation of the quantitative metabolic changes in a living organism in a cycle of 4 different phases of the post-aggression metabolism caused by a stressor, represented by arrows. The arrows signify the ↑ increase, ↓ decrease and → constancy of the process or of the parameter. This essentially hormonal changes affect the entire emotional occurrence in the organism: *physiologically:* vegetative (autonomic) nervous system, redox systems, acid-base balance, etc., *psychologically:* aggressive as well as reactions of fear (angst)/ panic, *morphological and structural:* symptom / structural phenomena; **Picture in front:** Using the example of the BRAC-/post-aggression metabolism process, which both follow a 4-phase pattern to, it is shown that at the point of bifurcation, where the phase of "pure" Catabolic changes into the anabolic phase of increasing compensation and the organism decides (has to decide), whether it wants or needs to leave the "normal energy level E_B ", or gets back to the state of deactivation.

When compiling a VFA, only the vowel "A" is uttered two times for 5 seconds, since the vowel "A" is a periodic signal that may be pronounced context-free in every culture and every age. Figure 4 shows a time-series analytical treatment of a wave file with the spoken vowel "A".

Aim:

The aim of the various studies in the last 10 years since the development of the VFA has been the utilization of the VFA in medicine but also in industry, i.e. to examine in the communications man - machine / building.

Results:

The following examples (see figure 5) show samples evaluations with the VFA of now more than 10.000 probands in a variety of stressors of different qualities and quantities of challenged

stress reactions. Each of these conducted VFA, supported conclusions about the empathic as well as the emotional-functional behavior of the probands, as the figures illustrate.

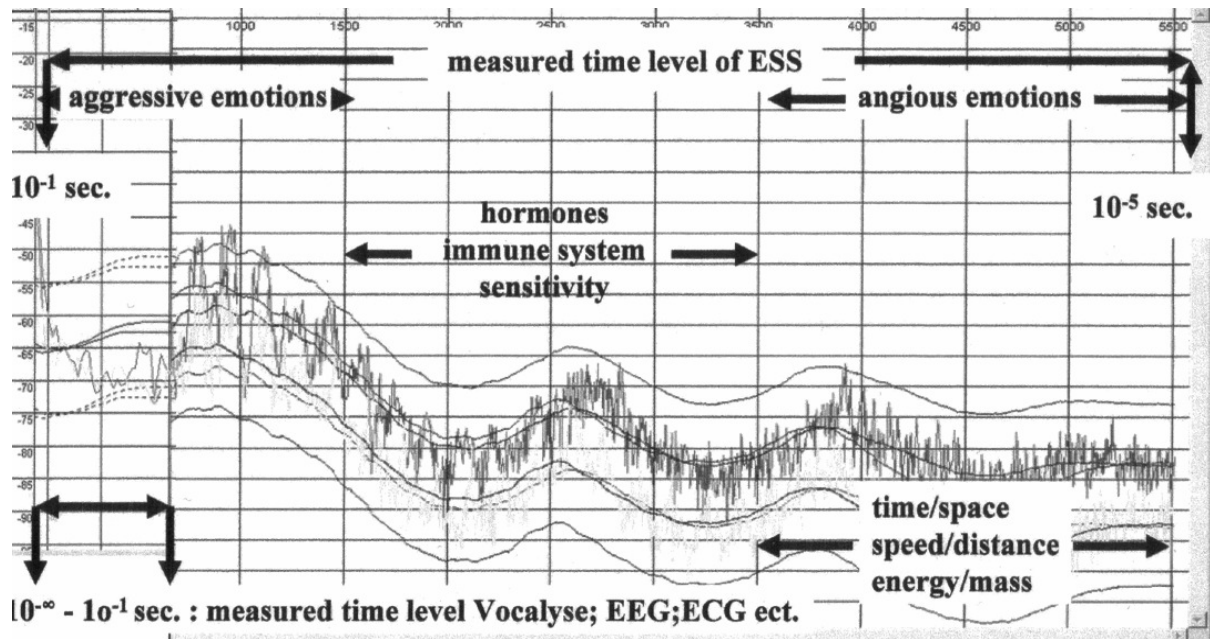


Figure 4: On the x-axis the graph illustrates the **quality** (space-time [Hz]) and on the y-axis the **intensity** (quantity [dB]) of system specific biological rhythms of various biological systems, which cover the frequency band of 0-5500 Hz and correspond with a section of the general biological rhythm system (BRS).

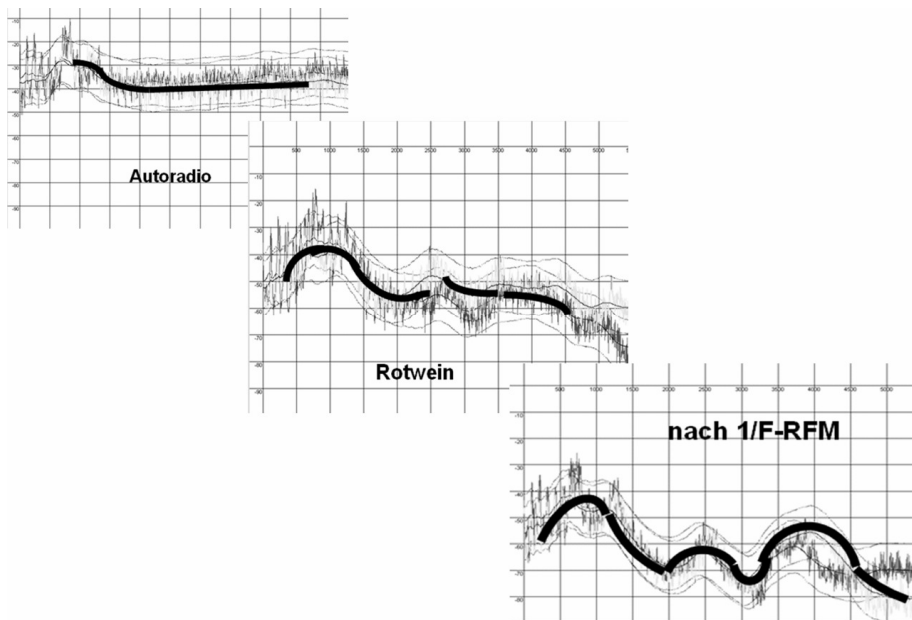


Figure 5. The biological rhythms already signal difficulties, because they swing a-rhythmic, meaning the heights of the amplitude make different "jumps" and follow no logic anymore. **Left:** Depiction of a disturbance of the organism in the meaning of white noise caused by physical environmental stimuli (car radio). **Middle:** Depiction of a disturbance of the organism in the meaning of white noise by chemical stimuli (red wine). **Right:** Restoration of the normal vocal 1/f-noise by a proper modulated biological rhythm and corresponding equipment;

Discussion:

The results of the open practice trials especially with vibrations as stressors show that on the basis of the measurement methodical possibilities of ESP findings, the communication human – machine / (psycho-social) environment can be assessed with a high reproducibility. The conducted studies have demonstrated a sensitivity and specificity of > 90% for almost all (of) ESP. Moreover, the VFA has a very wide range of possibilities for empathic description of an individual.

Because of these characteristics the VFA is able to measure the empathic emotional-functional black box mechanisms of the human organism. This constitutes the necessity for the bit of VFA in many areas of the communication human - machine. With the probability that a time series analysis of a biological signal permits, future behavior in the emotional-empathic as functional area now can be derived from the past. In the sector of machinery and building development, which produce a variety of vibrations with verified impact on the behavior of the human organism it is of particular importance, as with the VFA it now can be evaluated, how the user / inhabitant might or will behave in future under the influence of the vibrations.

Conclusion:

In summary therefore it can be stated that:

- 1.VFA is a reproducible empathic and emotional-functional diagnostic method for the human organism.
- 2.VFA allows to control individual empathic, emotional and functional reactions of human organism during an application of defined acoustic/vibration stressors.
- 3.VFA supports the process of optimizing the human-machine-interaction by impartial controlling and mobilization of consecutive targeted interventions in order to develop an optimal prevention for organism and to sustain health and manpower.
- 4.VFA is an optimal enhancement to conventional morphological and chemical diagnosis and visual biometric methods.

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