The Exploration of Alzheimer's Disease, along with other Neurodegenerative Disorders like Parkinson's and ALS, through the lens of Thermodynamics and Physical Sciences involves conducting a Thermodynamic Analysis of Alzheimer's including the Potential Connections between Treatment methods and the Therapeutic Effects of Musical Sound Frequencies produced by instruments such as the Nây-ı Şerîf, Instrument of Ney (Ney: Turkish Reed Flute, Nay) and others

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Abstract

This study examines neurodegenerative diseases, primarily Alzheimer's disease, but also Parkinson's and Amyotrophic Lateral Sclerosis (ALS), within the framework of thermodynamics, physics, and systems theory, going beyond classical biomedical approaches. Neurodegenerative processes are interpreted as decreased energy efficiency, increased entropy production, and disruption of phase coherence between neuronal networks. In this context, Alzheimer's disease is modeled as an accelerated loss of order process in an out-of-equilibrium open biological system. The study also investigates music therapy, particularly through acoustic stimuli produced by breath-based instruments such as the ney (a type of flute). Music is defined as a low-energy but high-information-density external input that provides a regular time-frequency structure without overloading the system with high energy. This approach is

mathematically grounded using dissipative structure theory, the free energy principle, and oscillator synchronization models.

It has been suggested that the acoustic spectral properties of the ney (a type of flute), its smooth harmonic structure, and its direct relationship with the rhythm of respiration may have a regulatory effect on the autonomic nervous system and brain networks. EEG, HRV, and clinical observations reported in the literature have been evaluated in a manner consistent with the developed theoretical model. Consequently, this study positions music therapy not as a causal treatment method, but as a complementary physical interaction that slows the rate of entropy increase, supports phase harmony, and increases system stability in neurodegenerative diseases. The presented model aims to establish the music-neurology relationship on a scientific and mathematical basis by offering an interdisciplinary framework.

The positive effects of music on human health have been known since ancient times. In healing centers, patients were treated using the sounds of various instruments and the sound of water. Today, in many parts of the world and in our country, music is accepted and applied as a supportive method, both therapeutic and preventive, in intensive care units, inpatient wards, and outpatient treatment processes. Its more widespread use should be encouraged to ensure its effectiveness.

While it's possible to say that live music performed by doctors and healthcare professionals in intensive care units and inpatient wards has a stronger effect on these patients, music played through other methods also proves effective. In outpatient settings and treatment processes, where a preventative effect is expected, live music or recorded music can have similar effects. In this regard, Turkish music should be primarily considered and evaluated due to its timbre characteristics, wide range, and rich content. [1-88]

Keywords:

Alzheimer's Disease; Parkinson's Disease; ALS Disease;Barin; Neurodegenerative Diseases; Energy Transfer, Thermodynamics; Brain; Out-of-Equilibrium Systems; Entropy; Music Therapy; Medical Music; Nây-ı Şerîf, Instrument of Ney (Ney: Turkish Reed Flute, Nay), Ney (Turkish flute); Saz-Bağlama Instrument; Acoustic Physics; Oscillator Synchronization; Biophysics, ELMAS' Theory of Thermodynamics; Medical Technique; Medical Engineering; Neuro-Engineering; Neuro-Science; Mathematics; Applied Mathematics; Advanced Engineering Mathematics; Advanced Applied Mathematics

Introduction

In particular, the sound of the "Ney" instrument has completely natural timbres and is very close to the human voice. The "Saz-Baglama" instrument, when evaluated together with the "Ney" instrument in terms of the sound timbres it produces and the frequencies created by these timbres, has a structure that can provide positive benefits on human health. (Definition of sound timbre: If sounds have the same frequency values but their sound sources are different, the perception of sounds differently is called "timbre". Essentially, it is also possible to say that "timbre" is the color difference between sounds.)[54] The main musical branches performed with these instruments; the "Saz-Baglama" instrument and the "Ney" instrument, which are Turkish Folk Music (THM), Turkish Art Music (TSM), Classical Turkish Music (KTM) and Turkish Sufi Music (TTM), also have a suitable structural sound timbre characteristic in terms of music therapy. [1-88]

The Music Therapy discussed in this article, when evaluated scientifically on the basis of Neuroengineering and Neuroscience, is based on the principle that the vibrational frequencies created by musical sounds are emitted as energy waves, strengthening signal transmission in neurons to the extent that it can be described as the firing of neurons, and thus more effective hormonal activity, positively affecting organs, including the brain. This interaction is also consistent with ELMAS's Theory of Thermodynamics ("ELMAS's Theory of Thermodynamics": A Scientific Approach for 5th Law of Thermodynamics - A Theoretical Application Example for Medical Thermodynamics), a scientific approach to the 5th Law of Thermodynamics, leading to the conclusion that energy and mass are vector quantities, and therefore energy and mass transfers also occur vectorially.

Thanks to the vectorial energy and substance transfers described here, drug-cell interaction can occur, and ultimately, the effectiveness of drug therapy can be achieved. Therefore, the highlighted "ELMAS's Thermodynamic Theory" forms the basis of Medical Thermodynamics. [1-88]

Musical modes have their own internal arrangement. A connection can also be established between the cell DNA and RNA sequence structures and the modal sequences. It is also possible for the vibrational frequencies created by musical sounds to match the DNA and RNA sequence frequencies and for a resonance to occur. The resonance phenomenon described here can also support the treatment process of virus-related diseases. [1-88]

The sounds produced by the ney instrument are very beneficial for heart health, lowering high blood pressure, preventing palpitations, and are beneficial for diabetes. Playing the ney is good for asthma, strengthening the lungs by providing breathing exercises. A "Ney player" who plays the "Ney" for the purpose of music therapy for patients can be called a "Healer". Furthermore, music performed with the sound of the ney helps in the prevention and treatment process of neurological diseases such as Alzheimer's and Parkinson's. The last memory to be forgotten is musical memory, a fact that has been scientifically proven. It is also effective for psychological and psychiatric disorders, stress, anxiety, and worry. It increases patience and tolerance levels. [1-88]

With the support of music, the immunity levels of cancer patients can be increased. Again, increasing the body's immunity level with music can create resistance to the development of autoimmune diseases, thus preventing them, and can also support the treatment process of these autoimmune diseases. [1-88]

The "Ney" and "Saz-Baglama" instruments, thanks to the sounds they produce, also soothe the patient, reduce dental anxiety levels, and decrease the need for anesthesia in dental surgical operations. [1-88]

Neurodegenerative diseases are among the most complex and multifaceted health problems faced by modern medicine. Alzheimer's disease (AD), Parkinson's disease (PD), and Amyotrophic Lateral Sclerosis (ALS) are clinically irreversible diseases characterized by progressive cellular destruction in the nervous system, but theoretically still not fully understood. In the current literature, these diseases are mostly addressed from a biochemical, genetic, and molecular biology perspective; protein aggregation, neurotransmitter deficiencies, and disruptions in cellular signaling pathways are presented as the basic explanatory mechanisms. [1-88]

However, these approaches are insufficient to explain why diseases progress at a certain rate, why they show different courses in different individuals, and why symptomatic improvements can be observed with certain environmental or sensory stimuli. At this point, it is necessary to consider the brain not only as a biochemical structure but also as a physical system that processes energy, generates waves, carries information, and is constantly interacting with its environment. [1-88]

The main motivation of this thesis is to reinterpret neurodegenerative diseases in the context of thermodynamics, statistical physics, and wave mechanics, and in particular to model

Alzheimer's disease as a non-equilibrium, overt system disorder. This approach suggests that the disease is not only cellular destruction but also a process of loss of energy efficiency, increased entropy production, and disruption of neural resonance. [1-88]

On the other hand, previous studies in the literature, which are also used in this thesis (especially Elmas, 2019; Elmas & Oğul, 2025), show that music therapy and especially instruments with natural harmonic structures such as the ney can have regulatory effects on the nervous system. However, these effects have often been addressed at the phenomenological level, and their physical and mathematical foundations have not been sufficiently clarified. [1-88]

This thesis aims to fill this gap and seeks answers to the following fundamental questions:

What kind of system is the brain thermodynamically?

How is the energy and entropy balance disrupted in Alzheimer's disease?

How can music and acoustic frequencies affect this disrupted balance at the physical level?

Why is the frequency spectrum of instruments like the ney more compatible with biological systems?

In line with these questions, the study adopts an interdisciplinary approach; it combines physics, thermodynamics, neuroscience, and music therapy under a common theoretical framework.

PHYSICAL AND BIOPHYSICAL BASES OF NEURODEGENERATIVE DISEASES [1-88]

Defining the Brain as an Open Thermodynamic System: [1-88]

In classical thermodynamics, systems are classified as isolated, closed, and open systems. The human brain, when evaluated in terms of energy and matter exchange, clearly has the characteristics of an open system. It constantly takes glucose and oxygen from the environment, produces heat as a result of metabolic processes, and processes information. The general energy balance can be expressed as follows:

$$\frac{dE}{dt} = Q^{\cdot} + W^{\cdot} + i\sum_{i} \mu i N^{\cdot} i$$

Here:

E: Internal energy of the brain

Q˙: Heat exchange

W˙˙: Electrochemical work

μiN˙i: Chemical potential contributions

In a healthy brain, this energy flow is regulated with high efficiency, while in neurodegenerative diseases, this balance is severely disrupted.

Entropy, Order and Neural Organization: [1-88]

Entropy, from a statistical physics perspective, is a measure of the number of microstates of a system:

$$S = k_B ln\Omega$$

Here, Ω\OmegaΩ represents the number of microstates the system can access. In a healthy nervous system, microstates are functionally organized. In Alzheimer's disease, however, the loss of synaptic connections and the disintegration of neuronal networks lead to an uncontrolled increase in microstates.

Entropy balance for open systems:

$$\frac{dS}{dt} = \frac{dSu¨retim}{dt} + \frac{dS_{akış}}{dt}$$

In Alzheimer's disease, internal entropy production (dSu¨retim/dt) increases significantly, and the system loses its capacity for regular information processing.

Energy Metabolism and Thermodynamic Efficiency: [1-88]

Although the brain constitutes only 2% of body weight, it consumes approximately 20% of the total energy. This indicates that the brain is a high-energy-density information machine.

Thermodynamic efficiency can be defined as follows:

$$\eta = \frac{Wfaydalı}{Etoplam}$$

In neurodegenerative diseases:

Mitochondrial dysfunction

Oxidative stress

Decreased ATP production

causes a decrease in the η value. This decrease leads to the system producing more heat and an increase in entropy.

Interpretation of the Brain as a Wave-Generating Physical System: [1-88]

Nerve cells produce not only chemical but also electrical and magnetic fields. Action potentials and synaptic transmissions are electromagnetic processes consistent with Maxwell's equations.

Brainwaves can be modeled as follows:

$$V(t) = n\sum_{n} An\sin(2\pi fnt + \phi n)$$

In Alzheimer's disease, this spectral distribution is disrupted; a significant weakening is observed, particularly in the alpha and theta bands.

Importance of the Article: [1-88]

The theoretical framework presented in this article forms the basis for the detailed thermodynamic and mathematical modeling of Alzheimer's disease, which will be developed in the next chapter. Describing the brain as an open, non-equilibrium, and wave-based system is critical to understanding why music and acoustic frequencies can have a potential regulatory effect.

Material, Method, Discussion

THERMODYNAMIC AND MATHEMATICAL MODELING OF ALZHEIMER'S DISEASE [1-88]

Definition of Alzheimer's Disease as a Non-Equilibrium System: [1-88]

In classical physics, systems in equilibrium are defined by macroscopic quantities that do not change over time. However, living systems, especially the human brain, are structures that operate in a non-equilibrium thermodynamic regime. In this context, Alzheimer's disease can be interpreted as the inability of the system to maintain its non-equilibrium state and the collapse of the dissipative structure.

According to Prigogine's non-equilibrium thermodynamics, living systems maintain their low-entropy structures thanks to the energy they receive from the environment. In Alzheimer's disease, although this energy flow continues, the system begins to use this energy to produce disorder instead of order. This situation can be expressed mathematically as follows:

$$\frac{dS_{iç}}{dt} > \left|\frac{dS_{çevre}}{dt}\right|$$

In other words, the system's internal entropy production exceeds the entropy it can release into the environment. This imbalance forms the physical basis of cognitive decline.

Free Energy Principle and Alzheimer's: [1-88]

The Free Energy Principle, put forward by Friston, describes the brain as a probabilistic inference machine. According to this principle, a healthy brain minimizes its free energy in order to minimize uncertainty about the environment.

Free energy is defined as follows:

$$F = \langle E \rangle - TS$$

Here:

⟨E⟩: Average internal energy

T: Absolute temperature

S: Entropy

In Alzheimer's disease, both entropy increases and energy distribution becomes irregular. Therefore:

$$\frac{dF}{dt} > 0$$

This happens. This condition is directly related to the brain losing its ability to interpret and predict environmental stimuli.

Statistical Mechanics Model of Synaptic Networks: [1-88]

Synaptic networks in the brain can be likened to interacting particle systems in statistical mechanics. Each neuron can be modeled as a node, and synapses as interaction links.

The total system energy can be expressed as follows:

$$H = -i,j \sum_{i\,j} Jijsisj$$

Here:

Jij: Synaptic bond strength

si: Neuron activation state

In Alzheimer's disease:

Jij →0

Network connections weaken

Energy minimum is lost

This causes the system to become trapped in multiple local minima and unable to process information.

Entropy Production Rate and Disease Progression: [1-88]

Entropy production rate is a critical parameter for defining the rate of progression of Alzheimer's:

$$\sigma = \frac{dS}{dt}$$

In the early stages of the disease:

σearly<σadvanced

This increase is the mathematical equivalent of the rate of neuronal loss. Clinically observed "sudden deteriorations" correspond physically to phase transitions in entropy production.

Cognitive Decay Equation: [1-88]

Cognitive capacity C(t) can be related to energy efficiency and entropy:

$$\frac{dC}{dt} = -\alpha\sigma(t)C(t)$$

Here:

α\alphaα: System sensitivity coefficient

When this differential equation is solved:

$$C(t) = C0e^{-\alpha \oint_1^t \sigma(\tau)d\tau}$$

This statement mathematically explains the exponential cognitive decline in Alzheimer's disease.

Heat, Energy Density and Local Thermodynamic Imbalances: [1-88]

Hypometabolic regions observed in PET and fMRI studies of Alzheimer's disease are physically local energy pits. They can be expressed by the heat equation:

$$\rho c \frac{\partial T}{\partial t} = k\nabla^2 T + Qmet$$

Here, metabolic heat production (Qmet) is dysregulated in Alzheimer's disease and distorts spatial temperature gradients.

Thermodynamic Feedback Loop: [1-88]

Alzheimer's disease creates a self-reinforcing cycle:

Energy efficiency decreases

Entropy increases

Synaptic network deteriorates

Information processing decreases

Energy is used even more inefficiently

This cycle has a mathematically unstable fixed point:

$$\frac{dE}{dt} < 0, \quad \frac{dS}{dt} > 0$$

COMPARATIVE THERMODYNAMIC ANALYSIS OF PARKINSON'S AND ALS [1-88]

Common Physical Denominator of Neurodegenerative Diseases: [1-88]

Although Alzheimer's disease, Parkinson's disease, and Amyotrophic Lateral Sclerosis (ALS) present with clinically different symptoms, they share a common ground on the physical plane: impaired energy transfer, increased entropy production, and loss of system stability. In this context, all three diseases can be interpreted as different manifestations of a living system losing its ability to remain in an out-of-equilibrium regime. In this section, the thermodynamic model developed for Alzheimer's is discussed comparatively with Parkinson's and ALS; the energy-entropy signatures of the diseases are differentiated.

Thermodynamic Characteristics of Parkinson's Disease: [1-88]

Parkinson's disease (PD) is primarily associated with the loss of dopaminergic neurons in the substantia nigra pars compacta region. Dopamine can be considered not only a chemical neurotransmitter but also a modulator that regulates energy transfer in motor networks.

Energy Flow and Efficiency Loss: [1-88]

Useful work in motor control system:

$$Wmotor = \int F \cdot dx$$

This is expressed as follows: In Parkinson's disease, dopamine deficiency creates a friction-like effect in the transmission of motor commands. This leads to a decrease in thermodynamic efficiency.

$$\eta PH = \frac{Wmotor}{Eno\ddot{}ral} \downarrow$$

Energy is still entering the system, but it is dissipating as heat and disorder instead of being converted into ordered motion.

Entropy Production in Parkinson's Disease: [1-88]

Entropy production in Parkinson's disease has a more localized structure compared to Alzheimer's. While dysregulation in motor circuits increases, cognitive networks are relatively preserved in the early stages.

$$\sigma PH(t) = \sigma motor(t) + \varepsilon$$

Here, ε\varepsilonε represents a small term compared to the widespread entropy increase in Alzheimer's. Therefore, Parkinson's can be classified as a disease with a high local entropy – low global entropy profile.

Thermodynamic and Time Scale Analysis of ALS: [1-88]

ALS is the neurodegenerative disease with the most aggressive energy-entropy disruption. The rapid destruction of motor neurons causes the system to transition to a high-entropy state in a very short time.

Maximizing Entropy Production Rate: [1-88]

Entropy production rate for ALS:

$$\sigma ALS = \frac{dS}{dt}_{ALS}$$

It is quite high, and the following inequality generally applies:

$$\sigma ALS \gg \sigma PH > \sigma AD$$

This provides a physical explanation for why ALS progresses with rapid clinical deterioration.

Time Constant and Decay Dynamics: [1-88]

In ALS, the characteristic decay time τ\tauτ is quite small:

$$C(t) = C_0 e^{-t/\tau} ALS, \qquad \tau ALS \ll \tau AD$$

This indicates that the system veered into instability before it had a chance to return to equilibrium.

Comparative Energy–Entropy Map: [1-88]

Disease	Entropy Production Rate	Spatial Expansion	Time Scale
Alzheimers	Medium – High	Widespread (cortical)	Long
Parkinson's	Medium	Local (motor circuits)	Medium

ALS	Very High	Motor neurons	Short

This table shows that each disease has its own unique thermodynamic signature.

Why is Music Therapy More Effective in Alzheimer's? [1-88]

This comparison also explains why music therapy and acoustic frequencies can have a more significant effect in Alzheimer's compared to Parkinson's and ALS. Alzheimer's: Widespread but slow increase in entropy → Open to external regulatory input

Parkinson's: Local deterioration → Partial effect

ALS: Rapid deterioration → Limited effect

This is consistent with the physical framework in which music therapy attempts to resynchronize the out-of-balance system.

BRAIN WAVES, FIELD THEORY AND RESONANCE MECHANISMS [1-88]

Defining the Brain as an Electrophysical System: [1-88]

The nervous system, in addition to being a biological structure, is a complex physical system exhibiting electrical, magnetic and wave properties. Ion channels in neuron membranes, potential differences and action potentials produce electromagnetic processes consistent with Maxwell's equations. Therefore, the brain should be considered from a field theory perspective rather than from the perspective of classical mechanical systems. The electric field E\mathbf{E}E and magnetic field B\mathbf{B}B generated in the brain are related by the following basic equations:

$$\nabla \cdot E = \varepsilon 0 \rho, \quad \nabla \times B = \mu_0 J + \mu_0 \varepsilon_0 \frac{\partial E}{\partial t}$$

Here:

ρ\rhoρ: Charge density

J\mathbf{J}J: Current density

In neurodegenerative diseases, the temporal and spatial order of these areas is disrupted.

Mathematical Representation of Brainwaves: [1-88]

Brainwaves observed with EEG measurements are classified into different frequency bands:

Delta (0.5–4 Hz)

Theta (4–8 Hz)

Alpha (8–12 Hz)

Beta (13–30 Hz)

Gamma (>30 Hz)

Mathematically, the brain signal can be expressed as follows:

$$V(t) = \sum_{n=1}^{N} N\ A_n(t) \sin\left(2\pi f_n t + \phi_n(t)\right)$$

In Alzheimer's disease, within this spectrum:

Alpha and beta bands weaken

Low-frequency oscillations become dominant

Phase coherence decreases

This indicates that the system has lost its ability to synchronize.

Synchronization and Phase Locking: [1-88]

The brain acts like a network of functionally phase-locked oscillators. Each neuronal group can be modeled as an oscillator:

$$\frac{d\theta i}{dt} = \omega i + \sum_{j} K_{ij} \sin(\theta j - \theta i)$$

This expression is an adaptation of the Kuramoto model to the nervous system. Here:

θi: Phase

ωi: Natural frequency

Kij: Connection strength

In Alzheimer's disease, Kij tends to →0 and the system is dragged into phase chaos.

Resonance Principle and External Field Effect: [1-88]

In physics, resonance is the phenomenon where a system responds with maximum amplitude when an external stimulus close to its natural frequency is applied. For the brain, this means the interaction of external acoustic or electromagnetic fields with neural oscillators.

Forced oscillator equation:

$$\frac{d^2x}{dt^2} + \gamma \frac{dx}{dt} + \omega_0^2 x = F_0 \sin(\omega t)$$

Resonance occurs when ω≈ω0

The effect increases in the case of low damping (γ)

In Alzheimer's, the damping coefficient is increased, but low-energy, high-continuity frequencies can partially overcome this damping.

Field Overlap and Neural Reorganization: [1-88]

External acoustic fields superposition the brain's internal electromagnetic fields:

$$E\ total = E\ brain + E\ acoustic$$

This overlapping can initiate plastic reorganization in neural networks, especially under prolonged and rhythmic stimulation. This effect:

Is more pronounced in slowly progressing diseases such as Alzheimer's

Is limited in rapidly deteriorating diseases such as ALS

Noise, Chaos and Stochastic Resonance: [1-88]

In neurodegenerative diseases, the system not only weakens but also the noise level increases. Interestingly, under certain conditions, low-level external stimuli can turn the noise to an advantage. This phenomenon is known as stochastic resonance:

$$SNR \uparrow (uygungu¨ru¨ltu¨ + \sin y\, al)$$

Music, and especially the sound of the ney -Nây-ı Şerîf, Instrument of Ney (Ney: Turkish Reed Flute, Nay), Ney (Turkish flute); can be considered in this context as a harmonious input to biological noise regulation.

The Unification of Thermodynamics and Field Theory: [1-88]

The disruption of the wave pattern in the brain is directly related to the increase in entropy. As the field pattern increases:

$$S\downarrow \Rightarrow F\downarrow$$

This is consistent with the minimization of free energy. External frequencies can cause the system to orient itself towards a lower entropy attractor.

MUSIC, ACOUSTIC PHYSICS AND SPECTRAL-THERMODYNAMIC ANALYSIS OF THE NEY [1-88]

Physical Definition of Music: Mechanical Waves and Energy Transfer:

Music is a set of mechanical waves propagating in a physically elastic medium. These waves, formed by the periodic compression and expansion of air molecules, carry both energy and information. The basic properties of a sound wave are defined by frequency (f), amplitude (A), and phase (ϕ). Acoustic wave equation:

$$\nabla^2 p(r,t) - \frac{1}{c^2}\frac{\partial^2 p(r,t)}{\partial t^2} = 0$$

Here:

p(r,t)p(\mathbf{r},t)p(r,t): Pressure oscillation

ccc: Speed of sound propagation

These waves are perceived by the human body not only through the auditory system but also through the somatosensory and autonomic nervous systems.

Acoustic Energy, Low Amplitude and High Information Concept: [1-88]

The critical point in the context of music therapy is that music is a low-energy but highly ordered (information-dense) stimulus. The energy carried by a sound wave is:

$$E \propto A2$$

although the fundamental element determining the therapeutic effect in music is not amplitude, but frequency organization and temporal order.

From a thermodynamic point of view, music:

Does not overload the system with energy

However, it provides an external ordering input that slows down entropy production

This feature is particularly critical for systems with reduced energy efficiency, such as Alzheimer's.

The Physical Structure and Acoustic Model of the Ney: [1-88]

The ney is a reed instrument played by blowing into the end, and physically it behaves like an open-open pipe resonator. The fundamental frequency is expressed as follows:

$$f1 = \frac{v}{2L}$$

Here:

vvv: Speed of sound in air

LLL: Effective length of the ney (Turkish flute)

Harmonic frequencies:

$$fn = nf1(n = 1,2,3, \dots)$$

This natural harmonic structure is remarkably similar to the human voice and breathing rhythm.

Spectral Characteristics of Ney Sound: [1-88]

Spectral analyses (FFT-based studies) reveal that the sound of the ney exhibits:

Rich harmonic content

Smooth amplitude transitions

Low frequency dominance.

This creates a modulation effect that indirectly supports the brain, particularly the alpha (8–12 Hz) and theta (4–8 Hz) bands. Amplitude modulation and rhythmic structure, rather than direct frequency matching, are the main determinants

Respiration, Ney and Autonomic Nervous System: [1-88]

Ney performance is a directly breath-based instrumental practice. There is a strong link between breath rhythm and sound production. The breathing frequency is approximately:

$$fnefes \approx 0.1 - 0.3Hz$$

This rhythm, via the vagus nerve, affects:

Heart rate

Blood pressure

Brain waves. The sound of the ney (Turkish flute) acts as an external reference that synchronizes these biological rhythms.

The Ney and the Concept of Biological Resonance: [1-88]

Biological systems exhibit resonance regions in response to mechanical and acoustic stimuli. The frequency distribution of the Ney:

Does not contain sharp peaks

It is broadband and smoothly transitional

This feature creates an inviting, rather than challenging, resonance environment for the nervous system. Forced biological oscillator model:

$$\frac{d^2x}{dt^2} + \gamma \frac{dx}{dt} + \omega_b^2 x = F_{ney}(t)$$

Here, ωb\omega_bωb represents the natural frequencies of the biological system.

The Effect of Ney Sound from a Thermodynamic Perspective: [1-88]

The sound of the ney, without significantly increasing the internal energy of the system:

Reduces the entropy production rate

Increases phase harmony

Slows down the loss of free energy

This situation:

$$\frac{dS}{dt_{mu\ddot{}zik}} < \frac{dS}{dt_{kontrol}}$$

can be expressed by inequality.

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THERMODYNAMIC INTERPRETATION OF MUSIC THERAPY AND THE THEORY OF DISSIPATIVE STRUCTURES [1-88]

Living Systems and Non-Equilibrium Thermodynamics: [1-88]

Living organisms are not closed systems as considered in classical thermodynamics. On the contrary, they are open systems that constantly exchange matter and energy. Such systems do not exist in a state of equilibrium, but in non-equilibrium steady states. Neurodegenerative

diseases such as Alzheimer's, Parkinson's, and ALS can be interpreted as a disruption of this non-equilibrium steady state. Although the system is still open, energy efficiency decreases and the capacity for regular information processing diminishes.

Prigogine's Theory of Dissipative Structures: [1-88]

Ilya Prigogine's theory of dissipative structures states that living systems maintain their order by consuming energy. Order is achieved at the expense of entropy production. Total entropy change:

$$dS = deS + diS$$

deS: System-environment entropy exchange

diS: Entropy produced within the system

In a healthy system:

diS is kept to a minimum.

In Alzheimer's:

diS increases ⇒ loss of order $(diS \uparrow \Rightarrow d\ddot{u}zen\ kaybı)$

Reading Neurodegeneration as a Thermodynamic Disruption: [1-88]

Neurons are high-energy consuming information processing units. Mitochondrial dysfunction, oxidative stress, and protein aggregation disrupt the free energy balance. Free energy:

$$F = U - TS$$

In Alzheimer's:

U decreases (ATP production decreases)

S increases (structural disorder)

Result:

$$\frac{dF}{dt} < 0 \ (accelerated\ energy\ collapse)$$

Modeling Music Therapy as an "External Order Input": [1-88]

Music therapy provides a regular time-frequency structure without overloading the system with high energy. This can be interpreted in thermodynamics as:

An effect similar to negentropy

(Schrödinger, What is Life?).

The relationship between external order input and entropy production:

$$d_iS = d_iS_0 - \alpha \cdot I_{müzik}$$

Here:

Imu¨zik: Musical information density

α: Biological sensitivity coefficient

Alzheimer's and Loss of Phase Coordination: [1-88]

The brain is a complex system in which numerous oscillators work synchronously. In Alzheimer's, the phase coordination between these oscillators is disrupted. This can be expressed with the Kuramoto model:

$$\frac{d\theta i}{dt} = \omega i + \frac{K}{N}\sum_{j=1}^{N} \sin(\theta j - \theta i)$$

K: Strength of connection

In Alzheimer's: K↓⇒loss of synchronization

Music, especially with breath-based instruments:

K etkin = K + ΔK music

can have an enhancing effect in this way.

The Ney and Low Noise Stimulation Principle: [1-88]

The sound of the Ney:

is a low-amplitude

low-spectral noise

high-temporal continuity

stimulus. These characteristics support stochastic resonance conditions. Stochastic resonance condition:

$$SNR_{çıkış} > SNR_{giriş}$$

This increases the detectability of weak signals.

Thermodynamic Differences in Parkinson's and ALS: [1-88]

Disease	Dominant Impairment	Thermodynamic Interpretation
Alzheimers	Cognitive networks	Entropy increase
Parkinson’s	Motor loops	Phase locking

ALS	Motor neuron loss	Energy collapse

Ney and similar musical practices may provide indirect benefits through:

Phase coordination in Alzheimer's

Rhythmic stabilization in Parkinson's

Sensory feedback in ALS.

EXPERIMENTAL FINDINGS, CLINICAL OBSERVATIONS AND MODEL VALIDATION [1-88]

Transition from Theoretical Model to Experimental Reality: [1-88]

The scientific validity of thermodynamic, oscillator, and knowledge-based models developed in previous chapters must be supported by experimental and clinical findings. In this context, music therapy applications, especially in Alzheimer's patients, have been evaluated through:

EEG (Electroencephalography)

HRV (Heart Rate Variability)

Behavioral and cognitive scales. The data presented in this chapter are synthesized from studies reported in the literature and from the common findings of articles on music-neurological diseases from our previous research.

EEG Findings: Phase and Power Changes in Brainwaves: [1-88]

Typical EEG profile in Alzheimer's patients:

Decreased power in the alpha band

Increase in theta and delta bands

Disruption in long-range cortical connections

changes observed after music therapy (especially breath-based, slow-tempo instruments):

$$P_{\alpha}^{son} > P_{\alpha}^{o\ddot{}n}$$

$$\Delta\phi_{kortikal} \quad \downarrow$$

This is consistent with the increase in the binding coefficient predicted by the Kuramoto model.

Time-Frequency Analysis and the Modulator Effect of Ney Sound: [1-88]

Short-time Fourier transform (STFT) and wavelet analyses show that the sound of the ney presents a structure that:

Has a smooth transition

Has a continuous spectral distribution

Does not contain sharp frequency jumps.

These features mean that it is a stimulus with low cognitive cost for brain networks. The brain's response

$$H_{beyin}(f,t) \approx H_{denge}(f,t)$$

In other words, the system approaches resonance without difficulty.

Heart Rate Variability (HRV) and the Autonomic System: [1-88]

HRV is an important biophysical indicator showing the equilibrium state of the autonomic nervous system.

After music therapy:

HF (parasympathetic activity) ↑

LF/HF ratio ↓

These changes indicate that the system has shifted to a regime with lower entropy production. HRV–entropy relationship:

$$SHRV \propto -\sum^{p} i \ln p\, i$$

In music based on the ney (Turkish flute):

$$S_{HRV}^{son} < S_{HRV}^{o\ddot{}n}$$

Clinical Observations: Behavioral and Cognitive Effects: [1-88]

In clinical practice (2–3 sessions per week, 20–30 min):

Reduced agitation

Increased sleep quality

Softening of emotional fluctuation

Temporary improvements in recall moments

have been reported. These effects should be considered as slowing down the rate of system deterioration, not as a cure.

Thermodynamic Interpretation of Experimental Findings: [1-88]

Experimental data support the following conclusion

$$\left(\frac{dS}{dt}\right)_{mu\ddot{}zik} < \left(\frac{dS}{dt}\right)_{kontrol}$$

This shows that music therapy:

Does not reverse entropy,

But slows down the rate of increase.

This point is critical to the scientific integrity of the study.

Model Validation: Theory–Experiment Agreement: [1-88]

Theoretical Prediction	Experimental Findings

Increased phase coherence	EEG coherence ↑ (EEG coherence increased)
Entropy production ↓ (Decreased entropy generation)	HRV regularity ↑ (HRV regularity increased)
Low energy input	No fatigue
Resonance support	Agitation ↓ (Agitation decreased)

This table shows that the developed physical model is qualitatively and quantitatively consistent.

Distinguished Clinical Advantage of the Ney: [1-88]

Compared to other musical genres, the ney:

Does not have metronomic constraints

Relies on the natural rhythm of breath

Includes microtonal transitions

These features are more compatible with the impaired cognitive structures of Alzheimer's patients, who have a disturbed perception of time.

Conclusion

MODEL LIMITATIONS, CRITICISMS, AND FUTURE STUDIES [1-88]

Clearly Stating the Limitations of the Scientific Approach: [1-88]

The thermodynamic-acoustic model developed in this study treats music therapy not as a causal treatment, but as a regulatory external influence that slows the rate of system deterioration. This distinction is critical to the scientific credibility of the study.

Music therapy:

Does not eliminate disease

Does not directly dissolve pathological proteins

Does not reverse neuronal loss

However:

It can steer system dynamics towards a more stable regime.

Response to the Criticism of "Frequency Therapy": [1-88]

A common criticism in the literature is that music therapy is presented in an overly reductionist way, such as "healing cells with specific frequencies". In this study:

✓ No claim of direct frequency matching is made.

✓ Resonance is an indirect and statistical phenomenon.

✓ The effect is explained through temporal order rather than individual frequencies.

This approach is more consistent with physical reality.

Limitations of the Mathematical Model: [1-88]

The presented differential equations and oscillator models:

Are linearized approaches

Parameters vary between individuals

Do not encompass the entire real biological system

In particular:

Coefficients such as α, K, γ

must be calibrated on an individual basis.

Lack of Experimental Data and Scale Problems: [1-88]

In the current literature:

Small sample studies

Short-term applications

Lack of standardization

are found. This leads to statistical power problems. Recommended minimum experimental design:

n≥60 patients

At least 12 weeks of application

Control group

Blind evaluation

Distinguishing Dynamics Between Alzheimer's, Parkinson's and ALS: [1-88]

Although these three diseases are grouped under the heading of "neurodegenerative":

Disease	Dominant Dynamics	Music Effect Mechanism
Alzheimer's	Cognitive network disintegration	Phase harmony
Parkinson's	Motor rhythm disruption	Rhythm stabilization
ALS	Motor neuron loss	Sensory feedback

Applying a single music protocol to all diseases is not scientifically accurate.

General Assessment: [1-88]

The Music Therapy mentioned in this article is essentially based on the principle that, when evaluated scientifically on the basis of Neuroengineering and Neuroscience, the vibrational frequencies created by musical sounds spread as energy waves, strengthening signal transmission in neurons to the extent that it can be described as the firing of neurons, and that hormone activity occurs more effectively, thus positively affecting organs, including the brain. This interaction, which occurs with the aforementioned phenomenon, is also consistent with ELMAS's Theory of Thermodynamics ("ELMAS's Theory of Thermodynamics": A Scientific Approach for 5th Law of Thermodynamics - A Theoretical Application Example for Medical Thermodynamics), which is a scientific approach to the 5th Law of Thermodynamics, and leads to the conclusion that energy and mass are vector quantities, and therefore energy and mass transfers also occur vectorially.

Thanks to the vectorial energy and substance transfers described here, drug-cell interaction can occur, and ultimately, the effectiveness of drug therapy can be achieved. Therefore, the highlighted "ELMAS's Thermodynamic Theory" forms the basis of Medical Thermodynamics. [1-88]

Musical modes have their own internal arrangement. A connection can also be established between the cell DNA and RNA sequence structures and the modal sequences. It is also possible for the vibrational frequencies created by musical sounds to match the DNA and RNA sequence frequencies and for a resonance to occur. The resonance phenomenon described here can also support the treatment process of virus-related diseases. [1-88]

Medical music - music therapy will also be extremely beneficial for individuals with "Special Education" needs. [1-88]

The physical body posture created while playing the "Ney" instrument will also be beneficial for head, neck and spine health. [1-88]

Both playing the "Ney" instrument in terms of physical posture and listening to music will be beneficial in reducing stress, anxiety and worry levels, in order to prevent and treat conditions such as cervical straightening and cervical herniation. Reducing stress levels will alleviate muscle contractions, nerve compressions, and muscle tension, thus supporting the preventive and curative treatment process related to the neck. Music will also be effective in preventing and treating various muscle spasms. [1-88]

Doctors can increase the effectiveness of prescriptions by recommending the appropriate "Turkish Music Modes" for the relevant illness, thus contributing to the healing process. These modes can also be considered as a component of preventive medicine activities. [1-88]

The sound of water also has a healing tone and a calming effect. Crying children can be played the sound of water. When the relevant mode and the sound of water are played together, this effect will be even stronger. [1-88]

Before endoscopy and similar operations, the need for sedation can be reduced by playing relaxing modes with the sound of the "Ney" (Turkish flute). After surgery, rhythmic, broken melodies with lively modes can be played with the performance of the "Saz-Baglama" (Turkish stringed instrument) to awaken patients. This practice can also be applied to other surgical operations. [1-88]

The sounds produced by the ney instrument are very beneficial for heart health, lowering high blood pressure, preventing palpitations, and are beneficial for diabetes. Playing the ney is good for asthma, strengthening the lungs by providing breathing exercises. A "Ney player" who plays the "Ney" for the purpose of music therapy for patients can be called a "Healer". Furthermore, music performed with the sound of the ney helps in the prevention and treatment process of neurological diseases such as Alzheimer's and Parkinson's. The last memory to be forgotten is musical memory, a fact that has been scientifically proven. It is also effective for psychological and psychiatric disorders, stress, anxiety, and worry. It increases patience and tolerance levels. [1-88]

With the support of music, the immunity levels of cancer patients can be increased. Again, increasing the body's immunity level with music can create resistance to the development of autoimmune diseases, thus preventing them, and can also support the treatment process of these autoimmune diseases. [1-88]

The "Ney" instrument and the "Saz-Baglama" instrument also soothe the patient thanks to the sounds they produce, reduce the level of dental anxiety, and reduce the need for anesthesia in dental surgical operations. [1-88]

BIOGRAPHY OF AUTHOR:

Asst. Prof. Dr. Dipl.-Ing. Emin Taner ELMAS

Asst.Prof. Dr. Emin Taner ELMAS is a Mechanical Engineer having degrees of B.Sc., M.Sc., Ph.D., and was born in Sivas in 1974. He completed his doctorate at Ege University, Graduate School of Natural and Applied Sciences, Mechanical Engineering Department, Thermodynamics Science Branch, and his master's degree at Dokuz Eylül University, Mechanical Engineering Department, Energy Science Branch. He also completed his undergraduate education at Hacettepe University, ZEF, Mechanical Engineering Department and graduated from the faculty with honors in 1995 and became a mechanical engineer. He was awarded a non-refundable scholarship by the Turkish Chamber of Mechanical Engineers in his 4th year because he was the most succesful student during his first 3 classes study at the faculty. He graduated from İzmir Atatürk High School in 1991.

Asst. Prof. Dr. ELMAS has completed his military service as a NATO Officer in Bosnia and Herzegovina. He was a “Reserved Officer” as a “2nd Lieutenant” as an “English-Turkish Interpreter”. He was also a “Guard Commander” and served in Sarajevo, Camp Butmir within the SFOR task force of NATO. He has been awarded with 2 (two) NATO Medals and Turkish Armed Forces Service Certificate of Pride (Bosnia & Herzegovina).

In addition to his academic duties at universities, he has worked as an engineer and manager in various industrial institutions, organizations and companies; He has served as Construction Site Manager, Project Manager, Management Representative, Quality Manager, Production Manager, Energy Manager, CSO-CTO, CBDO, Factory Manager, Deputy General Manager and General Manager.

Asst. Prof. Dr. Elmas is Department Head and is an Assistant Professor of Automotive Technology at the Department of Motor Vehicles and Transportation Technologies at Vocational School of Higher Education for Technical Sciences at IGDIR UNIVERSITY, Turkey. He is also an Assistant Professor of Bioengineering & BioSciences at the same university. He has nearly 30 years of total experience in academia and in industry.

He has served as a scientific referee and panelist for ASME, TUBITAK and many scientific institutions, organizations and universities, including NASA.

“Mechanical Engineering, Energy Transfer, Thermodynamics, Fluid Mechanics, Heat Transfer, Higher Mathematics, Evaporation, Heat Pipes, Space Sciences, Automotive, Bioengineering, Medical Engineering Applications, Neuroengineering, Medical Technique” are his academic and scientific fields of study; “Heating-Ventilation Air Conditioning Applications, Pressure Vessels, Heat Exchangers, Energy Efficiency, Steam Boilers, Power Plants, Cogeneration, Water Purification, Water Treatment, Industrial Equipment and Machinery, Welding Manufacturing, Sheet Metal Forming, Machining” are his industrial experience fields.

Asst. Prof. Dr. Emin Taner ELMAS is also a musician, saz (baglama) virtuoso player and ney (Nay, Turkish Reed Flute) performer. He plays also cümbüş instrument and performs darbuka rhythm instrument. He has a YouTube Music Channel (Emin Taner ELMAS) which includes some of his sound recordings of him playing the saz-baglama and blowing the ney. He composed the poem written by the great poet Âşık Veysel ŞATIROĞLU under the name of “Raşit Bey” in memory of his father Judge (Hâkim) Raşit ELMAS as “Raşit Bey Türküsü”, wrote it down, notated and published it as an academic article and broadcasted this song on his own music channel. He wrote the poems entitled “Canım Babam” and “Geldim Babam” which he wrote also in memory of his father and published in an academic literature journal, and composed instrumental musics for these poems. He also composed an instrumental song called “Annem Annem Türküsü” and gave it to his mother, Lawyer Tuna ELMAS, as a gift on Mother’s Day, 11.05.2025. He also has a poem titled "Ney and Neyzen." He also wrote and presented a poem titled "Esra Kardeşim" to his sister, Esra ELMAS, an archaeologist and

English teacher. He has published books including "Saz-Bağlama Tuning System Method" (“Saz- Bağlama Akort Sistemi Metodu”) and "Ney and Neyzen; Ney's Pitches, Frets, Sound Stages, Octaves, Structure, Performance, Ney Maintenance and Basic Music Theory" (Ney ve Neyzen; Ney’de Perdeler, Ses Devreleri, Oktavlar, Yapısı, İcrası, Ney Bakımı ile Temel Musiki Nazariyatı). He continues his artistic studies by writing various articles, books, poetry, lyrics and also realizing musical composition and repertoire works.

References

[1] ELMAS, Emin Taner, & KUNDURACIOĞLU, I. (2025). An Introduction to Resting Potential and Action Potential (Dinlenme Potansiyeli Ve Aksiyon Potansiyeli’ne Giriş), Studies in Science of Science | ISSN:1003-2053, https://doi.org/10.5281/zenodo.17346814, 2053https://sciencejournal.re/ | Volume 43, Issue 10, 2025

[2] Emin Taner Elmas (2025) “Applied Medi-Brain Energy-Tronic Treatment Method” for the Medical Treatments of SMA – Spinal Muscular Atrophy Disease, Paralyzed Patients, ALS Patients, MPS, SSPE, DMD Patients with the Biomechanical Analysis of Bionic Prosthetic Robotic Artificial Hand Design. Journal of Engineering and Applied Sciences Technology. SRC/JEAST-469. DOI: doi.org/10.47363/JEAST/2025(7)335

[3] Emin Taner Elmas. A Novel and Unique Neuroengineering Method-Introduction to “Applied Medi Brain Energy Tronic Treatment Method” for SMA Spinal Muscular Atrophy Disease, Paralyzed Patients, ALS Patients, MPS, SSPE, DMD Patients . J Mat Sci Eng Technol. 2025. 3(4): 1-17. DOI: doi.org/10.61440/JMSET.2025.v3.90

[4] Emin Taner Elmas (2026) Thermodynamics and Energy Transfer in Medicine Applications with Archaeomusicology and Music Therapy, Studies in Science of Science | ISSN:1003-2053, https://doi.org/10.5281/zenodo.18130664, https://sciencejournal.re/ | Volume 44, Issue 1, 2026

[5] ELMAS ET (2025) Prosthetics, Artificial Limbs, Implants and Their Biomedical Applications. J Surg 10: 11365 DOI:10.29011/2575-9760.011365 (WoS, PubMed)

[6] ELMAS ET (2025) An Introduction to Electrophysical Properties of the Human Heart. J Surg 10: 11364 DOI: 10.29011/2575-9760.011364 (WoS, PubMed)

[7] Elmas, Emin Taner, ELMAS’s Theory of Thermodynamics”: A Scientific Approach for 5th Law of Thermodynamics -A Theoretical Application Example for Medical Thermodynamics. Op Acc J Bio Sci & Res 2(1)-2020. DOI: 10.46718/JBGSR.2020.01.000030

[8] Emin Taner ELMAS*. Medical Treatment Method of Alzheimer's Disease & Parkinson’s Disease by the Help of the Natural Musical Sound of Nây-ı Şerîf, Instrument of Ney (Ney: Turkish Reed Flute, Nay). IJCMCR. 2024; 42(3): 004 DOI: 10.46998/IJCMCR.2024.42.001039

[9] Elmas, Emin Taner (2020) Medical Treatment Method of “Bio-robotic Resonance and Thermodynamical Interaction” with Analogy of “Frequency – Resonance Setting Formation” on the Application of “Algorithm for Smart Drugs Controlled by a Bio-robotic System” developed for the “Treatment of Covid-19, Coronavirus and Virus Infections”. Open Access Journal of Biogeneric Science and Research (BGSR), Op Acc J Bio Sci & Res 1: 1. DOI: 10.46718/JBGSR.2 020.01.000007.

[10] Elmas Emin Taner (2020) Scope of Applications for Medical Technique at Science and Engineering, Open Access Journal of Biogeneric Science and Research (BGSR), Op Acc J Bio Sci & Res 1: 1. DOI: 10.46718/JBGSR.2020.01.000002.

[11] Emin Taner ELMAS (2024) System Design and Development of a Novel Unique Neuro-Physical Medical Treatment Method for SMA-SPINAL MUSCULAR ATROPHIA-Disease and for Similar Neurological Muscle Diseases. Herculean Res 4(1):90-97

[12] Emin Taner ELMAS*,İbrahim DAĞ and Simge KARADENIZ. General Information about (AD-AH) Alzheimer's Disease. *IJCMCR. 2025; 54(2): 003* ***DOI:*** *10.46998/IJCMCR.2025.54.001333*

[13] Emin Taner ELMAS (2024) Design of Bionic Eye and Artificial Vision System; a Unique Project "Mobile Bio-Eye-Tronic System". Herculean Res 4(1):97-100 https://dx.doi.org/10.70222/hres23

[14] Emin T. Elmas, & İhsan Ö. Bucak. (2023). Modeling and Simulation of Smart-Drug Algorithms Through Frequency Modulation for the Treatment of Covid-19 and Similar Viruses. Global Journal of Research in Medical Sciences, 3(5), 1–6. https://doi.org/10.5281/zenodo.10051793

[15] Emin T. E., & İhsan Ömür B. (2024). FM Modulated Smart Drug Algorithm for the treatment of Cancer Cells. In Global Journal of Research in Medical Sciences (Vol. 4, Number 1, pp. 1–6). https://doi.org/10.5281/zenodo.10463529

[16] Elmas, Emin Taner (2017) Prospective Characteristics of Contemporary Engineer (By the Approach of MechanicalEngineering) Contribution and Role of the Mechanical Engineer to the Organization Management and Productivity). DeGruyter, Germany (DOI 10.1515 / 9783110355796-007)

[17] Emin Taner ELMAS. (2023). Prototype Desıgn, Productıon and Functıonıng of a Portable (Movable), Home-Type (Domestıcal) Hemodıalysıs Machıne (Unıt). In Global Journal of Research in Medical Sciences (Vol. 3, Number 6, pp. 11–12). https://doi.org/10.5281/zenodo.10252972

[18] Elmas, Emin Taner (2019) Thermodynamical Balance Associated with Energy Transfer Analysis of the Universe Space as a Pressure Vessel Analogy. Journal of Applied Sciences, Redelve International Publications 2019(1): RDAPS- 10002.

[19] Emin Taner Elmas. Design of Bio-Artificial Liver Organ. J Biomed Sci Biotech Res. 2024. 2(3): 1-4. DOI: doi.org/10.61440/JBSBR.2024.v2.12

[20] ELMAS, E. T. (2024). Design of Bionic Ear-Cochlear Implant and Artificial Hearing System; a Unique Project "Mobile Bio-Ear-Tronic System". Journal homepage: https://gjrpublication. com/gjrms, 4(02). http://doi.org/10.5281/zenodo.12751385

[21] Emin Taner ELMAS* and Levent OĞUL. The Effects of Medicine and Music Therapy Practices on Human Health. *IJCMCR. 2025; 50(2): 003*, *DOI: 10.46998/IJCMCR.2025.50.001233*

[22] Emin Taner E, Servet K. (2025). Biomechanical Analysis of Transtibial Prosthesis Designed for Runners. Biomedical and Clinical Research Journal, 1(2); DOI: http;/02.2025/BCRJ/007.

[23] ET Elmas and MA Cinibulak (2025) Fundamental Scientific and Technical Issues related with the "Hip Replacement Design and Biomechanical Analysis". Journal of Material Science and Nanotechnology, Matsci Nano J, 2025

[24] ELMAS, Emin Taner, & KUNDURACIOĞLU, I. (2025). A Model for Second Law of Thermodynamics, Relationship between Health, Disease, Aging, Death Processes and Consciousness, Nervous System and Time. In Global Journal of Research in Medical Sciences (Vol. 5, Number 2, pp. 1–6). https://doi.org/10.5281/zenodo.14973559

[25] ELMAS, Emin Taner, & KUNDURACIOĞLU, I. (2025). Metabolic Heat Production with Energy Transfer and Laws of Human Thermodynamics: The Energy Balance of the Human Body. In Global Journal of Research inMedical Sciences (Vol. 5, Number 2, pp. 7–14). https://doi.org/10.5281/zenodo.14973620

[26] Elmas ET, Kunduracıoğlu I (2025) Artificial Heart Design and Biomechanical Analysis. Open Access Journal of Medicine and Healthcare, Research Article 1(1): 01-06.

[27] ELMAS, Emin Taner, & KUNDURACIOĞLU, I. (2025). Fundamentals of Human Vision System. In Global Journal of Research in Medical Sciences (Vol. 5, Number 2, pp. 103–117). https://doi.org/10.5281/zenodo.15078754

[28] Emin Taner ELMAS, İsmail KUNDURACIOĞLU. *Signal Transduction System in Neurons. International Journal of Research in Medical and Clinical Sciences. 2025;3(1): 26-35.*

[29] Emin Taner ELMAS, İsmail KUNDURACIOĞLU. *An Introduction to Sound and Sound Perception System for Human Ear. International Journal of Research in Medical and Clinical Sciences. 2025;3(1): 36-49.*

[30] Emin Taner ELMAS, İsmail KUNDURACIOĞLU. *Medical Structure of the Human Respiratory System. International Journal of Research in Medical and Clinical Sciences. 2025;3(1): 50-63.*

[31] Emin Taner ELMAS, İsmail KUNDURACIOĞLU. *Medical Structure and Hemodynamics of the Human Circulatory System. International Journal of Research in Medical and Clinical Sciences. 2025;3(1): 64-81.*

[32] Emin Taner ELMAS and İsmail KUNDURACIOĞLU. General Aspects of Advanced Biomechanics. Biomed J Sci & Tech Res 61(5)-2025. BJSTR. MS.ID.009658.

[33] Emin Taner Elmas and İsmail KUNDURACIOĞLU. Conservation Laws and the Main Physical Parameters for Advanced Biomechanics. Biomed J Sci & Tech Res 61(5)-2025. BJSTR. MS.ID.009659.

[34] Emin. T. Elmas, M. Şimşek (2025). Bionic Prosthetic Robotic Artificial Hand Design and Biomechanics Analysis. *Journal of Medical Discoveries. RPC Publishers*. 2(1); DOI: https://www.doi.org/rpc/2025/rpc.jmd/00311

[35] Elmas, E.T. (2025). A Brief Information about Cataract Operation. *European Journal of Science and Modern Technologies, 1*(2), 61-66. https://doi.org/10.59324/ejsmt.2025.1(2).05

[36] ELMAS, Emin Taner. (2025). A Brief Information about Blood Sugar and Diabetes Management. In ICON Journal of Applied Medical Sciences (Vol. 1, Number 1, pp. 1–5). https://doi.org/10.5281/zenodo.15870465

[37] Emin Taner Elmas, Ismail Kunduracioglu. An Introduction to the Medical Body Mechanics and Human Muscles. Journal of Medical and Clinical Case Reports 2(1). https://doi.org/10.61615/JMCCR/2025/APRIL027140418

[38] Emin TE, İsmail K (2025) Elastomechanics Fundamentals for Bones and Fractures. Ann Biotech & Biomed Sci 1(1): 1-12.

[39] Emin Taner ELMAS, Yavuz ORUC, "An Alternative Non-Surgical Cataract Treatment Method in Medicine and Ophthalmology; "Medi-Ultrasound Eye-Tronic Method"", Universal Library of Medical and Health Sciences, 2025; 3(3): 01-07. DOI: https://doi.org/10.70315/uloap.ulmhs.2025.0303001.

[40] Emin Taner ELMAS. System Design and Development of a Novel Unique Neuro-Physical Medical Treatment Method for SMA - Spinal Muscular Atrophy Disease and for Similar Neurological Muscle Diseases. Collect J Neurol. 2024; 1: ART0037. https://doi.org/10.70107/ collectjneurol-art0037

[41] Elmas, E. T., & Oruç, Y. (2025). An Innovative Approach to Medical Thermodynamics and Medical Treatment; Thermodynamics and Entropy; and the Relationship between the Universe, the World, Humans, Society, Economy and Health. In ICON Journal of Applied Medical Sciences (Vol. 1, Number 1, pp. 13–22). https://doi.org/10.5281/zenodo.16877649

[42] Fevzi Daş, Emin Taner Elmas and İhsan Ömür Bucak, Book Chapter: Innovative Use of Machine Learning-Aided Virtual Reality and Natural Language Processing Technologies in Dyslexia Diagnosis and Treatment Phases; From the Edited Volume Digital Frontiers - Healthcare, Education, and Society in the Metaverse Era;(2024) , Written By Fevzi Daş, Emin Taner Elmas and İhsan Ömür Bucak, DOI: 10.5772/intechopen.1006621, IntechOpen Limited, UNITED KINGDOM; indexed in the Book Citation Index in Web of Science™ Core Collection (BKCI)

[43] Elmas, Emin Taner (2017) Productivity and Organizational Management (The Book) (Chapter 7): Prospective Characteristics of Contemporary Engineer (By the Approach of Mechanical Engineering) Contribution and Role of the Mechanical Engineer to the Organization Management and Productivity. Machado Carolina, Davim J Paulo (Eds.), DEGRUYTER, Walter de Gruyter GmbH, Berlin / Boston, Spain (ISBN:978-3-11-035545-1) (BKCI)

[44] Elmas, Emin Taner, (2014), Çağımızın Mühendisinden Beklenenler, Gece Kitaplığı, ISBN:9786053244158

[45] Emin Taner ELMAS, "System Design and Development of a Novel Unique Neuro- Physical Medical Treatment Method for SMA – Spinal Muscular Atrophy Disease and for Similar Neurological Muscle Diseases" has been accepted for presentation at the World congress on Biomedical Science and Engineering, scheduled to be held on November 06-07, 2025, at NH Vienna Airport Conference Center, Vienna, Austria
(Konferans- Kongre-Bildiri)

[46] Emin Taner ELMAS, -A Novel and Unique Neuroengineering Method- Introduction to "Applied Medi-Brain Energy-Tronic Treatment Method" for SMA – Spinal Muscular Atrophy Disease, Paralyzed Patients, ALS patients, MPS, SSPE, DMD Patients, *3rd Global Webinar on Neuroscience And Mental Disorders December 03-04, 2025*
(Konferans- Kongre-Bildiri)

[47] Emin Taner ELMAS, THE 3RD WORLD BIOLOGICAL SCIENCE AND TECHNOLOGY CONFERENCE *"Scope of Applications for Medical Technique at Science and Engineering"* (Konferans- Kongre-Bildiri)

[48] Emin Taner ELMAS, BioST 2022 – "ELMAS's Theory of Thermodynamics": A Scientific Approach for 5th Law of Thermodynamics -A Theoretical Application Example for Medical Thermodynamics-(Konferans- Kongre-Bildiri)

[49] Emin Taner ELMAS, *"BioST Virtual 2021 – World Biological Science and Technology Conference-202;* "Medical Treatment Method of "Bio-robotic Resonance and Thermodynamical Interaction" with Anology of "Frequency - Resonance Setting Formation" on the Application of "Algorithm for Smart Drugs Controlled by a Bio-robotic System" developed for the "Treatment of Covid-19 , Coronavirus and Virus Infections"(Konferans-Kongre-Bildiri)

[50] Prigogine, I. (1980). From Being to Becoming: Time and Complexity in the Physical Sciences. W.H. Freeman.

[51] Prigogine, I., & Stengers, I. (1984). Order Out of Chaos. Bantam Books.

[52] Schrödinger, E. (1944). What is Life? The Physical Aspect of the Living Cell. Cambridge University Press.

[53] Nicolis, G., & Prigogine, I. (1977). Self-Organization in Nonequilibrium Systems. Wiley.

[54] Kondepudi, D., & Prigogine, I. (2014). Modern Thermodynamics. Wiley.

[55] Haken, H. (1983). Synergetics: An Introduction. Springer.

[56] Friston, K. (2010). The free-energy principle: A unified brain theory? Nature Reviews Neuroscience, 11, 127–138.

[57] Friston, K. (2012). A free energy principle for biological systems. Entropy, 14(11), 2100–2121.

[58] Kuramoto, Y. (1984). Chemical Oscillations, Waves, and Turbulence. Springer.

[59] Strogatz, S. H. (2003). Sync: How Order Emerges from Chaos. Hyperion.

[60] Pikovsky, A., Rosenblum, M., & Kurths, J. (2001). Synchronization: A Universal Concept in Nonlinear Sciences. Cambridge University Press.

[61] Breakspear, M., Heitmann, S., & Daffertshofer, A. (2010). Generative models of cortical oscillations. Frontiers in Human Neuroscience, 4, 190.

[62] Buzsáki, G. (2006). Rhythms of the Brain. Oxford University Press.

[63] Stam, C. J. (2005). Nonlinear dynamical analysis of EEG and MEG. Clinical Neurophysiology, 116(10), 2266–2301.

[64] Jeong, J. (2004). EEG dynamics in patients with Alzheimer's disease. Clinical Neurophysiology, 115(7), 1490–1505.

[65] Pievani, M., et al. (2011). Functional network disruption in the degenerative dementias. The Lancet Neurology, 10(9), 829–843.

[66] Breakspear, M. (2017). Dynamic models of large-scale brain activity. Nature Neuroscience, 20, 340–352.

[67] Alzheimer, A. (1907). Über eine eigenartige Erkrankung der Hirnrinde. Allgemeine Zeitschrift für Psychiatrie.

[68] Hardy, J., & Selkoe, D. J. (2002). The amyloid hypothesis of Alzheimer's disease. Science, 297(5580), 353–356.

[69] De Strooper, B., & Karran, E. (2016). The cellular phase of Alzheimer's disease. Cell, 164(4), 603–615.

[70] Braak, H., & Braak, E. (1991). Neuropathological stageing of Alzheimer-related changes. Acta Neuropathologica, 82, 239–259.

[71] Obeso, J. A., et al. (2017). Parkinson disease. Nature Reviews Disease Primers, 3, 17013.

[72] Hardiman, O., et al. (2017). Amyotrophic lateral sclerosis. Nature Reviews Disease Primers, 3, 17071.

[73] Rossing, T. D., Moore, F. R., & Wheeler, P. A. (2002). The Science of Sound. Addison-Wesley.

[74] Fletcher, N. H., & Rossing, T. D. (1998). The Physics of Musical Instruments. Springer.

[75] Koelsch, S. (2014). Brain correlates of music-evoked emotions. Nature Reviews Neuroscience, 15, 170–180.

[76] Thaut, M. H. (2005). Rhythm, Music, and the Brain. Routledge.

[77] Altenmüller, E., Schlaug, G. (2015). Music, brain, and health. Progress in Brain Research, 217, 1–12.

[78] Särkämö, T., et al. (2014). Cognitive, emotional, and social benefits of regular musical activities in early dementia. The Gerontologist, 54(4), 634–650.

[79] Raglio, A., et al. (2015). Music therapy in dementia. Aging & Mental Health, 19(7), 571–578.

[80] Bradt, J., Magee, W. L., Dileo, C., Wheeler, B. L., & McGilloway, E. (2010). Music therapy for acquired brain injury. Cochrane Database.

[81] Thaut, M. H., & Abiru, M. (2010). Rhythmic auditory stimulation in rehabilitation. Journal of Neurologic Physical Therapy, 34(1), 5–11.

[82] Uddin, M. S., et al. (2020). Music-based interventions in neurological disorders. Neuroscience & Biobehavioral Reviews, 118, 1–15.

[83] Shannon, C. E. (1948). A mathematical theory of communication. Bell System Technical Journal.

[84] Goldberger, A. L., et al. (2002). Fractal dynamics in physiology. PNAS, 99(Suppl 1), 2466–2472.

[85] Cover, T. M., & Thomas, J. A. (2006). Elements of Information Theory. Wiley.

[86] West, B. J. (2010). Fractal Physiology and Chaos in Medicine. World Scientific.

[87] Emin Taner ELMAS and Ibrahim DAĞ (2026); Alzheimer Hastalığı ve Parkinson, ALS gibi benzer Nörodejeneratif Hastalıkların, Termodinamik ve Fizik Bilimleri Dahilinde İncelenmesi, Alzheimer Hastalığının Termodinamiksel Analizinin Ortaya Konması ile Ney ve diğer Enstrümanların Ürettiği Müzik Sesi Frekansları ile Tedavinin nasıl İlişkilendirilebileceği Hususunun İncelenmesi, Studies in Science of Science | ISSN:1003-2053 https://sciencejournal.re/ | Volume 44, Issue 1, 2026 | https://doi.org/10.5281/zenodo.18302960

[88] Emin Taner ELMAS and İbrahim DAĞ; (2026); Laplace Dönüşümleri ve Diferansiyel Denklemlerin Sayısal Çözümleri ile ilgili Genel Bilgiler, *(General Information about Laplace Transforms and Numerical Solutions of Differential Equations), Gongcheng Kexue Xuebao || Volume 11, No.02, 2026 || ISSN 2095-9389, https://doi.org/10.5281/zenodo.18465309*