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THE IMPACT OF VIBRO-ACOUSTIC STIMULATION ON THE PSYCHOLOGICAL RESILIENCE OF PATIENTS WITH CHRONIC PAIN

AUTHOR’S ABSTRACT

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The dissertation comprises a total of 230 pages, of which 213 pages constitute the main text. The bibliography spans 9 pages and includes 118 bibliographic sources—18 in Cyrillic, 100 in Latin script, and 23 online sources. The appendices occupy 3 pages. The main text contains 17 figures and 51 tables. The structure of the dissertation includes an introduction, three chapters, a list of references, and appendices. The first chapter provides a theoretical overview and conceptual framework. The second chapter presents the design of the empirical study, including its methods, instruments, and research procedures. The third chapter focuses on the analysis and interpretation of the research results.

The doctoral research was conducted at the Faculty of Pedagogy, Plovdiv University "Paisii Hilendarski," within the Department of Psychology. The dissertation was submitted and approved for defense by the academic committee of the Department of Psychology at the Faculty of Pedagogy on March 4, 2025. The public defense of the dissertation will take place on June 3, 2025, at 11:00 AM in the conference hall of the New Building of Plovdiv University "Paisii Hilendarski," before an academic jury consisting of Prof. Dr. Kirlika Simeonova Tagareva, Assoc. Prof. D.Sc. Manol Nikolov Manolov, Prof. D.Sc. Margarita Angelova Stefanova-Bakracheva, Assoc. Prof. D.Sc. Stoil Lyubenov Mavrodiev, and Assoc. Prof. Dr. Doncho Stoyanov Donev. The materials related to the defense are available at the university library.

INTRODUCTION

The accelerating pace of technological, economic, and social change in modern industrial societies increases the demands for adaptation and the corresponding levels of stress among their citizens. In contemporary organizations that rely on information technology, the growing volume of data that employees must process daily creates conditions for cognitive overload. The increasing demands for cognitive efficiency in the workplace present a new reality in which individuals must demonstrate psychological resilience on a daily basis, even in routine tasks. Closely linked to these heightened adaptation requirements is the rising interest in various interventions and methods for developing psychological resilience (resilience).

Most definitions of resilience associate the construct with the ability to rapidly return to normal psychophysiological functioning after experiencing significant adverse events, intense stress, traumatic situations, or crises. Such definitions frame resilience as a response mechanism outside the context of everyday life, emphasizing its role in extreme or post-crisis scenarios rather than in daily psychological endurance.

The relevance of this issue stems from the growing importance of psychological resilience in stress adaptation and overall quality of life. The present dissertation focuses on the impact of vibroacoustic stimulation (VAS) on resilience in a specific population group, based on three fundamental premises. First, to circumvent the challenges associated with applying a systemic approach to resilience development, the core objective of this research is to explore the potential for cultivating specific components of psychological resilience through VAS. VAS is a device-based method that employs rhythmically perceived tactile stimuli to directly influence attention and nervous system arousal, inducing a state of psychophysical relaxation and regeneration. It likely affects fundamental neuropsychological processes that underlie certain components of resilience, which are valid for all individuals. The application of such a “universal” and “mechanical” approach to resilience enhancement presents both advantages and limitations.

Second, individuals suffering from chronic pain represent a particularly suitable target group for this study, as they exhibit heightened sensitivity to changes in neuropsychophysiological parameters that influence both the body and the nervous system.

Thirdly, chronic pain continuously challenges and tests patients' psychological resilience, creating favorable conditions for assessing the effects of interventions aimed at enhancing resilience. In this context, the potential of VAS can be systematically examined within an experimental setting involving this specific research population. The present study focuses on individuals diagnosed with fibromyalgia, a condition characterized by chronic, widespread musculoskeletal pain, fatigue, cognitive impairments, anxiety-depressive symptoms, and other somatic complaints. Despite its debilitating nature, the precise etiology of fibromyalgia remains unidentified. It is widely accepted that its symptomatology is triggered or exacerbated by a range of psychological and physical stressors. The absence of a clearly defined cause, combined with patients’ heightened sensitivity to emotional stressors, provides an optimal environment for investigating the effects of vibroacoustic stimulation on psychological resilience within the real-life context of a condition that inflicts continuous psychological strain.

If VAS proves effective in enhancing resilience, its application as a device-based method could circumvent the need for extensive assessment of individual resilience components and instead provide a direct and scalable means of resilience support. This would enable widespread accessibility to resilience-enhancing interventions, benefiting large groups of individuals—both those with and without chronic pain—without necessitating the involvement of trained specialists. Furthermore, the method could offer individuals daily and even hourly access to a tool designed to support resilience and cognitive efficiency. The potential for improving resilience among chronic pain patients through VAS could have far-reaching implications, extending to numerous healthy individuals operating in high-stress environments that continually challenge their psychological endurance. Additionally, VAS could be expected to positively impact the quality of life and professional functioning of individuals suffering from post-traumatic stress symptoms.

The relevance of this research is further underscored by the fact that while psychological resilience is a widely discussed and frequently analyzed topic in organizational settings, effective practical measures for its daily support remain largely absent. Individuals are often left to cultivate resilience independently, relying on recommendations and guidance from sporadic training sessions. At the same time, the demands for sustained cognitive performance under conditions of information overload and strict deadlines have become an everyday reality. Although individuals are expected to demonstrate resilience in both their professional and personal lives, they are rarely provided with structured tools and resources to develop it. This study examines the possibility of addressing this contradiction through the application of vibroacoustic stimulation. Demonstrating the effectiveness of VAS in enhancing resilience and specific aspects of cognitive functioning could pave the way for its widespread implementation, offering meaningful benefits for nearly every individual.

Research Objectives and Methodology

The primary objective of this dissertation is to examine the potential of a device-based research-therapeutic methodology for vibroacoustic stimulation (VAS) in positively influencing psychological resilience. The study seeks to identify the specific mechanisms through which VAS affects resilience and enhances individuals' ability to sustain voluntary attention.

Achieving this objective necessitates addressing the following research tasks:

- Conducting a literature review of theoretical frameworks and defining key concepts;
- Formulating the research problem;
- Identifying empirical physiological indicators of resilience;
- Developing a model of the studied phenomenon and determining resilience factors that can be influenced through VAS;
- Designing and pilot testing a vibroacoustic stimulation apparatus;
- Defining independent and dependent variables;
- Constructing a research design;
- Selecting a sample of study participants;
- Choosing appropriate research methods and techniques;
- Analyzing and discussing the results in relation to the proposed hypotheses.

The **object of study** is vibroacoustic stimulation in the context of its potential to support psychological resilience. The **subject of study** is the identification of mechanisms and resilience factors that can be influenced through VAS.

The **main hypothesis** posits that VAS will have a more effective impact on attention stability, latent resilience factors, energy restoration, stress responses, and the intensity of chronic pain in study participants through a specific and controlled variation in the frequency of vibro-stimuli, compared to constant-frequency vibrations.

Research Methods

To empirically test the proposed model, the following methodologies were employed:

- **Psychophysiological stress test**, measuring changes in skin conductance in response to stressors;
- **Device-based vibroacoustic stimulation**, as an intervention;

- **Computerized test for attention stability**, assessing sustained concentration;
- **Computerized visual-analog scale test for self-assessment of pain intensity**;
- **Computerized visual-analog scale test for self-assessment of latent resilience factors**.

Statistical Analysis

The empirical data were processed using various statistical methods, including:

- **Descriptive statistics** (mean value and standard deviation);
- **t-test for paired comparisons**;
- **Analysis of variance (ANOVA)**;
- **Regression analysis**.

These methods allowed for a comprehensive evaluation of the impact of VAS on resilience-related psychological and physiological parameters.

STRUCTURE AND CONTENT OF THE DISSERTATION

Given the specific nature of this dissertation research, its structure follows a conventional format. The **first chapter** outlines the theoretical framework of the studied phenomena and provides an in-depth examination of the factors contributing to psychological resilience that can be influenced through the vibroacoustic stimulation (VAS) methodology. The **second chapter** presents the design of the empirical study, including the research methods, instruments, and procedures employed. The **third chapter** provides a detailed analysis of the empirical results, followed by a discussion, conclusions, summary, a description of the study's contributions, and final remarks.

CHAPTER ONE.
THEORETICAL FRAMEWORK OF THE STUDY

1.1. Definition and Conceptual Characteristics of Resilience

The first chapter of this dissertation examines the key concepts and factors of resilience, assessment methods, and the neurobiological foundations of psychological resilience. A central focus is placed on identifying the neurophysiological mechanisms and resilience factors that can be positively influenced through apparatus-based methodologies.

The term *resilience* originates from the Latin *resilio* and is defined as the ability to adapt and remain stable under stress. It encompasses both psychological aspects, such as emotional competence and crisis resistance, and intentional actions aimed at coping with stressors. Various models, including Bronfenbrenner’s ecological model and the compensatory model, describe the mechanisms of resilience and emphasize its role in psychological well-being.

Research identifies three primary factors contributing to resilience: internal characteristics such as self-efficacy and cognitive flexibility, external factors such as social support, and the dynamic interaction between them. Ungar (2008) views resilience as a product of social context, whereas Fredrickson (2001) highlights the role of positive emotions. Maddi’s (2006) *Hardiness Model* defines commitment, control, and challenge acceptance as essential elements of resilience. Internal and external resilience factors include self-esteem, emotional regulation, optimism, social support, and access to resources. According to Grotberg (1995), these are categorized into three groups: social resources (“I have”), personal characteristics (“I am”), and coping skills (“I can”).

Resilience can be regarded as both a stable personality trait and a dynamic process influenced by neural, psychological, and social factors. Depending on the context, it can manifest as general resilience (common to most individuals), true resilience (specific to vulnerable individuals), or inoculated resilience (developed through overcoming difficulties). The resilience approach emphasizes an individual's strengths and resources rather than focusing on problems, fostering resilience by mobilizing both internal and external resources while shifting the focus from difficulties to solutions.

The assessment of resilience employs various methodologies, including the *Connor-Davidson Resilience Scale (CD-RISC)*, the *Hiew (SRC) questionnaire*, and the *Maltby & Hall (2022) model*, which examines recovery, social cohesion, nervous system stability, and adaptability. Resilience is a crucial determinant of mental health and stress adaptation. It is not a fixed trait but a process shaped by social environments, personal resources, and supportive relationships. Its development requires an integrated approach that combines internal and ecological factors, and its study and application in interventions are vital for enhancing individuals’ ability to cope with life’s challenges.

1.2. Neurobiological Foundations of Psychological Resilience

Psychological resilience is a complex and dynamic ability to adapt to stress and challenges, based on the interaction between neurobiological, cognitive, and social factors. At the neurobiological level, it is associated with brain structures, neurotransmitter systems, stress regulation, and energy balance.

Neurobiological Mechanisms of Resilience

When an individual faces stress, a conflict arises in the brain between the mesolimbic dopamine pathway, responsible for pleasure, and the prefrontal cortex, which governs long-term goal regulation. This activates the amygdala, insula, and anterior cingulate cortex, intensifying the perception of threat and deficiency. Adaptive individuals engage the parasympathetic nervous system to regulate arousal, employ positive cognitive strategies, and reinforce motivation through positive emotions.

Mediator Systems and Stress Responses

Key neurotransmitters linked to resilience include dopamine, serotonin, and norepinephrine. These modulate motivation, emotions, and cognitive control. Stress regulation occurs through the hypothalamic-pituitary-adrenal (HPA) axis and the autonomic nervous system. Dysregulation in these systems is associated with psychological disorders such as depression and post-traumatic stress disorder (PTSD). Serotonin plays a role in limiting aggression, impulsivity, and anxiety, with higher levels correlating with improved social functioning. Norepinephrine is essential for energy mobilization and sustained attention—optimal levels enhance vigilance, while excessive activation leads to anxiety and impulsivity.

Traumatic Stress and the Sympathetic Vicious Cycle

Chronic stress triggers a vicious cycle in the sympathetic nervous system, leading to hypervigilance, cortisol depletion, and cognitive impairments, increasing the risk of depression, anxiety, and cardiovascular diseases. Additionally, inflammatory processes associated with chronic stress can undermine psychological resilience.

Neuroplasticity and Psychological Resilience

Neuroplasticity enables the brain to adapt by forming new neural connections. Psychotherapy and pharmacotherapy influence this process by altering activity in key brain regions. Mindfulness practices, physical exercise, and controlled stress interventions enhance resilience by modulating neural networks related to self-regulation and emotional processing.

Genetics, Epigenetics, and Psychological Resilience

Genetic predisposition influences an individual's susceptibility to stress, but epigenetic mechanisms, shaped by social environments, regulate gene expression related to resilience. Early life experiences, parental care, and social factors play a crucial role in shaping stress responses and emotional stability throughout life.

Self-Control, Volitional Effort, and Energy Regulation

Self-control and executive functions rely on a limited energy resource—blood glucose. Baumeister et al. demonstrated that exerting self-control depletes glucose levels, impairing subsequent performance on tasks requiring volitional effort. Resilient individuals effectively allocate their energy resources, whereas those vulnerable to stress experience chronic sympathetic activation, leading to energy depletion, cognitive exhaustion, reduced self-control, and lower psychological resilience.

Directed Attention and Its Restoration

Kaplan's *Attention Restoration Theory (ART)* conceptualizes directed attention as a finite resource necessary for self-control and executive functioning. Excessive use of this resource results in *directed attention fatigue (DAF)*, manifested as irritability, cognitive difficulties, and diminished self-regulation, ultimately undermining resilience. Kaplan and Berman suggest that involuntary attention can be leveraged to restore this limited resource through exposure to sensory-perceived stimuli that induce dissociation, maintain engagement over time, and do not provoke boredom or mental resistance. Research indicates that natural environments meet these criteria, supporting the recovery of directed attention and strengthening psychological resilience.

Conclusion

The neurobiological foundations of psychological resilience encompass a complex network of brain structures, neurochemical processes, and social interactions. Self-control, directed attention, stress responses, and resilience depend on limited energy resources, which can be replenished through appropriate interventions. Studies suggest that epigenetic mechanisms, neuroplasticity, and emotional regulation practices significantly influence adaptation to stress and the enhancement of resilience.

1.3. Instrumental Methods in Applied Psychophysiology and Resilience

Applied psychophysiology explores the interaction between psychological and physiological processes to develop methods aimed at improving mental and physical health. A central focus in this field is the use of instrumental techniques that enable measurable and direct modulation of physiological processes, thereby supporting adaptability and resilience. This section examines several instrumental methodologies that directly or indirectly contribute to fostering psychological resilience.

Biofeedback and Neurofeedback

Biofeedback and neurofeedback are among the most extensively researched methods for enhancing self-regulation and stress resilience. Biofeedback enables individuals to regulate physiological processes such as heart rate, breathing patterns, muscle tension, and skin conductance. One of the most significant indicators of psychological resilience is heart rate variability (HRV), which reflects the balance between energy expenditure and recovery within the autonomic nervous system. Studies by Lehrer & Gevirtz (2014) and Prinsloo et al. (2011) demonstrate that HRV biofeedback training enhances adaptability and stress management.

Neurofeedback, a specialized form of biofeedback, focuses on modulating brain activity by providing real-time feedback on electroencephalographic (EEG) patterns. This technique helps individuals improve concentration, reduce anxiety, and mitigate symptoms of depression and post-traumatic stress disorder (PTSD). For instance, Saxby & Peniston (1995) found that neurofeedback can reduce pathological beta waves (linked to anxiety) while increasing alpha wave activity, which promotes relaxation and cognitive regeneration.

Transcranial Direct Current Stimulation (tDCS) and Cranial Electrotherapy Stimulation (CES)

Transcranial direct current stimulation (tDCS) and cranial electrotherapy stimulation (CES) are neuromodulation methods that apply low-intensity electrical currents to the scalp. tDCS influences neuronal excitability via anodal and cathodal electrodes, with research indicating that stimulation of the prefrontal cortex enhances cognitive flexibility and reduces anxiety and depressive symptoms (Siever, 2013). CES, on the other hand, utilizes microcurrent pulses applied to the earlobes or scalp, stimulating the natural production of serotonin, endorphins, and dopamine. Clinical studies (Kirsch & Gilula, 2007) confirm CES’s effectiveness in alleviating anxiety and insomnia, factors that significantly impact psychological resilience.

Audio-Visual Entrainment (AVE/BWE – Brainwave Entrainment)

Audio-visual entrainment (AVE) employs rhythmic light and sound pulses to synchronize brainwave activity with external stimuli, leading to measurable EEG changes. This instrumental technique is applied to reduce stress, improve sleep, and manage symptoms of depression and PTSD (Siever, 2015). AVE also induces dissociation, wherein an individual’s attention is diverted from intrusive thoughts and anxiety-inducing memories, akin to the effects of deep meditation (Collura & Siever, 2009). Additionally, AVE enhances cerebral blood flow and optimizes brain metabolism, contributing to improved cognitive function and emotional stability.

Skin Electrical Conductance as an Indicator of Resilience

Psychological resilience has traditionally been assessed through self-report questionnaires, which are susceptible to both conscious and unconscious biases. Consequently, objective physiological markers such as skin conductance level (SCL/GSR) have gained importance. This biometric parameter measures sympathetic nervous system activity, reflecting the individual’s energy consumption and recovery dynamics under stress. Research (Walker et al., 2019) indicates that highly resilient individuals exhibit a more rapid habituation to stress stimuli, whereas individuals with PTSD demonstrate heightened and prolonged SCL responses (Grasser et al., 2022).

SCL measurement allows for an in-depth analysis of an individual's stress response style and energy recovery profile. Evidence suggests that resilient individuals efficiently mobilize and restore energy, which serves as a critical mechanism for effective stress management. Due to its reliability, skin conductance is employed as an objective biomarker for resilience in the present study.

Conclusion

This section reviews key instrumental methods in neuromodulation and psychophysiological regulation that contribute to psychological resilience. Biofeedback and neurofeedback provide tools for self-regulation of physiological stress responses. Transcranial direct current stimulation (tDCS) and cranial electrotherapy stimulation (CES) enhance emotional regulation and cognitive flexibility by modulating neural activity and stimulating the natural production of key neurotransmitters. Audio-visual entrainment (AVE) influences brainwave activity, reducing anxiety and promoting relaxation. Finally, skin conductance (SCL/GSR) serves as a reliable biometric marker for objectively assessing resilience and energy recovery following stress exposure. These methodologies offer new perspectives for resilience research and development, providing scientifically validated interventions for enhancing adaptability and stress management.

1.4. Vibro-Acoustic Stimulation (VAS) and Vibro-Acoustic Therapy (VAT)

Vibro-acoustic therapy (VAT) utilizes low-frequency sound vibrations (30–120 Hz) combined with specifically selected musical melodies to influence the nervous system, alleviate symptoms of stress, anxiety, and chronic pain. Vibro-acoustic stimulation (VAS) is a similar approach but without the musical component. Theoretical models suggest that these interventions can enhance psychological resilience by modulating voluntary attention, providing the nervous system with energy, and supporting emotional regulation.

According to Blacket (2012), VAS fosters awareness, attention control, and physical relaxation, aiding in the reduction of anxiety and stress. Griffin (2012) discusses attention dissociation as a key mechanism in various psychotherapeutic techniques used for processing traumatic experiences. VAS produces a similar effect by employing rhythmic sensory stimulation, which temporarily disengages conscious fixation on external and internal stressors. Isaacs' (1993) theory posits that trance states facilitate adaptation and mitigate cognitive overload. VAS induces such effects through sensory isolation and predictable, safe rhythmic tactile stimulation for the user.

Kaplan (1995) explores the **Attention Restoration Theory (A.R.T.)**, emphasizing the role of involuntary attention in “recharging” cognitive executive resources. Similar to exposure to natural environments, VAS enables passive engagement of attention, thereby promoting the regeneration of voluntary self-control. Henscum (2017) conceptualizes chronic pain as a neurological phenomenon closely linked to anxiety and depression. VAS can lower nervous system arousal and support awareness and cognitive reorganization processes essential for managing chronic pain.

Both VAT and VAS influence the nervous system by inducing dissociation, withdrawing attention from stress stimuli, reducing sympathetic nervous system activity, and facilitating deep relaxation states. Through their physiological and cognitive effects, these interventions create conditions for restoring adaptive energy, enhancing self-regulation, and stabilizing emotional states. Consequently, they emerge as promising methods for fostering psychological resilience and facilitating recovery from stress-related experiences.

CHAPTER TWO
DESIGN OF THE EMPIRICAL STUDY

2.1. Research Design, Independent and Dependent Variables, and Control Procedures

The study employs a **quasi-experimental within-group intra-subject design** with a **crossover paradigm** between the two conditions. The **independent variable** is the change in vibration frequency, which has two levels: **vibro-acoustic stimulation with a slow frequency change** (referred to as VRP 1, from “vibro-relaxation procedure”) and **vibro-acoustic stimulation with a fixed vibration frequency** (VRP 2). The experimental factor under investigation is the **presence of frequency variation in the vibro-stimulation compared to its absence**.

The **dependent variables** include **percentage-based derivative parameters of changes in skin conductance**, which assess the recovery of sympathetic nervous system arousal after exposure to a stressor in a stress test, fluctuations in nervous system arousal during VRP sessions, the **K sust. att. coefficient** in the **Attention Stability Test**, chronic pain intensity on a **visual analog scale (VAS)**, and latent resilience factors measured via **self-assessment on a visual analog scale**.

Control Procedures for Experimental Conditions, External Confounding Variables, and Artifacts

The study design accounts for potential **confounding variables** that could influence the experimental outcomes:

- **The effect of the initial exposure to the experimental intervention**, ensuring that the first exposure does not disproportionately influence subsequent responses.
- **The cumulative effect of multiple exposures**, preventing residual effects from the first intervention from affecting the second.
- **The influence of ultradian rhythms**, which can affect physiological responses based on the body's natural biological cycles.

2.2. Object, Subject, and Research Questions of the Empirical Study

The **object of the study** is **vibro-acoustic stimulation (VAS) and its role in enhancing psychological resilience** in the participants.

The **subject of the study** focuses on **identifying resilience mechanisms and factors** that can be influenced by VAS.

Upon completion of the study, the research aims to answer the following questions:

- What criteria should be considered in designing **VAS programs** to positively impact psychological resilience?
- Does the **modulation of stimulation rhythm (frequency variation)** affect **attention stability, subjective perception of chronic emotional and physical distress, reduction of excessive nervous system arousal after stressor exposure, latent resilience factors, voluntary directed attention, and executive functions**?

2.3. Research Objectives, Tasks, and Hypotheses

The **primary objective** of this dissertation is to develop an **apparatus-based methodology for VAS** and investigate its potential effects on **resilience and voluntary attention concentration**.

To achieve this goal, the study involves the following tasks:

- **Reviewing theoretical frameworks and defining key concepts**.
- **Formulating research problems and questions**.
- **Identifying empirical physiological indicators of resilience**.
- **Developing a conceptual model of the studied phenomenon** and identifying resilience-related factors that can be influenced through VAS.
- **Constructing and pilot-testing a VAS device**.
- **Defining independent and dependent variables**.
- **Selecting an appropriate research design**.
- **Choosing study participants**.
- **Selecting appropriate methods and instruments**.
- **Analyzing and interpreting results in relation to the proposed hypotheses**.

Research Hypotheses

Hypothesis 1

It is assumed that the **K sust. att. coefficient in the Attention Stability Test** will be higher **after both VRP 1 and VRP 2 procedures** compared to the baseline scores before the VAS procedures. Additionally, it is expected that the score **after VRP 1 will be higher than after VRP 2**.

Hypothesis 2

It is assumed that **the pain intensity score on the visual analog scale (VAS)** will be lower **(indicating greater pain relief effect)** immediately **after VRP 1 compared to VRP 2**.

Hypothesis 3

It is hypothesized that the **average level of nervous system arousal following exposure to an auditory stressor in the stress test** will be **lower after VRP 1 than after VRP 2**. Nervous system arousal will be quantified using **the average skin conductance level (SCL) in relative percentage**.

Hypothesis 4

It is expected that **nervous system arousal will reach a lower minimum level during VRP 1 procedures** compared to VRP 2. Arousal will be quantified using **the minimum skin conductance level (Minimum SCL relative value in %)**, which serves as an indicator of the lowest nervous system activation level during measurement.

Hypothesis 5

It is assumed that the **cumulative score on the visual analog scale for latent resilience factors** will be **higher after VRP 1 than after VRP 2**.

The experimental schedule, including measurements and testing procedures, is presented in **Table 5** below.

Table 5 – Schedule of Measurements and Tests During the Course of the Experiment

Measurements and Tests Before the Start of the Experimental VRP Procedures	**Measurements and Tests After the Second Experimental VRP Procedure, Conducted Before the Start of the Fourth Procedure (Data is Not Recorded During the First Procedure, as It Is Considered as introductory)**	**Measurements and Tests After the Fourth Experimental VRP Procedure, Conducted Before the Start of the Sixth Procedure, Which Is Not Included in the Experimental Conditions (Data is Not Recorded During the First Procedure)**
Attention Stability Test with Measured Parameter **K att. stab**. (Attention Stability)	Attention Stability Test with Measured Parameter **K att. stab.** (Attention Stability)	Attention Stability Test with Measured Parameter **K att. stab**. (Attention Stability)
Psycho-Physiological Stress Test with Measured Parameter: **Average SCL Relative Value in %.**	Psycho-Physiological Stress Test with Measured Parameter: **Average SCL Relative Value in %.**	Psycho-Physiological Stress Test with Measured Parameter: **Average SCL Relative Value in %.**
Visual Analog Scale for Self-Assessment of **Latent Resilience Factors**	Visual Analog Scale for Self-Assessment of **Latent Resilience Factors**	Visual Analog Scale for Self-Assessment of **Latent Resilience Factors**
Visual Analog Scale for Self-Assessment of **Chronic Pain Intensity**	Visual Analog Scale for Self-Assessment of **Chronic Pain Intensity**	Visual Analog Scale for Self-Assessment of **Chronic Pain Intensity**

Note: At the end of each VRP procedure, the minimum SCL value (Minimum SCL relative value in %) and the self-assessment score of chronic pain intensity using a visual analogue scale are measured.

2.4. Research Methodologies

2.4.1. Apparatus-Based Method for Vibro-Acoustic Stimulation (VAS)

The vibrational stimuli in the study are generated by transducers embedded in a **lounge-type reclining chair**, controlled through a **central control unit**. The **vibro-acoustic stimulation (VAS)** is administered using two procedures:

- **VRP 1**: Vibro-acoustic stimulation with a frequency range of **45–35 Hz**,
- **VRP 2**: Vibro-acoustic stimulation with a fixed frequency of **40 Hz**,
- **Session duration**: **23 minutes** per procedure.

2.4.2. Apparatus-Based Method for Measuring Nervous System Arousal via Skin Conductance

The **electrical parameters** associated with changes in sympathetic nervous system arousal are recorded using the **Mind-Reflection GSR** device and its accompanying software **VERIM Lab**.

The following **skin conductance level (SCL) parameters** are measured during each session:

- **Average SCL relative value (%)**: Represents the percentage-based change in skin conductance throughout the entire measurement session, relative to the initial baseline at the start of recording.
- **Minimum SCL relative value (%)**: Indicates the lowest recorded skin conductance during the measurement period, relative to the initial baseline. Negative values represent the **lowest point of sympathetic nervous system arousal and energy consumption**. This serves as a **quantitative indicator of autonomic nervous system relaxation** and energy conservation.

2.4.3. Visual Analog Scale (VAS) for Self-Assessment of Chronic Pain Intensity

The **visual analog scale (VAS)** is a **psychometric tool** designed to assess subjective experiences that cannot be directly measured. It is widely used in **clinical practice and psychological research** due to its **simplicity, sensitivity, and adaptability**.

The VAS is particularly effective in **capturing small changes** in perceived pain intensity **without influencing responses through predefined options**. For this reason, **multiple VAS-based questionnaires** were used in the present study.

For questionnaire generation, the study utilized the **VAS-RRP Generator**, an **online tool** available at http://www.vasrrp.net/vasrrp/default.htm. The **minimum score** on the **pain self-assessment scale** is **0**, and the **maximum score** is **1**, with **precision recorded up to four decimal places** (e.g., **0.5432**).

2.4.4. Visual Analog Scale for Self-Assessment of Latent Resilience Factors

A **large-scale study** by **Maltby & Hall (2022)** identified **four core resilience factors** common across **61 resilience assessment instruments** developed over the past **30 years**. According to their findings, **any comprehensive resilience assessment** should include these four categories, as they provide a **robust and reliable evaluation** of psychological resilience.

These four factors are:

1. **Emotional recovery** (following stress exposure).
2. **Social cohesion** (quality of social interactions and support).
3. **Cognitive resilience** (stability of cognitive functioning).
4. **Adaptability** (flexibility in response to novel situations).

Participants assess their status on these factors using **visual analog scales**, with questions designed to gauge their **position between two polar opposite states**. The **minimum total resilience score** is **0**, while the **maximum score** is **6**.

2.4.5. Computerized Test for Assessing Attention Stability – SART2 (Sustained Attention to Response Task)

Attention stability is considered a **key empirical indicator** of **executive functioning and psychological resilience**. Effective executive function utilization, defined as **sustainability**, is one of the **four core latent resilience factors** in **Maltby & Hall’s classification (2022)**.

To evaluate **sustained attention**, the study employs the **computerized SART2 test**, which is freely available via the **PsyToolkit platform**:

- **Access link**: https://www.psytoolkit.org/experiment-library/sart2.html
- **Developed by**: **Stoet (2010, 2017)**

The **SART2 test** assesses **executive function, impulse control, and sustained attention**, making it a **valuable tool for evaluating the cognitive resilience of participants**.

2.4.6. Computerized SART Test for Assessing Attention Stability

The **SART (Sustained Attention to Response Task)** test requires participants to execute a **motor response** (pressing the spacebar) when presented with frequently occurring stimuli (digits **1 to 9, except for 3**) and to **withhold their response** when the **rare stimulus** (digit **3**) appears on the screen.

The **Attention Stability Coefficient (K. att. stab.)** is calculated using the following formula:

$$K.att.stab. = (N - E)t$$

where:

- **N** = total number of trials in the test (**always 225**),
- **E** = total number of errors (both commission and omission errors),
- **t** = total task duration in seconds.

Higher values of **K. att. stab.** indicate **better performance and greater attention stability**, whereas lower values suggest **weaker sustained attention and poorer performance**. The study does not compare participants' results with normative data but instead examines **intra-individual changes** at three time points: **baseline measurement before experimental procedures, after VRP1 procedures, and after VRP2 procedures**.

2.5. Research Procedure

All **30 participants** took part in **six experimental sessions**, each including **a 23-minute vibro-acoustic stimulation (VAS) procedure**, delivered by the **same device, in the same room, and administered by the same experimenter**.

- During the **first (1st) and final (6th) sessions**, **physiological data were not recorded**.
- The **first session did not include any cognitive or self-report assessments**.
- During the **sixth session**, VAS procedures were performed **without recording physiological effects**, but **cognitive and self-assessment tests were administered before the procedure**.

Before the **fourth (4th) and sixth (6th) VAS procedures**, the following assessment methods were applied:

- **Stress test with skin conductance level (SCL) measurements**,
- **SART test for sustained attention stability**,
- **Visual Analog Scale (VAS) for self-assessment of chronic pain intensity**,
- **Visual Analog Scale (VAS) for self-assessment of latent resilience factors**.

2.6. Participants

The study involved **30 participants** (**13 males and 17 females**), all **adult residents of Sofia, Bulgaria**, aged **between 24 and 56 years** (**mean age: approximately 38 years**).

All participants had been **diagnosed with fibromyalgia** by a **rheumatologist** and had lived with the condition for at least **two years**. None of the participants had **prior experience with VAS devices** or had **previously used VAS for managing their condition**.

Recruitment was conducted through:

- **A specialized fibromyalgia patient group on Facebook**,
- **Direct referrals from rheumatologists diagnosing and treating fibromyalgia patients**.

Participants **reported chronic pain, sleep disturbances, difficulties with sustained attention, and mood fluctuations** as part of their condition.

Inclusion Criteria:

- **Confirmed fibromyalgia diagnosis** by a rheumatologist for at least **two years**.

Exclusion Criteria:

- **Comorbid medical conditions**,
- **Pregnancy**,
- **Recent surgical procedures with unhealed wounds**,
- **Recent vaccination within the past month**.

CHAPTER THREE
ANALYSIS OF THE RESULTS FROM THE EMPIRICAL STUDY

3.2.2. Analysis of Results in the Context of the Hypotheses

The study tested **five hypotheses**, which were subjected to **statistical analysis**. The following statistical methods were used: **descriptive statistics** (mean and standard deviation), **paired t-tests**, **ANOVA variance analysis**, and **regression analysis**.

Hypothesis 1

It was hypothesized that **the sustained attention coefficient (K. att. stab.) would be higher after the two VRP1 procedures compared to the two VRP2 procedures**. The results of the **paired t-test** for the variable “**sustained attention coefficient” (K. att. stab.)** after VRP1 and VRP2 procedures indicate a **statistically significant difference**, confirming that **K. att. stab.** was **significantly higher after VRP1 compared to VRP2**. The **t-value was positive and greater than 3 (t = 30.505, p < 0.01)**.

Group-level statistical comparisons further confirmed this effect:

- **Mean K. att. stab. after VRP1 = 0.5323**
- **Mean K. att. stab. after VRP2 = 0.4673**

The statistical analysis **supports Hypothesis 1**, confirming that **VRP1 procedures improve sustained attention more effectively than VRP2 procedures**. These results suggest that the **more dissociative nature of the vibro-stimulation in VRP1** plays a key role in **restoring volitional attention and executive functions**. VRP1 provides conditions that allow participants to **temporarily disengage from the sensory perception of chronic pain and its associated cognitive and affective components**.

Hypothesis 2

It was hypothesized that **the Visual Analog Scale (VAS) score for perceived pain intensity would be higher (indicating lower pain perception and a greater analgesic effect) immediately after VRP1 compared to VRP2**.

The **paired t-test** for the variable "**VAS score for self-assessment of chronic pain intensity"** after VRP1 and VRP2 confirmed **a statistically significant difference**. The **t-value was positive and greater than 3 (t = 11.016, p < 0.01**), supporting the hypothesis that **pain perception was significantly lower after VRP1**.

This outcome can be interpreted within the framework of the **neuromatrix theory of descending pain modulation**, which suggests an interaction between **negative emotional states and chronic pain perception**. The **dissociative nature of VRP1 procedures** allows **not only a redirection of sensory attention but also disengagement from the affective and cognitive components of chronic pain**.

Hypothesis 3

It was hypothesized that **the average level of nervous system arousal following exposure to an auditory stressor in the stress test would be lower after VRP1 procedures compared to VRP2 procedures**.

The **paired t-test** for the variable "**Average SCL relative value after stressor (%)"** after VRP1 and VRP2 procedures **did not reveal a statistically significant difference**. The **t-value was negative (t = -1.243, p > 0.05**), indicating that the **hypothesis was not supported**.

This suggests that **VRP1 did not significantly reduce nervous system arousal following stressor exposure compared to VRP2**. Potential explanations for this outcome include:

1. **The short duration of the intervention** – The **experimental period may have been insufficient** for observable physiological changes in stress-response mechanisms.
2. **The passive nature of VAS** – Unlike **active training interventions such as biofeedback**, **VAS does not involve active retraining of stress-response habits**.
3. **Stability of stress-response patterns** – Research suggests that **skin conductance responses (SCL) to stress tend to change slowly**, typically over a period of **at least two months** of combined therapy and **daily self-practice** in stress-response regulation (**Khazan, 2013**).

Given that **VAS is a passive relaxation method**, it may not be sufficient to alter ingrained stress-response habits.

Hypothesis 4

It was hypothesized that **nervous system arousal would reach a lower level during VRP1 procedures compared to VRP2 procedures**. Nervous system arousal was quantified by measuring the **minimum skin conductance level (SCL) relative value in %**, which serves as an indicator of the lowest level of nervous system arousal during the procedure.

The **hypothesis was confirmed**. Results from the **paired t-test** for the variable “**minimum achieved nervous system arousal during the vibrostimulation procedure (MIN SCL during procedure)”** after VRP1 and VRP2 procedures revealed a **statistically significant difference**. The **t-value was negative and greater than 3 ($t = -6.959$, $p < 0.01$)**, indicating that the **minimum arousal level achieved during VRP1 was significantly lower than during VRP2**.

Group-level statistical comparisons further confirmed that **VRP1 led to a greater reduction in sympathetic nervous system activation** compared to VRP2. According to theoretical frameworks, a **temporary reduction in sympathetic activity serves as an indicator of a return to normal cognitive, affective, and physiological functioning** after exposure to stressors. The **deactivation of the sympathetic nervous system via attentional dissociation from stressors** creates conditions that facilitate **subsequent resilience-enhancing effects**, including **energy restoration, improved attentional concentration, and enhanced emotional tone** in participants.

Hypothesis 5

It was hypothesized that **the total score on the Visual Analog Scale (VAS) for self-assessment of latent resilience factors would be higher after VRP1 procedures compared to VRP2 procedures**.

The **hypothesis was confirmed**. Results from the **paired t-test** for the variable “**self-assessment of resilience factors (Resilience Self-Assessment)”** after VRP1 and VRP2 procedures indicated a **statistically significant difference**. The **t-value was positive and greater than 3 ($t = 5.479$, $p < 0.01$**), demonstrating that **the resilience self-assessment score was significantly higher after VRP1 than after VRP2**.

Statistical analysis supports the conclusion that **the key differentiating factor between VRP1 and VRP2 procedures was the controlled variation in vibro-stimulation frequency**. The **controlled frequency variation in VRP1 resulted in a measurable improvement in self-assessment of resilience factors**, as recorded by the VAS.

Possible mechanisms explaining this improvement include:

- **Attentional dissociation**, which allows temporary disengagement from stressors.
- **Restoration of volitional attention**, leading to improved executive function.
- **Replenishment of cognitive energy**, facilitating greater mental clarity.
- **Enhancement of emotional tone**, contributing to an overall sense of well-being.

These findings suggest that **VRP1, characterized by controlled frequency variation, is more effective in strengthening resilience-related factors than VRP2**. The results highlight **the importance of frequency modulation in vibro-acoustic stimulation as a key parameter for optimizing resilience-enhancing interventions**.

Discussion

The central assumption underlying the hypotheses was that the independent variable—the vibro-stimulation characteristics of VRP1—would have a more pronounced effect on the dependent variables than the vibro-stimulation characteristics of VRP2, leading to greater improvements in resilience factors among the study participants. This assumption was based on the hypothesis that VRP1 would exert its effects more effectively due to **controlled frequency modulation**, unlike VRP2, where the stimulation frequency remained constant throughout the procedure.

According to theoretical models, the key **mechanisms** through which vibro-acoustic stimulation (VAS) enhances psychological resilience include:

- **Dissociation** – a temporary and complete shift of attention away from stress-inducing internal and external stimuli toward vibro-stimuli.
- **Restoration of attentional control** – enabling individuals to regain volitional control over their focus.
- **Recovery and enhancement of executive functions and self-regulation** – improving cognitive flexibility and inhibitory control.
- **Energy conservation and replenishment** – reducing energy consumption, thereby optimizing adaptive responses.
- **Facilitation of positive emotional states** – creating neurophysiological conditions that support emotional stabilization.
- **Temporary suppression of stress-response neurophysiological effects** – mitigating the impact of stress reactions during VAS sessions.

A substantial body of research confirms the effectiveness of **sensory stimulation involving frequency modulation** and other stimulus alterations in influencing cognitive functions and attention. These studies primarily focus on **auditory, visual, or electrical stimuli**.

The Role of Sensory Overload and Dissociation in VAS

According to **Siever (2000)**, achieving a dissociative state and **nervous system stabilization** through rhythmic sensory stimulation requires several sequential conditions:

1. **Sensory overload** and full attentional engagement with the stimulation.
2. **Induction of a stimulus-driven confusion state**, leading to a gradual disengagement from habitual focal points of concentration and bodily awareness.
3. **Complete silencing of internal cognitive processes**, including thoughts, emotions, and stress-response habits.
4. **Formation of conscious and subconscious associations** with the induced psychophysiological state.
5. **Experience of a neurophysiological reset**, promoting mental and physical homeostasis.

To achieve **sensory overload and dissociation**, Siever initially employed **fixed and unchanging** stimulus parameters but evolved toward using **controlled stimulus variation** over his **35 years of experience** in neuromodulation.

Comparison to Physiotherapy and Electrotherapy Approaches

The findings of **Takeva (2022)** in **physiotherapy and electrotherapy for pain management** suggest that **continuous exposure to fixed stimuli leads to habituation**, reducing therapeutic effectiveness. To counteract this, **modulation techniques** are applied, including **frequency shifts, amplitude variations, and waveform alterations**. This principle helps explain:

1. **Why both VRP1 and VRP2 procedures effectively reduced pain**.
2. **Why VRP1 had a superior pain-relieving effect compared to VRP2**.

Given the **short duration of the experiment**, a key question remains **unanswered**:

- Can **long-term application of VAS** lead to **sustained behavioral changes in stress response and resilience-building habits**?
- Would **a longitudinal study** confirm the effects proposed in **Hypothesis 3**, which was not supported in this experiment?

Controlled Frequency Modulation as a Key Parameter in VAS

The **only difference** between VRP1 and VRP2 was the presence of **controlled frequency modulation** in VRP1. This variation led to **greater sympathetic deactivation**, as measured by the **Minimum SCL relative value in %**. This deactivation suggests that **controlled frequency shifts induce attentional dissociation**, which in turn enhances **energy restoration, attentional stability, and emotional regulation**—all critical components of psychological resilience.

VAS and Resilience: A Novel Research Area

Currently, **no published studies specifically designed to measure the effects of VAS and vibro-acoustic therapy (VAT) on psychological resilience exist**. Thus, direct comparisons of **Hypothesis 5 findings** with prior research are **not possible**.

However, **numerous studies confirm the benefits of VAT for**:

- **Anxiety and depressive disorders**
- **Stress-related sleep disturbances**
- **Chronic pain syndromes**
- **Children with autism spectrum disorders (ASD)**

While ASD populations **cannot be directly compared to adults with stress-related disorders**, VAT’s impact on **reducing resistance to social interactions and promoting emotional engagement** suggests a potential **indirect link to resilience-building mechanisms**.

Implications for Resilience-Building

VAT does **not inherently develop psychological skills** such as **emotional stability, adaptability, or social engagement**. Instead, it **modulates neurophysiological states**, thereby **creating optimal conditions** for individuals to engage **more effectively in adaptive behaviors**.

The present study’s findings indicate that **VAS, particularly when frequency modulation is employed, has the potential to support resilience through attentional dissociation, cognitive restoration, and emotional stabilization**. Future research should explore **long-term effects** and compare VAS to other **sensory-based interventions** aimed at resilience enhancement.

Conclusions and Summary

Based on the verification of the hypotheses, the following conclusions can be drawn regarding the formulated research questions:

1. A **controlled and specifically modulated frequency change** in vibro-stimulation leads to a significant **positive effect on attentional endurance**, serving as an indirect empirical indicator of resilience.
2. A **controlled and specifically modulated frequency change** in vibro-stimulation leads to a significant **positive effect on participants' perceptions of chronic emotional, mental, and physical distress**.
3. A **controlled and specifically modulated frequency change** in vibro-stimulation significantly **reduces nervous system arousal**, serving as an indicator of the restoration of normal psychophysiological functioning after exposure to stressors.
4. **No significant difference** was observed between the two levels of the independent variable in terms of their effect on participants' stress response and recovery patterns over the **short duration of the study**.
5. A **controlled and specifically modulated frequency change** in vibro-stimulation leads to a significant **positive effect on social cohesion, adaptability, emotional recovery, and behavioral resilience**, which are considered latent factors of psychological resilience.

Limitations and Shortcomings of the Study

Despite its findings, this study has certain limitations, including:

- The **inability to generalize** the findings on the positive effects of frequency-modulated vibro-stimulation **to healthy individuals** without chronic pain.
- A **small sample size**, which limits the statistical power of the results.

- A **relatively short duration**, preventing the assessment of long-term effects.
- **No follow-up** to assess changes in dependent variables over a longer period **after** the experimental interventions.
- The use of **only one** psychophysiological parameter (**skin conductance**) as an empirical indicator, instead of two or three, which could have provided **higher reliability**.
- The **inability to use EEG analysis**, which is the most precise **psychophysiological method** for detecting changes in attention and participant states.

Recommendations for Future Research

Based on the findings and limitations of the present study, future research should aim to:

- **Include healthy participants** to compare the effects of vibro-acoustic stimulation (VAS) across different populations.
- **Establish a control and an experimental group** for more rigorous experimental validation.
- **Conduct a longitudinal study** to explore **long-term effects** on resilience and stress response.
- **Integrate EEG parameters** as part of the dependent variables to **more precisely** track neurophysiological changes.
- **Refine criteria for modulation parameters** of vibro-stimulation, such as:
  - The **optimal speed of frequency change** over time.
  - Determining **whether specific modulations induce relaxation or activation** in the nervous system.

Significance of the Study for Future Research

This research represents an **initial step** in establishing the **positive effects of vibro-stimulation on psychological resilience**. It applies a **combined methodology** integrating **psychometric and biometric** tools for evaluating experimental impacts, thus **validating** the beneficial influence of **frequency modulation in vibro-stimulation** on resilience factors.

By building upon the findings of this study, future researchers can **save time** and **focus their efforts** on identifying **more precise modulation criteria** to **achieve specific effects** in altering participant states.

Such research has the potential to **transition vibro-acoustic therapy (VAT) and vibro-acoustic stimulation (VAS) from experimental meth-**

odologies into established fields within **medicine, rehabilitation, and psychology**, contributing to their broader application in **clinical and therapeutic** settings.

Contributions of the Study

Theoretical Contributions

This research contributes to the **field of resilience studies** primarily through its **multidisciplinary approach**, which emphasizes the **neurophysiological foundations** of psychological resilience and the **potential of technological interventions** to enhance it. The study provides **new insights** into the relationships between **resilience, self-control, attentional endurance, and energy balance**, revealing **new opportunities** for future researchers to expand theoretical explorations, develop **new intervention methodologies**, and refine **applied technological approaches** for resilience support.

A **novel contribution** of this work is its **focus on studying psychological resilience through the lens of energy consumption and energy recovery** in response to stress. This **innovative approach** opens up **potential applications** for researchers to further investigate resilience and develop **more precise assessment and intervention methods**.

Methodological Contributions

In **methodological terms**, this study contributes through **the use of device-assisted methodologies** both for the **assessment and support of resilience**. The resilience of participants was assessed through a **combined methodology**, integrating:

- **Device-based measurements of physiological parameters**
- **Psychometric assessments** of **attentional endurance** and **latent factors of resilience**.

The **quantitative measurement of energy consumption and recovery** during **stress testing** and **vibro-stimulation** using **objective biometric indicators (biosignals recorded from the body) addresses existing challenges** in resilience assessment methodologies, such as:

- **Conscious or unconscious response distortions** in self-reported psychological tests.
- **Lack of direct measurement of recovery time** after stress exposure.
- **Loss of information on individual differences** in stress response and energy restoration.

The **use of visual analog scales (VAS)** for **chronic pain assessment** and **latent resilience factor evaluation** enables **precise detection of small changes** in participants' states over **short time intervals**, which is **challeng-**

ing to achieve with conventional resilience assessment scales. In this context, the **combined methodology** used in this study offers practical **advantages for evaluating interventions** that produce **subtle effects over short durations**.

A **key methodological achievement** of this research is the **validation of vibro-acoustic stimulation (VAS) as a resilience-supporting method**. The confirmation of **four out of five hypotheses** provides **empirical evidence** for **VAS mechanisms of action on psychological resilience** and advances theoretical and applied research in this field.

Practical Contributions

The **practical contributions** of this study lie in its strong focus on the **potential applications of its findings**. The research **developed and validated two device-assisted methodologies** for **assessing and supporting resilience**, which have **broad practical applications** across various professional domains.

Given the **growing demand for psychological resilience interventions** in high-stress work environments, **VAS technology** has **potential applications** in:

- **Schools and universities** (for students and staff resilience training)
- **Hospitals and healthcare settings** (for patient stress reduction and recovery)
- **Industrial and corporate organizations** (for employee resilience and stress management)
- **Law enforcement (MVR, military, and aviation personnel)** (for stress recovery and operational resilience)
- **Centers for children with special educational needs (SEN)**
- **Rehabilitation and social support centers for adults**
- **Balneotherapy and wellness centers**
- **Private users in home settings**

A **major practical benefit** of VAS equipment is its **ease of use**, requiring only **minimal training** and allowing **non-specialists** to operate it effectively **without the direct involvement of a psychologist**.

Current Implementation in Bulgaria

Notably, **several reference institutions in Bulgaria** have already adopted **VAS and VAT equipment**, including:

- **A hospital**
- **State and municipal centers for children with autism spectrum disorders (ASD) and special educational needs (SEN)**
- **The Bulgarian Air Traffic Control (РВД)**

In these organizations, **VAS/VAT equipment is integrated into sensory and stress-reduction rooms** operated by **in-house psychologists**.

Furthermore, the **combined device-based and psychometric assessment methodology** developed in this study can be **widely adopted** by professionals in the field of **mental health**, including:

- **School and organizational psychologists**
- **Clinical psychologists**
- **Psychotherapists**
- **Psychiatrists**

This study **establishes the foundation** for the **scientific validation** of **VAS as an effective resilience intervention**, bridging **experimental psychology, neurophysiology, and applied mental health practices**. Its **multidisciplinary methodology** and **practical focus** create **opportunities for large-scale implementation**, with potential benefits for **individuals, organizations, and healthcare institutions** worldwide.

CONCLUSION

The results of this study clearly demonstrate that, compared to vibration procedures **VRP2**, procedures **VRP1** exert a **more significant positive impact** on **attentional endurance, perception of chronic pain, depth of psycho-physiological relaxation during procedures, and latent resilience factors** among the participants, including **social cohesion, emotional recovery after stressors, and adaptability to new situations**.

Vibro-acoustic stimulation (VAS) supports psychological resilience by:

- **Restoring self-control, executive functions, and attentional endurance.**
- **Balancing energy consumption and recovery** in the autonomic nervous system.
- **Reducing stress responses** and temporarily distancing participants’ attention from sensory, affective, and cognitive aspects of chronic pain.

The **mechanisms** by which VAS exerts its positive effects on resilience include:

- **Rhythmic sensory entrainment** of brain activity (**gradual synchronization of EEG rhythms** with the vibration frequency).
- **Normalization of psycho-physiological arousal.**
- **Temporary dissociation** of attention from sensory sensations and internal dialogue.
- **Restoration of homeostasis in the body.**
- **Blocking or partially inhibiting the transmission of pain signals** to the central nervous system.
- **Induction of deep psycho-physiological relaxation.**
- **Creating a neurophysiological foundation for experiencing positive emotional states.**

The study's findings indicate that the **effectiveness of VAS mechanisms improves significantly when modulation of vibration frequency is introduced** (i.e., when the frequency is adjusted in a controlled manner over time).

Future Directions

Further research should focus on **identifying precise criteria for modulating VAS parameters** to achieve **specific and targeted psycho-physiological effects**. Additionally, **EEG analysis** should be incorporated to objectively register these effects.

A **longitudinal study** would be necessary to determine whether **VAS induces lasting changes** in stress response patterns, which were not significantly altered in the present study.

Practical Applications

The developed **assessment and intervention methodologies** have **practical value** and can be applied by:

- **Psychologists**
- **Psychotherapists**
- **Psychiatrists**
- **Social workers**
- **Other professionals providing psychological support for individuals under stress**

The **ease of use of VAS equipment**, requiring **minimal training**, suggests that it could **enhance the effectiveness of current approaches to resilience support**.

The study's conclusions may contribute to:

- **The design of VAS equipment and programs.**
- **The development of new methodologies for assessing and enhancing psychological resilience.**
- **The integration of VAS technology with psychometric, psychological, and psychotherapeutic tools for optimal results.**

This research lays the groundwork for **further validation and refinement** of **VAS applications** in **mental health, rehabilitation, and stress management**.

LIST OF PUBLICATIONS RELATED TO THE DISSERTATION TOPIC

1. **Shterev, R.** (2024). *Psychological Resilience and the Profile of Energy Consumption and Energy Recovery of the Individual.* BSU – Yearbook, Volume XLIX, 2024, ISSN: 1311-221X.
2. **Shterev, R.** (2024). *Mental Resilience, Brain Mediator Systems, and Brain Structures Related to Stress Regulation.* Proceedings from the Doctoral School and the 7th Doctoral Scientific Session of the Faculty of Philosophy at South-West University “Neofit Rilski,” 14.12.–15.12.2023, ISSN 2738-8328.
3. **Shterev, R. & Yanakiev, Y.** (2022). *Development of Psychological Resilience through Vibro-Acoustic Stimulation (VAS): Prognostic and Therapeutic Values.* E-Journal *Education and Development*, ISSN 2603-3577, Issue 10.
4. **Yanakiev, Y. & Shterev, R.** (2016). *Bio and Neurofeedback Methods for the Personal Development of People with Disabilities by Promoting Their Creative Potential. Pedagogy Educational Journal*, No. 8. Sofia: Az Buki National Publishing House for Education and Science, pp. 1070–1091 (in Bulgarian with an English abstract).