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The Applications of the Mindfulness-Based Cognitive Therapy and HRV Biofeedback in Modern Psychotherapy

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Abstract

This study evaluated the effectiveness of heart rate variability biofeedback (HRVB) and mindfulness-based cognitive therapy (MBCT) in diagnosing and treating stress and anxiety. HRVB provides real-time data on the autonomic nervous system (ANS), highlighting the balance between its sympathetic and parasympathetic functions, while MBCT, combined with breathing exercises, targets the parasympathetic system, promoting positive thought reconstruction. A 22-year-old male with extreme anxiety and palpitations underwent a 12-week psychotherapeutic program involving HRVB and MBCT techniques. He practiced daily personalized breathing and mindfulness exercises, integrating them into daily activities. The results showed a shift from a stressed sympathetic ANS state to a relaxed parasympathetic one. He also demonstrated the ability to control his heart rate and improve thought patterns, leading to better emotional balance. This study highlights the combined potential of HRVB and MBCT in enhancing stress resilience, vitality, and autonomic balance, highlighting HRVB's pivotal role in tracking patient progress in clinical settings.

Keywords: heart rate variability (HRV); autonomic; biofeedback; mindfulness

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Introduction

Heart rate variability biofeedback (HRVB) is a scientifically proven, noninvasive method and computer-based diagnostic program which monitors the autonomic nervous system (ANS) throughout the mind–body interaction, especially the balance between sympathetic (LF) and parasympathetic (HF) activity of the nervous system (Fournie et al., 2021; Khazan, 2013). Heart rate variability (HRV) is the variation of beat-to-beat intervals (bpm), also known as R-R intervals which evaluate a distance (ms) between each experienced heart rate (HR) beat (bpm), analyzing our overall psychophysiological conditions, vitality, cardiovascular health, and stress resistance (Malik et al., 1996). HRV is the natural rise and fall of HR in response to our breathing patterns, thoughts, emotions, the activity of concentration, conscious and subconscious fears, blood pressure, and hormones. Since a healthy HR should increase and decrease as we inhale and exhale, HRV reflects the general wellness of the organism, stress, autonomic balance, vitality, and homeostasis (Henriques et al., 2011). HRV measurements have become validated psychophysiological predictors of specific outcome situations in ecologically valid research and test paradigms with a parallel connection to the psychophysiological changes occurring in the participant. SDNN, the standard deviation of each normal R-R intervals of all cardiac cycles (IBIs), is the most important index for the HRV itself (Tabachnick, 2015). Monitoring SDNN and RMS-SD biomarkers in clinical settings can reveal participant's general cardiovascular health, stress resistance, psychophysiological resiliency to the environment, immunity, biorhythm regulation, and overall homeostasis (Fournié et al., 2021; Gevirtz & Lehrer, 2003). SDNN, together with RMS-SD, can be maintained or increased by awareness of proper breathing practices or techniques, especially with the concentration on an extended exhale phase and

activation of the heart rate deceleration (HRD) in response to various environmental stimuli during test or performance (Carlstedt, 2018). The most ideal or desired HRV combination in any clinical test or performance (compared to the baseline or pretest and posttest measurements) requires lowered HR (HRD), increased SDNN, and RMS-SD with the activation of the high frequency (HF). The HF predominance reflects sudden changes in prolonged R-R interval, which activates the parasympathetic activation of the ANS with vagal nerve stimulation (Malik et al., 1996). The LF/HF ratio is also an important index that calculates the overall balance between the sympathetic and parasympathetic nervous system, especially in individualized HRV profiles to see the effectiveness of the breathing-relaxation-based paradigms and treatment modalities (Lehrer et al., 2000). Among the many factors that impact HRV, the most crucial are cognitive functions and respiration connected to the conscious or unconscious activities of the mind, including stress, anxiety, and breathing patterns. HRV measurements reveal many psychosomatic disorders and stress-related reactions in connection to heart–brain functions (Goldberg, 2022). Higher HRV reflects overall good psychophysiological health and vitality, adequate flexibility to stress, good aerobic fitness, functional homeostasis, and balance between the sympathetic and parasympathetic nervous systems (Fournié, 2021). On the other hand, lowered HRV may be associated with aging, decreased autonomic activity, lower hormonal tonus, depression, panic attacks, anxiety, and fatigue that have a negative impact on ANS, typically causing exhaustion of the parasympathetic tonus and the vagus nerve (Gevirtz, 2013).

Healthy and high resting HRV generates refined breathing patterns as self-regulatory strength to reduce negative emotions and enhance self-awareness and mindfulness about negative thoughts (Segerstrom & Nes, 2007). HRVB enables individuals to learn to regulate their breathing and relaxation techniques to create a base for daily routines initiating mindfulness meditations and self-healing exercises (Lehrer & Gevirtz, 2014). Several studies suggested that HRVB with mindfulness-based interventions may be an effective treatment for generalized anxiety disorder, posttraumatic stress disorder (PTSD), and other psychophysiological disorders (i.e., Kemp et al., 2012; Prinsloo et al., 2013; Wells et al., 2012; Zucker et al., 2009). During the HRVB trainings, the individuals learn to breathe at the optimal respiratory frequency, which needs to be set and later optimized during the training to maximize the increase of their HRV for the best stress resistance (Moore et al., 2011; Prinsloo et al., 2013). HRVB displays beat-to-beat changes in HR to teach the clients to maximize the HR increase during inhalation and decrease HR during exhalation. This process which is practiced daily by the clients is naturally imprinted into the ANS and regulated by the vagus nerve and the mechanism called respiratory sinus arrhythmia (RSA; Gevirtz, 2013). The therapeutic goal is to increase the HRV by increasing the HRV amplitude (the length in HRs between the highest point of the inhale and lowest point of the exhale) to strengthen the stress resistance, homeostasis, and baroreflex mechanism in patients (Gevirtz, 2000, 2007, 2011; Gevirtz & Lehrer, 2003; Giardino et al., 2000; La Rovere et al., 1998; Lehrer, 2007).

The research has shown that combining HRVB with mindfulness-related psychotherapies, including prolonged exposure therapy (PET), acceptance and commitment therapy (ACT), mindfulness-based interaction (MBI), or mindfulness-based stress reduction (MBSR), is necessary to improve the efficacy of the treatments for stress and anxiety-related disorders, including PTSD and panic attacks (Dalenberg, 2014; Edwards, 2011; Gevirtz, 2015; Kim et al., 2021). Combining ACT, known for components of mindfulness-based therapy, with HRVB showed high compatibility as a powerful tool for treating anxiety and stress-related disorders including trauma (Gevirtz, 2015, 2020). MBI and HRVB were successfully combined in studies by Azam et al. (2016) and Krygier et al. (2013) to improve the patients' regulation of the autonomic and central nervous systems through the stress reduction program. In another study, the efficacy of the combination of HRVB and MBI showed a decrease in cortisol levels in participants (Bouchard et al., 2012; O'Leary et al., 2015; Sanada et al., 2016). The positive intervention of an 8-week MBSR program with HRV measurements was presented in the treatment of people with schizophrenia as an effective nursing intervention to reduce stress responses and improve HRV and psychological well-being (Kim et al., 2021). In applying stress-reducing treatments, a 5-week mindfulness meditation (MM) intervention and HRVB showed effective results for 76 participants in terms of reduced stress, anxiety, and depressive symptoms and improved sleep quality (van der Zwan et al., 2015). Integrating a 12-week compassion focus psychotherapy (CFP) program improved resting HRV in participants by focusing on self-compassion, writing skills, and emotional awareness (Steffen et al. 2021).

Mindfulness-based cognitive therapy (MBCT) is a contemporary psychotherapy initially designed for

the treatment of depression, but it has also been applied to the treatment of generalized anxiety and stress-related disorders (Evans et al., 2008; Kenny & Williams, 2007; Teasdale et al., 2000; van Aalderen et al., 2012). MBCT teaches patients to pay close attention to their internal experience, including concentration on the breath in the present moment, thoughts-related evaluating processes, body sensations, feelings, and emotions (Evans et al., 2008). MBCT is intended to improve inner awareness and acceptance of intrusive thoughts and feelings (Teasdale et al., 2000). MBCT educates participants to detach from habitual and repetitive negative thinking patterns and worrying thoughts which might lead to depression (Teasdale et al., 2000). MBCT programs train participants to be in the present moment with empathy for all people equally in a nonjudgmental manner (Baer, 2003; Kabat-Zinn, 1990). Some studies explored the relationship between MBCT and HRV combination, suggesting that mindfulness exercises may enhance the effectiveness of self-regulatory processes, including breathing to increase self-awareness about thoughts (Peressutti et al., 2012), and control over the HR to enhance HRV (Delizonna et al., 2009; Ditto et al., 2006). Considering meditative practices as part of MBCT, Peressutti et al. (2010) showed evidence that positive HRV changes correlated with years of experience and breathing practices of the meditators, whereas Ditto et al. (2006) found that scan meditation (a skill used in MBCT) had a positive effect on RSA breathing by increasing vagal activity of the parasympathetic control of the ANS among meditative participants.

The purpose of this study was to examine the effect of the relationship between MBCT with breathing exercises and the HRV changes seen in the patient who suffered from high anxiety, HR palpitations, and panic attacks. A 12-week MBCT program tailored to the patient after his first (baseline) HRV measurements generated a new HRV imprint where an additional four HRV measurements were analyzed and compared. This case study shows how poor HRV with symptoms of chronic stress, fatigue, and high anxiety can be modified within a few weeks and eventually completely changed by doing the MBCT breathing exercises and mindfulness techniques without any psychiatric medication.

Methodology

Participant

The patient was a 22-year-old college student suffering from high anxiety, anger issues, chronic panic attacks, and HR palpitations. His triggers included a turbulent relationship with his father, part-time work environment pressure, low self-esteem, and low self-confidence. The patient was single and financially unstable. He was a light smoker.

All procedures performed in studies involving human participants were in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. Informed consent was obtained from the participant included in the study.

MBCT Intervention

The 12-week MBCT program was designed to integrate aspects of controlled breathing exercises and cognitive work. The patient came to the clinic once a week and learned a 20-min breathing exercise in which he alternated two different breathing patterns. The first breathing pattern (3x2x6x2) he performed for 2 min in which he inhaled by nose for 3 s, then held for 2 s, then exhaled by mouth for 6 s, and then held the breath for 2 s after the exhale. The second breathing pattern (3x3x3) he learned involved inhaling for 3 s through the nose, then exhaling through the nose for 3 s, and then holding the breath after the exhale for 3 s. The patient alternated these two breathing patterns every 2 min for an overall 10 min. For the last 10 min, he performed only the meditative pattern (3x3x3) in which he inhaled for 3 s through the nose, exhaled through the nose for 3 s, and then held his breath after the exhale for 3 s. The patient continued the 20-min breathing exercise at home every morning before he went to work for the 12-week treatment period. The 20-min breathing exercise and its impact on HRV are presented in Table 1.

Table 1
A 20-Min Breathing Exercise

Time (min)	Breathing Pattern	Duration (min)	Purpose for HRV
1–2	3x2x6x2	2	Increased HRV
3–4	3x3x3	2	Relaxed HRV
4–6	3x2x6x2	2	Increased HRV
6–8	3x3x3	2	Relaxed HRV
8–10	3x2x6x2	2	Increased HRV
10–20	3x3x3	10	Relaxed HRV

3x2x6x2 Breathing Pattern

The purpose of the 3x2x6x2 breathing pattern was to increase the HRV by stretching the HR pulses during the highest point of the inhale phase when the HR goes up and the lowest point of the exhale phase when the HR goes down. Holding the breath for 2 s after inhaling increases HR, whereas holding the breath after exhaling lowers the HR.

This breathing exercise looks in reality through the HRV using a Polar RS800 watch (Figure 1). The underlining segment is a 1-min 3x2x6x2 breathing pattern. With this breathing pattern, we are stretching our HRV; in other words, we are increasing our stress resistance by extending the bpm within the highest point of the inhale phase and the lowest point of the exhale phase. We can see that the average HR was 64 bpm, the highest HR was 85, and the lowest HR was 54 bpm. The difference made was 31 bpm. This HR elasticity of the nervous system generated an SDNN of 130.1 ms or the TP was 16.900 ms, from which 89% of this energy was utilized in the LF 15.002 Hz, indicating more sympathetic activation of the nervous system. Our cells have memory, which means that if we practice breathing 3x2x6x2 regularly on a daily basis, we are imprinting (generating) HR coherence into the nervous system as HRV plasticity into the neurocardiovascular system. In critical daily situations, if we activate this breathing, the cells recognize the purpose of this HRV imprint, and they will react immediately to reduce the stress.

3x3x3 Breathing Pattern

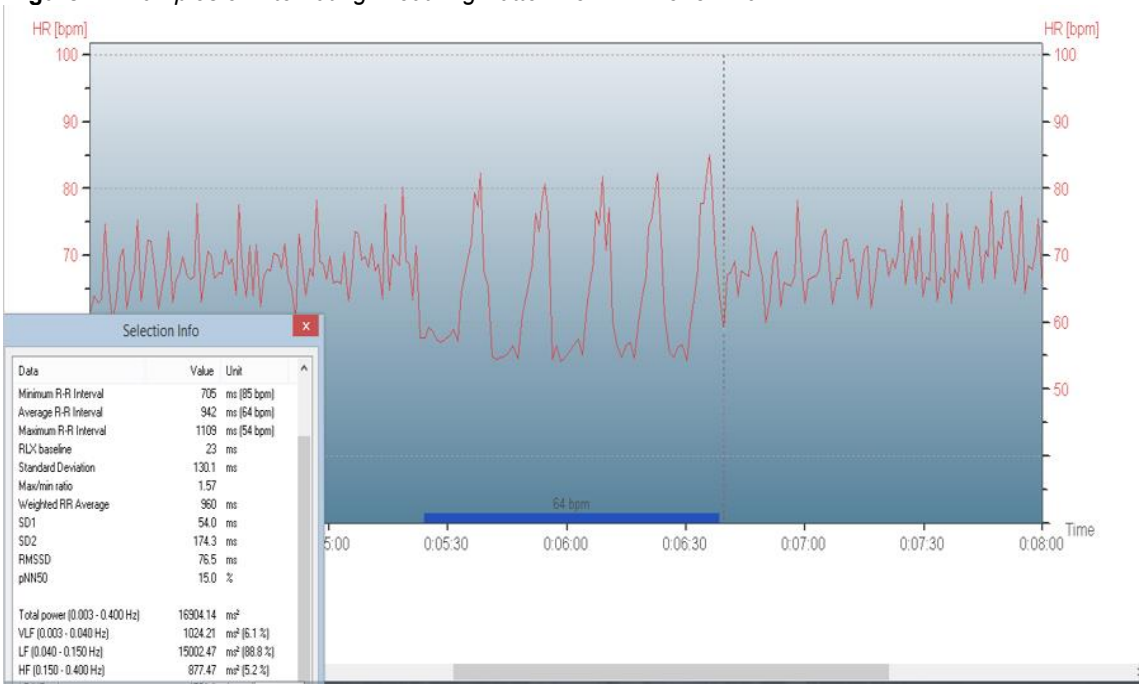
The 3x3x3 is a meditative pattern in which we concentrated on the coherence, stability, and endurance of the breathing in which the inhale and exhale phases are coherent and the same regarding the amplitude and frequency in the HRV graph.

HRV monitored by Polar RS800 watch shows the highlighted section of 3x3x3 breathing pattern (Figure 2). The purpose of this breathing pattern is to imprint into our cells and neurocardiovascular system the optimal HRV zone functioning in which we feel comfortably relaxed. In particular, the second part of this 1-min breathing pattern was very coherent. We can see that the highest point of the inhale was 79 bpm, the average was 69 bpm, and the lowest was 59 bpm, presenting lower variability and energy level as the SDNN was 54 ms. The TP was 2.319 ms, from which the HF indicating net parasympathetic stimulation was 67%. It is shown that for the activation of the parasympathetic nervous system, we do not need to generate a high variability. On the contrary, we need coherent and shorter breaths to the diaphragm region of the abdomen with a short maybe 2- to 3-s hold after the exhale phase to deepen the HR. Therefore, practicing this 3x3x3 breathing pattern daily can benefit people with high anxiety, sleeping problems, or difficulties switching off and relaxing.

The Cognitive Work

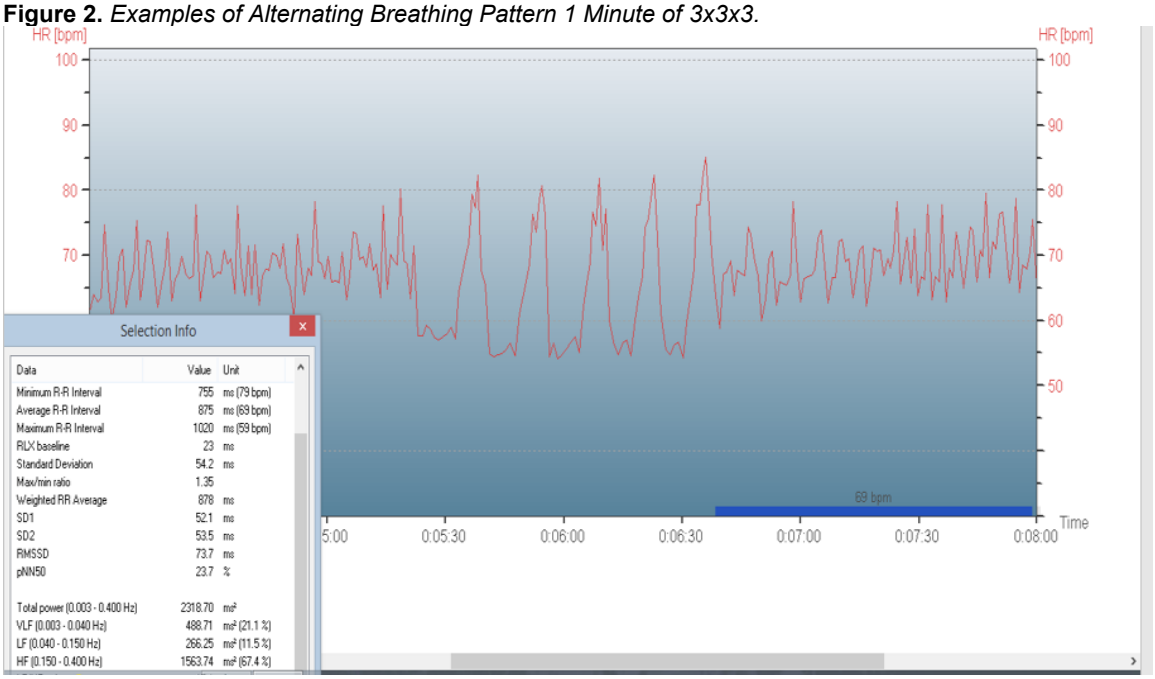
Applying MBCT with HRVB helped the patient increase his awareness of his intrusive thoughts and the ability to change or reevaluate them according to his willpower and intention. Throughout the applications of the MBCT, the patient learned to use positive self-talk and affirmations when exhaling to lower his HR in critical situations and thus slow down the current of the intrusive thoughts to be able to change them. The 6-s exhale phase, which he trained in during the morning exercises, allowed him to alter the negative images by applying mindfulness in critical situations and using positive self-talk. MBCT also integrated meditative techniques to enhance his moment-to-moment awareness, nonjudgmental acceptance, and unconditional empathy to increase his self-esteem in activating the parasympathetic nervous system.

Figure 1. *Examples of Alternating Breathing Pattern for 1 Min of 3x2x6x2.*



Note. Examples of the alternating breathing pattern for 1 min of 3x2x6x2 followed by 1 min of 3x3x3 monitored by Polar RS800 watch. The highlighted section is the 3x2x6x2 breathing with HRV data in the small table.

Figure 2. *Examples of Alternating Breathing Pattern 1 Minute of 3x3x3.*



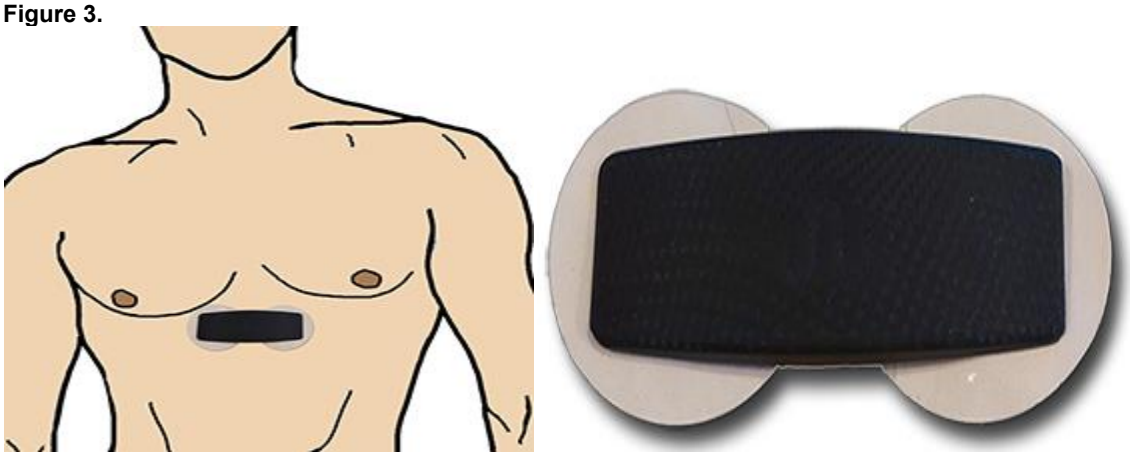
Note. Examples of alternating breathing pattern for 1 min of 3x2x6x2 followed by 1 min of 3x3x3 monitored by Polar RS800 watch. The highlighted section is the 3x3x3 breathing pattern with HRV data in the small table.

HRV Measurements

Biocom 6000 Bluetooth ECG Recorder was used in this study, and the HRV measurements were taken in a clinical setting. Biocom Technologies is the global leader in developing, manufacturing and marketing HRV products (Biocom Technologies, 2023). In addition, Biocom develops biomedical software and hardware products designed to monitor physiology for research and educational purposes.

HRV is analyzed by (a) time domain analysis which includes mean HR (bpm), mean R-R (ms), SDNN (ms), RMS-SD (ms), pNN50 (%); and (b) frequency domain analysis which includes the power spectrum of overall ANS including total power, VLF, LF-sympathetic activation, HF-parasympathetic activation, and LF/HF ratio (Malik et al., 1996). A 5-min HRV test was performed in a sitting position at the beginning of each psychotherapy session.

Figure 3.



Note. The placement of the Biocom 6000 Bluetooth ECG recorder on the participant to measure HRV using Biocom Technologies software.

Results

In the 12-week MBCT program tailored to the patient, 4 weeks: Week-1 baseline, Week-4, Week-8, and Week-12 final were thoroughly analyzed by HRV time domain analysis (Table 2) and HRV frequency domain analysis (Table 3). In addition, the changes and new HRV imprints of the 4 weeks were compared in graphs (Figures 4, 5) and the original Biocom Technologies Autonomic Assessments (Figures 6, 7, 8, 9), which displayed the actual 5-min HRV measurements taken at the beginning of each four therapeutic sessions.

Table 2
Time Domain Analysis

HRV Measurements	Mean HR (bpm)	Mean RR (ms)	SDNN (ms)	RMS-SD (ms)	pNN50 %
Week 1 - Baseline	113.9	526.7	38.2	9.5	0.0
Week 4	91.6	655.1	39.3	14.5	0.4
Week 8	78.3	766.7	54.7	37.6	16.6
Week 12 - Final	71.1	844.5	55.3	43.4	24.2

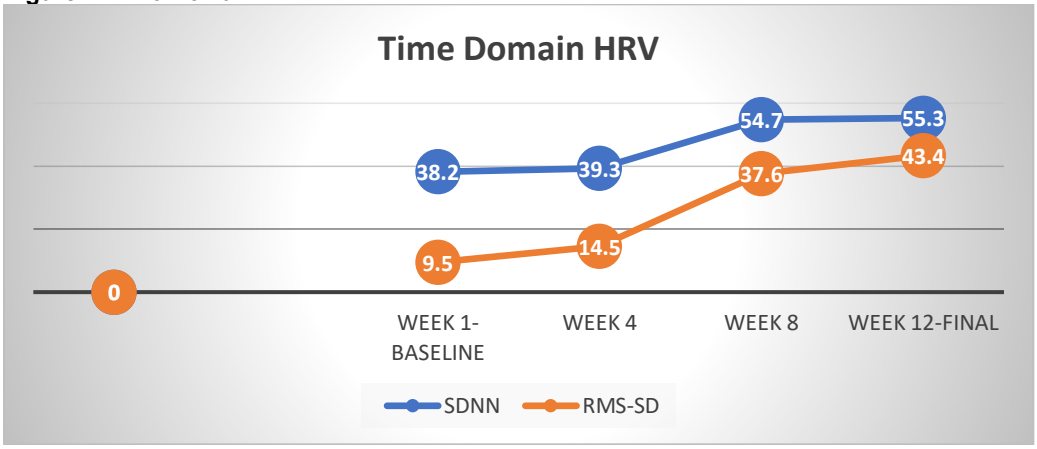
Note. The progress in patient's stress resistance is seen as the mean HR (bpm) is lowering and SDNN (HRV) and RMS-SD (parasympathetic level) indexes are increasing over the 12 weeks.

Table 3
Frequency Domain Analysis

HRV Measurement	TP (ms^2/Hz)	VLP (ms^2/Hz)	LF (ms^2/Hz)	HF (ms^2/Hz)	LF/HF	LF Norm %	HF Norm %
Week 1 - Baseline	473.9	355.8	95.0	23.2	4.1	80.4	19.6
Week 4	436.4	255.9	135.2	45.4	3.0	74.9	25.1
Week 8	776.6	246.6	145.5	384.7	0.4	27.4	72.6
Week 12 - Final	973.7	123.1	225.9	624.6	0.4	26.6	73.4

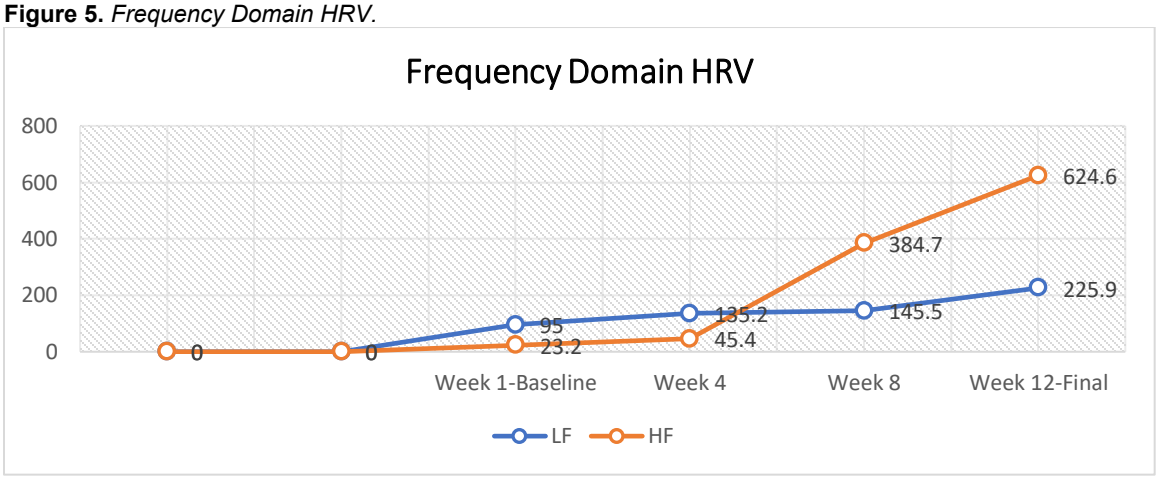
Note. The progress in the patient's stress resistance is seen as the TP (total power-index for energy level). It has increased over the 12 weeks, together with the enhanced level of the HF-parasympathetic vagal activation of the ANS.

Figure 4. *Time Domain HRV.*



Note. HRV improvement is measured in SDNN and RMS-SD index levels. The RMS-SD index indicates the parasympathetic branch, considered the most relevant and accurate measure of ANS activity over the short term.

Figure 5. *Frequency Domain HRV.*



Note. Improvement in HF (parasympathetic nervous system) vagal activity to learn relaxation techniques applying the breathing exercises and meditation techniques. HF index is also known as a "respiratory" band because it corresponds to the HR variations caused by respiration (this phenomenon is known as respiratory sinus arrhythmia [RSA]).

The original Biocom Technologies 5-min HRV assessments were taken before the first (baseline), fourth, eighth, and twelfth (final) psychotherapeutic sessions (Figures 6, 7, 8, 9). The most significant indicator of stress is the HR waveform graph which displays the activity of the HR variation impacted by conscious or unconscious breathing patterns with mental processes which created specific HRV waveforms. This process generates HR coherence or incoherence, interpreting the stress or relaxation responses for further HRV data analysis. Over the 12-week timeframe, the results displayed how the HR waveforms were changed and became more coherent, consistent, and synchronized, reflecting equal amplitudes of the inhale and exhale phases which generated balance in the ANS and homeostasis. The learned and trained psychotherapeutic progress culminated in Week 12 during the final HRV measurement outcome (see Figure 9).

Figure 6. *Week 1. HRV Baseline - Biocom Technologies Autonomic Assessment Showing High Stress Level of the Patient.*

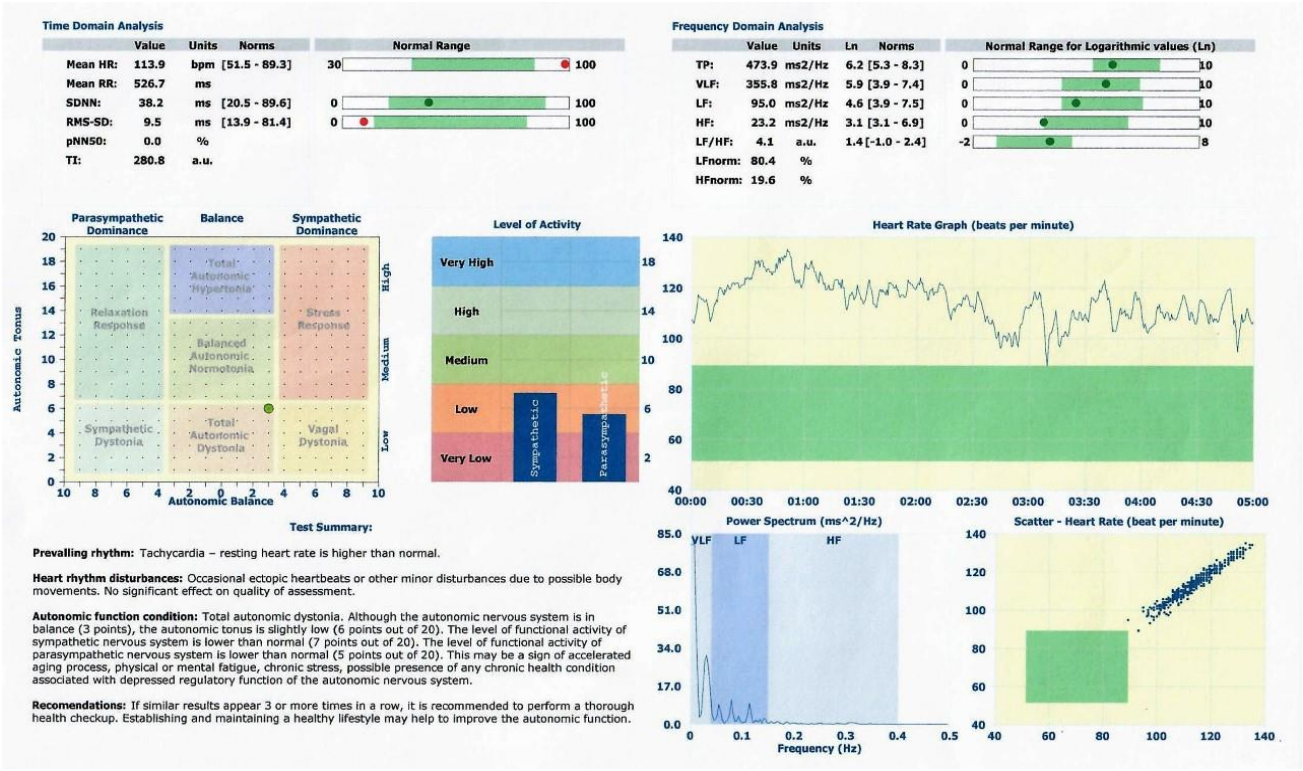


Figure 7. *Week 4. HRV-Biocom Technologies Autonomic Assessment Showing Moderated Stress Level of the Patient.*

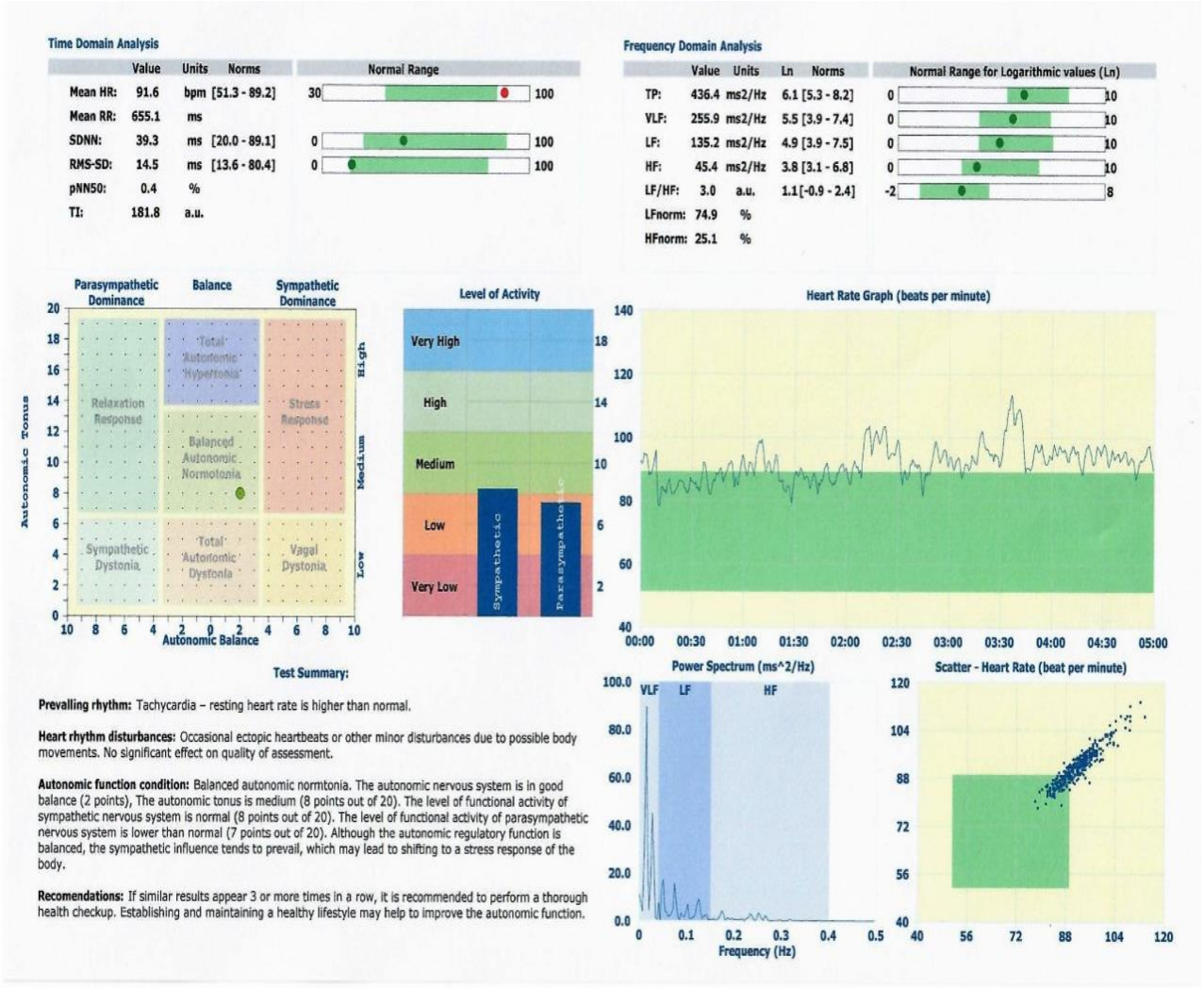


Figure 8. *Week 8. HRV - Biocom Technologies Autonomic Assessment Showing Improvement in Relaxation Ability of the Patient.*

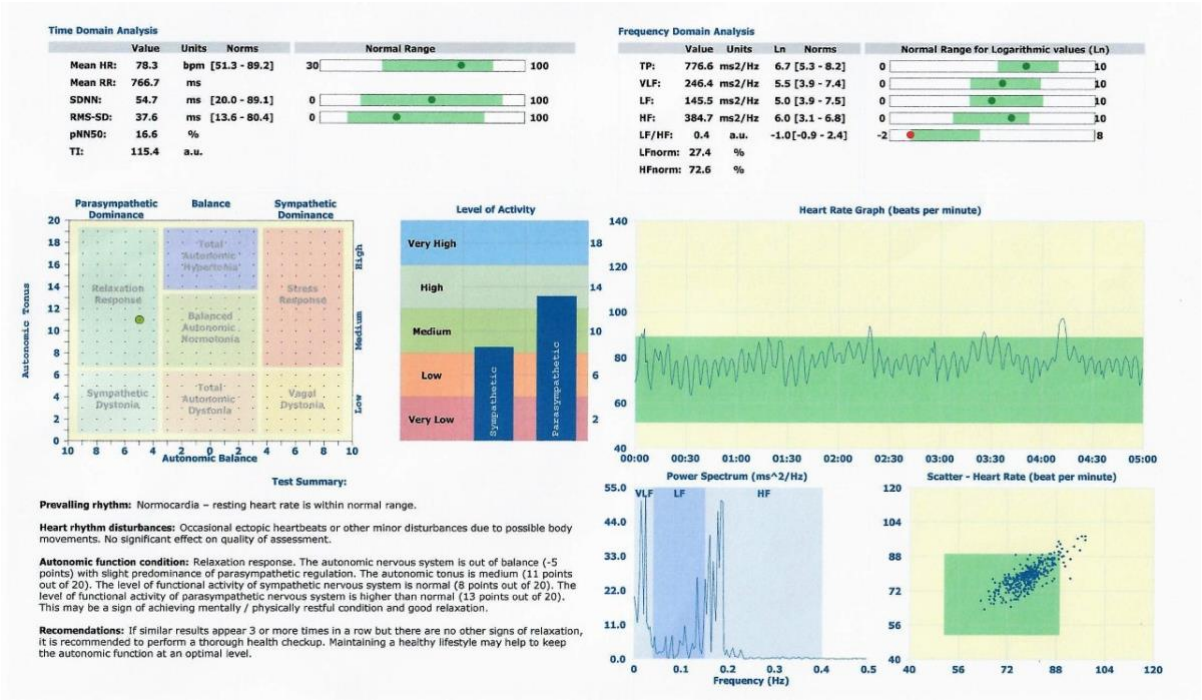
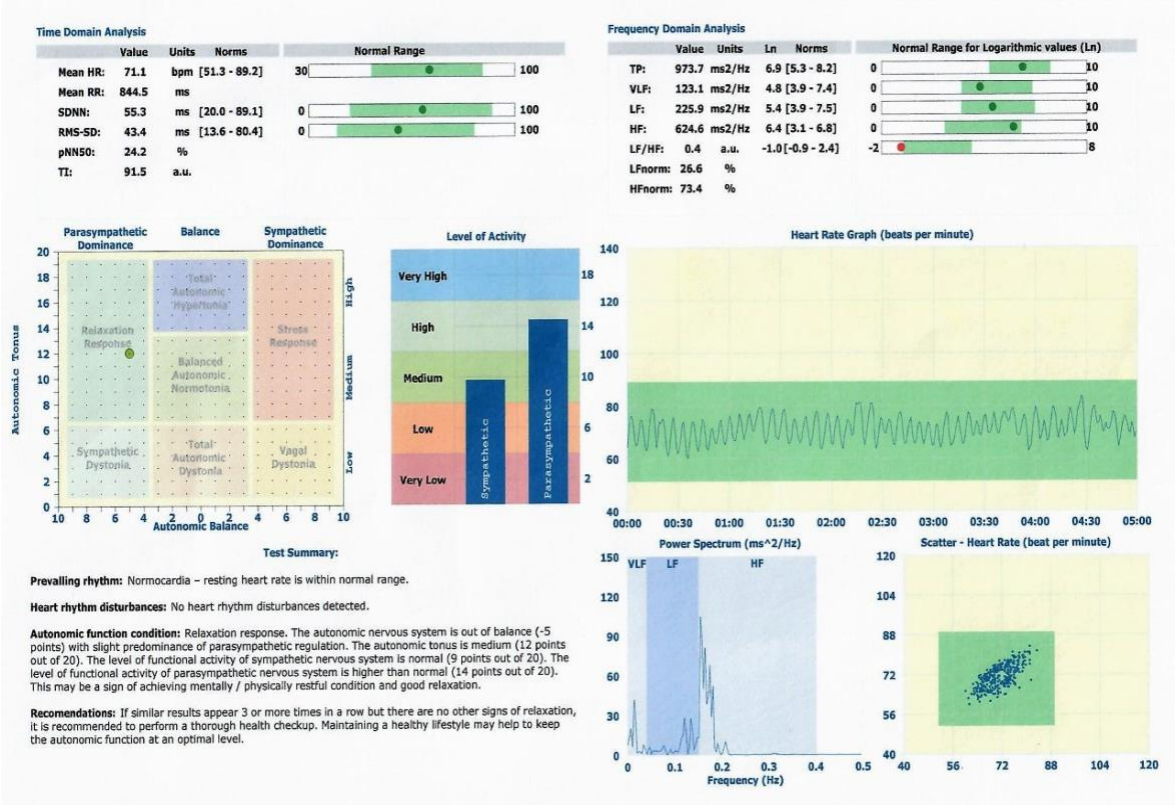


Figure 9. *Week 12. HRV Final - Biocom Technologies Autonomic Assessment Showing Good Relaxation Respond of the Patient.*



Discussion

The objective of this study was to show how the combination of the HRVB and MBCT might be applied in modern psychotherapeutic settings for effective diagnoses and treatment of the patient. It is evident that HRVB has become a well-sought noninvasive diagnostic tool for objectively diagnosing and monitoring the patients regarding anxiety and stress-related disorders. It is because only HRVB can provide the data of the ANS, which is essential information for a further therapeutic outline of the treatment. For psychotherapists, it is important to objectively see the stress level in patients and which branch of the ANS (sympathetic or parasympathetic) dominates to tailor the proper treatment and generate the balance of the ANS. In the therapeutic setting, the HRVB has become a very good learning and teaching tool when the patient is able to visually learn on the computer screen how anxiety and stress can be managed in terms of HR monitoring during the breathing exercises or when using positive mental affirmations and meditative practices. Similarly, HRVB should become a motivational and transparent diagnostic tool for the patient and the therapist to monitor the progress of the treatment, which can be seen just in a few weeks in the newly moderated HRV imprints of the patient. In other words, seeing on the screen the HRV outcomes, the patient cannot lie to the therapist if he does or does not do the breathing exercises daily, and neither can the therapist lie about the progress or failure of the treatment.

In this study, the HRVB was measured by computer-based Biocom Technologies Autonomic Assessments which provide comprehensive HRV examinations including time domain analysis, frequency domain analysis, heart rate graph waves, power spectrum analysis, scatter-heart rate graph, comparable levels of LF and HF activities, autonomic tonus and balance comparison, and written test summary (Biocom Technologies, 2023). The following sections offer narrative descriptions of the four HRV measurements thoroughly analyzed in the study. These descriptions are mental representations of the feelings and emotions experienced by the participant when the HRV measurements were taken. The 5-min HRV measurements were taken at the beginning of each session.

Week 1: Baseline HRV Measurement (Figure 6)

The patient came to the clinic for the first time and took the first baseline HRV assessment for an initial diagnosis. We can see that he felt very high anxiety and stress where the HR palpitations escalated over 135 bpm, activating the sympathetic nervous system with symptoms of chronic stress, fatigue, and insomnia. The average HR was 114 bpm, with a low SDNN of 38.2 ms in total autonomic dystonia.

We analyzed the situation, and he began to open up and disclosed his stressors, including bad relationships with his father and his boss at work. The patient also confessed to having feelings of anger towards everyone around him, especially towards his boss because he felt disrespected by him at work. He blamed others to excuse his failures. After we analyzed the situation, we introduced the breathing exercises 3x2x6x2 and 3x3x3 (see Table 1). He started to do breathing exercises daily along with MBCT and some mindfulness techniques to reevaluate his stances towards certain life situations and people positively. He was quite dedicated, and the positive results were soon achieved.

Week 4: HRV Measurement (5 Min; Figure 7)

In this HRV measurement, we can see that after 4 weeks of training, the HRV imprint became more coherent, lowering the patient's HR to 92 bpm (average) and generating a more balanced autonomic assessment. However, the nerve and the cognitive system still triggered minor palpitations stimulating the sympathetic nervous system. However, the HR palpitations were shorter in time and frequency but still reached 115 bpm, which is relatively high compared to his baseline. We can also see that the HR palpitations dropped quickly, which was a good sign for a faster recovery in terms of a new imprint of the HRV to the patient's ANS. The patient learned that the images of unresolved problems, such as faces or body images of his father or boss, from his subconsciousness were causing these HR spikes. It is because the ANS recognized the images as a mental threat trying to activate the sympathetic nervous system to fight them by increasing the HR. By applying the MBCT, the patient learned how to neutralize the intrusive images and reevaluate them differently in a more peaceful way using the new positive inner stances towards them more empathetically to accept them as learning and training opportunities for his stress resistance.

Week 8: HRV Measurement (5 Min; Figure 8)

In this HRV measurement, the patient reached the parasympathetic HF vagal activity for the first time. We can see that the HRV became more coherent, and HR spikes are more consistent in frequency and amplitude. This new HRV imprint guaranteed

comfortable and optimal HRV zone functioning, positively impacting overall homeostasis. The average HR was lowered to 78 bpm which increased the SDNN (54.7 ms) and RMS-SD (37.6 ms), respectively, showing increased stress resistance and vitality.

The patient was dedicated to breathing exercises, and we can see excellent phases of HRV coherence in deep HF parasympathetic relaxation. As the HR lowered, the current of the thoughts also slowed, allowing him to reconstruct the thoughts more comfortably and empathetically using the MBCT techniques. Therefore, if the patient knew how to activate HF and relaxation in the ambulatory or clinical environment, he could maintain the new HRV imprint anywhere and anytime, using his skills and willpower. In other words, the ANS and homeostasis will only activate what is trained, learned, and imprinted on the ANS.

Week 12: Final HRV Measurement (5 Min; Figure 9)

In this measurement, the patient performed the 3x3x3 meditative breathing pattern. The goal was to calm the mind and completely switch off in a more meditative-empathetic mode. This was his best HRV outcome, and it was not easy to do it at all. The average HR was lowered to 71 bpm with increased RMS-SD (43.4 ms) in deep HF parasympathetic vagal meditative response. The most important was that the patient was able to maintain the 3x3x3 breathing meditative HRV shape for 5 min without any conscious or unconscious disturbances, seen in the HRV graph as desynchronized or incoherent HR spikes. During the 12 weeks, the patient also developed specific MBCT skills and coping mechanism techniques which he wisely applied in daily stress-related situations. Applying the MBCT, the patient also completely reevaluated some stances to his current situation, especially in the relationships with his father, which used to cause him stress, hate, and anger previously seen as HR spikes in the HRV graphs. As we can see, with dedicated training, the optimal HRV zone functioning can eventually be imprinted into the ANS system by practicing daily breathing exercises with positive affirmations, visualization skills, and self-talk.

It became evident that it took a few weeks for the patient to understand and familiarize himself with the mechanism of breathing exercises in connection to his inner work in terms of using positive self-talk. The patient disclosed having problems seeing and detecting negative and fearful thoughts at the beginning of the treatment sessions. However, as he practiced more, he felt better and became more self-confident and in control. He reported that in critical stress-related situations or worries about the future, he immediately applied the 3x2x6x2 breathing pattern, which helped him regulate the stress as he slowly exhaled through the mouth. Especially during the extended exhale phase, he learned to repeat the affirmations and positive self-talks. He implemented the same techniques during moments of anger or flashbacks connected to past-related memories that were unexpectedly playing out through his mind. In this approach, we need to consider that the patient visually learned on the HRV computer how these intrusive images were detrimental to ANS, causing HRV incoherence and HR stress-related spikes.

Since his HRV was monitored weekly and he could see the HR incoherence, it helped him believe in this treatment technique with high self-confidence and determination. This therapeutic mechanism can be applied effectively based on self-hypnotism when, during the exhale phase, the time during the HR pulses (bpm) is spreading, and the ANS system is calming down. This therapeutic process confirmed a new self-healing paradigm on increasing mindfulness and self-awareness of thoughts connected to the deep subconscious level by embedding new positive images and schemas with high self-confidence.

Conclusion

This study advocates using HRVB as a scientific apparatus to measure stress with MBCT as a holistic modality. Combining both approaches has shown to be an effective diagnostic and therapeutic method for treating patients with stress-related disorders. The patient in the study made progress by following the exact procedures as seen on the HRV monitors. This progress developed the patient's motivation and self-confidence needed to believe in this treatment.

During the 12-week MBCT program, the patient could completely transform his stressful and unhealthy HRV pattern into a healthy one by activating the HF parasympathetic nervous system using willpower. Therefore, for psychotherapists, it is important to objectively assess the stress levels in the patient, especially by monitoring the patient's prevalent reactions and tendencies in either the sympathetic or parasympathetic nervous system.

By applying HRVB, the patients learn about their mind–body interactions, breathing, and thought processes. They quickly realize the detrimental

effect of negative and intrusive thoughts on their mental health. The real-time monitoring of HRV on the screens during the sessions enables psychotherapists to diagnose more quickly and efficiently. It also makes the treatment more transparent and interesting for the patients.

This study strengthens the idea that HRVB is an effective teaching and learning tool for psychotherapists and patients to increase the quality of the treatment and motivation factors for the patients in clinical settings.

Author Declaration

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