

# The Effectiveness of VAT in Alleviating Stress

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## ABSTRACT

Stress is one of the leading problems in terms of health and thousands of people die from it every day. Additionally, stress is worse when you have a pre-existing medical condition. Stress has a major impact on millions of people worldwide and pain is often found in society. Stress is considered to be one of the leading epidemics in this world and there has to be a way to promote consistent mental well-being in humans. Vibroacoustic Therapy or VAT for short can be the solution to this problem. We can use low sound frequencies to improve the quality of human life and to heal people of the stress found in their lives. In this research paper, the question of whether VAT holds up validity in reducing stress levels will be answered and future implications of this therapy will be discussed. Although VAT can also reduce physical pain, the specific topic of stress will be discussed throughout this paper and a baseline of knowledge regarding VAT will be established so that other researchers can do further exploration into this topic.

## **Introduction**

This epidemic known as stress has a myriad of fatal consequences, including death. According to the American Institute of Stress, stress is one of the leading causes of death, with over 120,000 people dying every year. This silent but deadly epidemic is commonly seen in everyday life, whether it can be seen in the form of family issues, assignments from school, or something not going your way. Furthermore, stress serves to not only be a key problem in American society but also globally. Yet even though stress is seen every day and millions of people are affected by it, the current methods to treat stress, such as using a stress ball or talking to a therapist through your feelings just isn't enough to many people. A new type of approach to relieving stress, known as Vibroacoustic Therapy (VAT), can help reduce stress by further levels and promote healthier practices in humans.

## **What is Vibroacoustic Therapy?**

It is helpful to define the term "vibroacoustic" before talking about what vibroacoustic therapy actually is. Vibroacoustic therapy uses audible sound vibrations to be sent to the body through the use of transducers; the phrase is derived from the Latin words vibro (to vibrate) and acoustic (to hear). To effectively transmit the sound waves into the patient's body, the transducers (speakers) are affixed to common home items including tables, mattresses, and couches. The science underpinning vibroacoustic therapy must be understood in order to establish sound cognizance. Every vibration has a unique speed, or frequency. For example, a high-pitched vibration will have a faster and higher frequency, but a low-pitched vibration will have a slower and lower frequency. Vibrations are measured in Hertz (Hz). Hertz is the SI unit for frequency, having one cycle equal to a second. The range of hertz that humans can hear variates from 20 Hz to 20,000 Hz. Anything below 20 Hz is considered to be infrasonic and anything above 20,000 Hz is considered to be ultrasonic. But in terms of Hertz, what is considered to be low frequency and high frequency? Lower frequency sounds are considered to be 500 Hz or lower while high-frequency waves are above 2000 Hz. Vibroacoustic Therapy uses sound frequencies that can be heard by the human ear but are in

the lower range of Hertz (ex. 20-30 Hz). Higher sound frequencies are reported to inflame irritation and stress levels, so lower sound frequencies are used to contribute a greater sense of stress relief.

## Mechanics of Vibroacoustic Therapy

One of the ways in which Vibroacoustic Therapy is through household items, such as a chair or a table, as mentioned before. Furthermore, there are chairs that are used specifically for VAT, one of which is called “Zen evolution” (Model ZK2, ZAV2, DVP3520/8, HD202 II West), a vibroacoustic armchair. This armchair consists of a vibro device that transmits the vibrations from the chair to the patient, a DVD with a 2-channel amplifier, and a subwoofer system (speaker that responds only to low-frequency sounds). The chair outputs music along with low-frequency sounds. The subwoofers (speakers) then produce sound frequencies between 4-8 Hz, which can then be heard by the headphones that the patient is wearing. Since humans can only hear frequencies ranging from 20 Hz - 20,000 Hz, patients have to wear headphones that solidify this range. Vibroacoustic Therapy with an armchair typically lasts around twenty minutes. The low-frequency sounds coming out of the chair help calm the patient and reduce stress, which can help those who suffer with diseases that stem from stress such as depression, cardiovascular disease, diabetes, Alzheimer's etc.

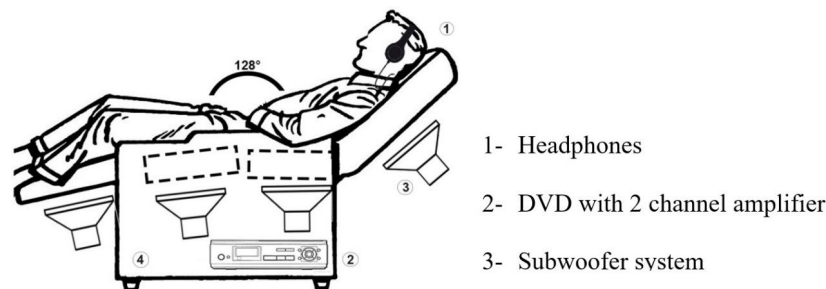


Fig. 1. Vibroacoustic chair (“Zen evolution”)

## What are some of the stress hormones in our body?

ACTH (Adrenocorticotrophic hormone), cortisol, and adrenaline are the main stress hormones in our body. While stress hormones may seem like a bad thing considering the word “stress” is in them, they are actually necessary to human survival. Stress hormones can trigger our flight-or-fight response, which is a natural bodily response to stressful situations in which a person can either take “flight” or “fight”. This bodily response is important to human survival because it controls human decisions and regulates emotions. However, when these hormones are exceeded to irregular amounts, these hormones have the ability to increase blood flow to the muscles and increase blood pressure. When there is an excessive amount of blood flow to muscles and blood pressure, it can cause numerous health problems including anxiety and depression, headaches, heart disease etc. Vibroacoustic therapy can be one of the solutions to fix this problem. Vibroacoustic therapy can actually reduce the levels of stress hormones, as mentioned before (ACTH, cortisol, beta-endorphins etc.) Furthermore, Vibroacoustic Therapy can not only be helpful for lowering stress hormones but also for reducing levels of physical pain. For example, a study in a hospital involving 40 adolescent patients was placed in a vibroacoustic chair to see if back pain in these patients has lowered. Based on the graph, this study shows that compared to the control group (group that did not receive vibroacoustic treatment), the VAT group reported a lower VAS score (Visual Analog Score). But whilst it is a general consensus that vibroacoustic therapy helps ease pain and reduce stress, there is still the question of how stress is related to music.

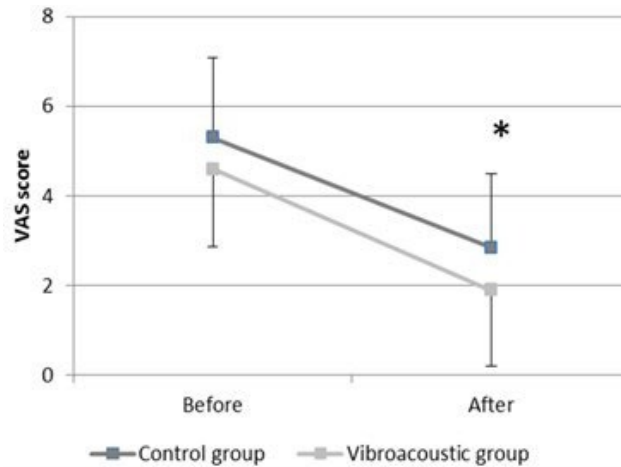


Figure 2. VAS score of control group compared to vibroacoustic group

### Stress hormones and its relation to music

Music has occasionally been discovered to control the amounts of stress hormones and reduce their presence. Lower frequency music has been demonstrated to reduce cortisol levels, which is the primary stress hormone. But not all music has a calming effect on people. For instance, it has been discovered that listening to classical music, which has lower frequencies, relaxes people whereas listening to techno music or heavy metal music which has higher frequencies, has the opposite effect. Stress hormones can be changed either positively or negatively by the sound waves that a person is listening to. Nevertheless, when combined with psychological entrainment, music appears to relax listeners. Entrainment is a concept in physics in which two objects vibrate in similar frequencies, causing harmony between the two objects and vibration to occur at the same frequency. Similarly, we can use music frequencies to align with the vibrations of physical processes, such as your heartbeat, to induce relaxation in someone. Yet it is important to note that the music has to be at a certain frequency in order to induce relaxation. Ideally, it should be at or below resting heart rate so that it can align with your heart rate, hence, promote relaxation and reduce stress. Vibroacoustic Therapy uses this concept of entrainment by transmitting low-frequency sounds, so it can align with heartbeats that are either at resting heart rate or below heart rate. Due to the physics concept of entrainment, it is easier for the human body to relax because the frequency of your heartbeat is aligned with the low sound frequencies emitted by Vibroacoustic Therapy.

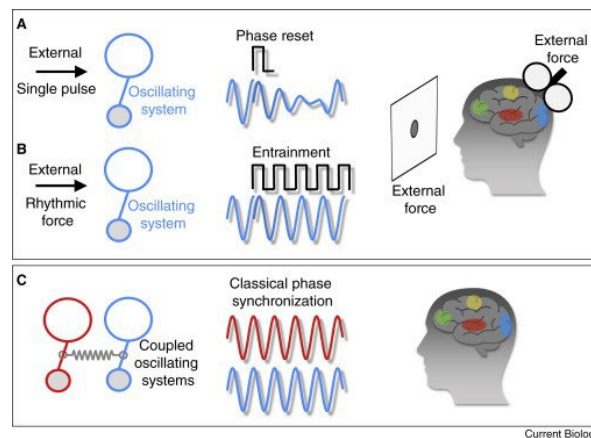


Figure 3. Diagram of how entertainment works

## VAT and its effectiveness in alleviating stress

Traditionally, the way we manage stress biologically is through the SNS (Sympathetic Nervous System) and PNS (Parasympathetic Nervous System). The SNS is responsible for contributing to the “flight or fight” response when under stressful conditions and also increases the rate of involuntary responses, which include heart rate, respiration activity, sweat gland activity, body temperature etc. Alternatively, the PNS is responsible for reversing the stress response through a process known as downregulating, which uses the Vagus nerve to send impulses from the brain to the body and vice versa. In other words, the brain tells your body what to do instead of the body telling the brain what to do. This method of the brain telling the body what to do lowers stress. But to measure levels of stress or detect stress, we can use GSR (Galvanic Skin Response), which is the measure of the skin's electrical resistance.

Why do we use GSR to measure stress? When we are stressed, the SNS starts acting up and induces the sweat glands to become active in our body. Due to the sweat glands in our body getting activated under stress, it increases the conductivity of the skin, which in turn, increases the electrical resistance of the skin. In a study done by Franca Delmastro and Cristina Dolciotti, they used a component of VAT (AcousticA) to emit vibrations similar to those that you would hear when using VAT. They then measured ECG (electrocardiogram) and GSR through wearable devices, such as BH and SH. Through these devices they were able to get a great deal of information, including the mean HRV (Heart Rate Variability), HR (Heart Rate), PNN50 (measure of HRV), LF/HF HRV (HRV frequency measurements) and the number of SCR's (Skin Conductance Response).

	ECG analysis								GSR analysis			
	MEAN HRV		MEAN HR		PNN50		LF/HF HRV		# SCRs		Cumulative Amplitude	
	Baseline	VAT	Baseline	VAT	Baseline	VAT	Baseline	VAT	Baseline	VAT	Baseline	VAT
# 1	948,28	1007,1	63,33	59,683	29,968	52,031	0,545	0,502	3	0	0,0048	0
# 2	937,27	987,76	64,06	60,768	25,545	32,843	1,019	1,116	43	16	0,4202	0,05946
# 3	984,19	951,26	61,037	63,158	24,262	19,529	1,069	1,161	27	18	0,0790	0,13926
# 4	771,36	798	78,143	75,24	4,884	3,231	1,026	2,164	76	5	0,9623	0,01055
# 5	1047,7	972,2	57,857	62,2	33,798	24,769	1,656	3,024	23	6	0,0870	0,01060
# 6	1052,9	1051,3	57,103	57,363	23,86	17,767	0,736	2,855	143	20	1,5017	0,14981
# 7	929,04	997,44	64,573	60,199	21,981	19,816	0,975	0,855	17	1	0,0346	0,00112
# 8	1144,8	1114	52,893	54,484	62,595	65,932	0,339	0,398	6	0	0,0095	0

Figure 4. ECG and GSR Analysis of VAT

In the ECG analysis, we can see that compared to the baseline(s), VAT has had a significant effect on HRV, HR, PNN50, and SCR. HRV is a measure of your heart rate variability so when your HRV is high, it means that your ability to adapt to situations and perform at your highest potential is prominent. In all of the participants, excluding #8, the mean HRV has increased greatly. VAT also lowered HR and reduced the SCR, which are both factors that contribute to our stress when at high levels. Through the GSR analysis, we can see that the levels of both of these factors have lowered in most of the participants. Finally, the Cumulative Amplitude has lowered in almost all of the participants. What does all of this information mean? This means that VAT is effective in lowering stress levels because the HR and SCR levels both decrease after using VAT. Additionally, VAT also contributes to the body's balance and wellbeing because of the increased levels of HRV.

## Conclusion

Stress takes form in a multitude of ways and as a result, can affect people in different ways because of it. Through the data analyzed in this paper, research supports that VAT is effective in reducing stress through the lowering of biological processes, such as Heart Rate and Heart Skin Conductance Rate. But even with such an invention as VAT, this doesn't mean that stress will suddenly come to an end. However, VAT tells us that we can approach stress in a different light and use methods that aren't usually practiced. Some common treatments to stress include

a stress ball or going to therapy and talking to someone about it. Yet something as simple as listening to low frequency sounds can come a long way. Furthermore, since VAT is not a very popular alternative to relieving stress, VAT can be popular once we make it more accessible to many populations. By decreasing the prices of Vibroacoustic Chairs, which start at around 1000 dollars, VAT can become more accessible to underprivileged populations. Once we start making VAT more accessible to people around the world, there will be a significant benefit the world can gain out of it. Therefore, with further research done on VAT and perfecting the science of VAT, the prevention of stress can become a more achievable task with time.

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## References

- Borrell, J., Torrellas, A., Guaza, C., & Borrell, S. (1980). Sound stimulation and its effects on the pituitary-adrenocortical function and brain catecholamines in rats. *Neuroendocrinology*, 31(1), 53–59.  
<https://doi.org/10.1159/000123050>
- Boyd-Brewer, C., & McCaffrey, R. (2004). Vibroacoustic sound therapy improves pain management and more. *Holistic Nursing Practice*, 18(3), 111-118.
- Delmastro, F., Di Martino, F., & Dolciotti, C. (2018, March). Physiological impact of vibro-acoustic therapy on stress and emotions through wearable sensors. In 2018 IEEE International Conference on Pervasive Computing and Communications Workshops (PerCom Workshops) (pp. 621-626). IEEE.
- Dudoniene, V., Varniene, L., Aukstikalnis, T., Lendraitiene, E., Cerkauskas, J., & Raistenskis, J. (2016). Effect of vibroacoustic therapy on pain management in adolescents with low back pain. *Journal of Vibroengineering*, 18(7), 4729-4735.
- Dudoniene, V., Varniene, L., Aukstikalnis, T., Lendraitiene, E., Cerkauskas, J., & Raistenskis, J. (2016). Effect of vibroacoustic therapy on pain management in adolescents with low back pain. *Journal of Vibroengineering*, 18(7), 4729-4735.
- Kantor, J., Kantorová, L., Marečková, J., Peng, D., & Vilímek, Z. (2019). Potential of vibroacoustic therapy in persons with cerebral palsy: an advanced narrative review. *International journal of environmental research and public health*, 16(20), 3940.
- Koelsch, S., Fuermetz, J., Sack, U., Bauer, K., Hohenadel, M., Wiegel, M., Kaisers, U. X., & Heinke, W. (2011). Effects of Music Listening on Cortisol Levels and Propofol Consumption during Spinal Anesthesia. *Frontiers in psychology*, 2, 58. <https://doi.org/10.3389/fpsyg.2011.00058>
- Lakatos, P., Gross, J., & Thut, G. (2019). A new unifying account of the roles of neuronal entrainment. *Current Biology*, 29(18), R890-R905.
- Salamon, E., Kim, M., Beaulieu, J., & Stefano, G. B. (2003). Sound therapy induced relaxation: down regulating stress processes and pathologies. *Medical Science Monitor*, 9(5), RA96-RA101.
- Skille, O. (1989). VibroAcoustic therapy. *Music therapy*, 8(1), 61-77.