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Title: The Effects of Musical Frequency and Interval on Meditation

Abstract: Music is an untapped resource when it comes to the healing arts. Scientific studies discussing the benefits of music on the mind and body routinely exclude musical frequency and interval. To investigate the effects of music during meditation, I recorded a nine-minute original composition that operationalized consonant intervals and solfeggio healing frequencies. Seven participants were asked to journal after meditating with four versions of the music, each utilizing a slightly different set of frequencies, (A = 440 Hz, equal temperament; A = 444 Hz, equal temperament; C = 523.25 Hz, Pythagorean interval; C = 528 Hz, Pythagorean interval), and once in silence. Interpretative phenomenological analysis showed music to quiet the mind, encouraging a deeper state of meditation. Heightened awareness, connection, and sensations of warmth and resonance were also reported. Four of the six participants who preferred meditating with music chose a 528 Hz track as the most impactful. The five participants who responded strongly to the 528 Hz Pythagorean tuning unanimously described it as calming and healing. These results align with the transformative characteristics attributed to music by Greek and Chinese philosophers, which have been verified in recent music therapy research. Furthermore, this discovery suggests that the healing properties of music can be maximized through frequency and interval, awakening the transformational qualities of sound and establishing a direct line to the transpersonal.

Keywords: music, meditation, interval, frequency, solfeggio, transpersonal

Introduction

There is enormous potential for music created with the purpose of healing. While the benefits of music on the mind and body are often recognized, musical frequency and interval are commonly overlooked (Goldsby et al., 2017; Landry, 2014; Lipe, 2002). It is the aim of this study to investigate how subtle adjustments in frequency and interval effect the ability of music to calm the mind during meditation practice.

Writings on the role played by music in balancing the life of an individual and society can be traced back to the philosophers of ancient Greece and China. Plato established music and gymnastics as essential to education and personal development in his Republic (Jowett, 1888). While gymnastics strengthened the body, music nourished the soul. Associated with virtue and temperance, Plato believed strong emotional

connections enabled music to transfer these qualities to the listener, keeping them on the right and noble path.

Just as virtuous music had the power to instill goodness and grace, unvirtuous music imposed the opposite. Aristotle warned that when performed for pleasure, music lost its virtue, diminishing the character of both the musicians and their audience (Jowett, 1885). For the soul to find a harmonious balance, it was essential the intrinsic value of music be maintained.

Chinese philosophy held similar views on music. Composed during the Warring States Period, Cook (1995) considered the *Yue Ji* to be “the single most influential work on music in the Chinese tradition” (p. 11). Although the author is unknown, it has been ascribed to Gongsun Ni Zi, a second-generation disciple of Confucius. This treatise defined two distinct words for music (Cook, 1995). Yin represented music for entertainment. Yue was spiritual music that engaged the emotions, initiating a healing process that brought harmony and balance to life. While yin was a reflection of society, yue had the power to transform it. Only a virtuous person (referred to as *junzi*) who possessed knowledge of yin could create yue. This virtue was attained through self-cultivation that led to the union of physical (Ritual) and spiritual (Music) realms. Cook (1995) explained how yue reconnected man to their heavenly nature (*xing*):

A refinement of Music is said to lead to control over one’s heart, which in turn leads to the birth of an easy, upright, loving, and compassionate heart, which in turn leads to happiness, then on to peace, then on to longevity, then on to the Heavenly, and finally on to the Spiritual. With the Heavenly, one is trusted without speaking, and with the Spiritual, one strikes awe into others without showing anger—this is how Music is used to control one’s heart. (p. 66) Control of the heart can be understood as regulating ego and attachment. As the primary obstacle to personal development, the assignment of positive or negative labels to experience creates an identification with the feeling, accentuating one’s emotional response. In the Chinese tradition, music counters earthly wants and objective desires by shifting attention away from self-oriented concerns. Lipe’s (2002) review of 52 articles published between 1973–2000 concerning music, spirituality, and health confirmed a trend in current research emphasizing music’s capacity to promote growth and healing through connection to the spiritual. The main themes within the literature expressed that music facilitated personal transformation by eliciting transpersonal experiences including self-transcendence and altered states of consciousness.

Second, music strengthened a sense of meaning and purpose while encouraging openness and creativity. Third, it established a link not only between the conscious and unconscious mind, but also between man and the divine. Only a single article mentioned the health benefits of meditation as a personal spiritual practice; however, the influence of music on meditation was not discussed.

Two studies investigating the effects of sound healing provided a basis for this research project. Landry (2014) determined that exposure to 12 minutes of vibration from Himalayan singing bowls produced a calming effect, significantly lowering systolic blood pressure and heart rate compared to silence before 20 minutes of directed relaxation. In another study conducted by Goldsby et al. (2017), a 60-minute sound healing session incorporating singing bowls with bells and gongs significantly reduced tension, anxiety,

and depression while improving spiritual wellbeing. Unfortunately, there was little account for musical frequency in either case since each singing bowl was only capable of generating a single tone.

It may be helpful to discuss some basic music theory before introducing musical interval and frequency. A major scale is a series of seven notes that concludes with the pitch an octave above the starting note (see Figure 1). A musical interval is the distance between two notes based on their position within the sequence. The interval of a perfect fifth indicates the distance between the initial note and the fifth note of the scale. The same process can be applied to determine the major sixth and major seventh. When played together, these notes sound their respective intervals (see Figure 2).

Figure 1

C major scale

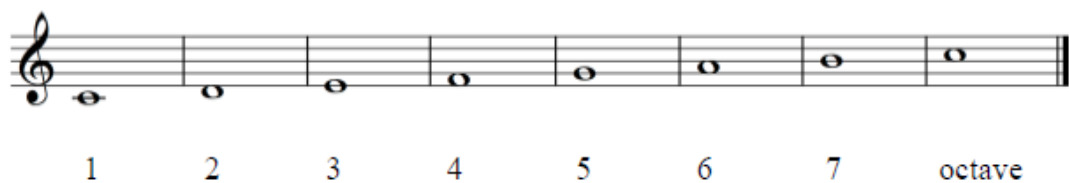


Figure 2

Musical intervals: perfect fifth, major sixth, major seventh



In their study of Pythagorean intervals and brain response, Foss et al. (2007) used intervals of a perfect fifth, major sixth, and major seventh. The perfect fifth had a ratio of $3/2$, the major sixth was $27/16$, and the major seventh was $243/128$. Foss tested a theory of Pythagoras that simple, consonant ratios would stimulate the brain less than complex, dissonant ratios. The perfect fifth had the simplest ratio and was the most consonant. The major sixth contained a bit of tension, but overall, the sound was still pleasing. The major seventh was the most dissonant and quite a contrast to the perfect fifth.

Foss et al. (2007) concluded that dissonant intervals produce significantly more brain activity than their consonant counterpart. The Pythagorean intervals evaluated by Foss et al. differ slightly from the equal temperament intervals of the Western tuning system adopted by much of the world (Daniélou, 1995). Pythagorean and equal temperament intervals were both implemented in this project.

Solfeggio healing frequencies were another component of this study. Uncovered by Dr. Joseph Puleo in the mid-1970s, Horowitz and Puleo (2001) introduced this ancient series of six tones to the general public. Each solfeggio frequency possessed unique healing properties including pain reduction, relief from guilt, relationship repair, peace, love, and expansion of consciousness (Horowitz & Puleo, 2001; Pereira, 2016).

The solfeggio syllables originated from a Gregorian chant dedicated to St. John the Baptist, where each hymn line ascended by a single scale degree (Horowitz & Puleo, 2001). As shown in Figure 3, once corresponding pitches are assigned to the solfeggio frequencies, what is produced is not scalar but something closer to the arpeggio of an A^b dominant seventh chord with the addition of a G natural (♮). While each of the frequencies is a little high when compared with Western equal temperament tuning, the E^b and high A^b are considerably sharp.

Akimoto et al. (2018) were among the first to test a solfeggio healing frequency scientifically. They concluded that listening to five minutes of 528 Hz music significantly decreased biological stress markers, encouraging a relaxed, concentrated state of mind. It is important to note that Akimoto et al. used pre-recorded piano music that was tuned to A = 440, which was then raised to A = 444, so the note C₅ becomes 528 Hz (see Table 1). However, it is unknown how frequently that specific key was played. This is why the effects of 528 Hz music were examined, not the frequency of 528 Hz.

Figure 3

Solfeggio healing frequencies. + difference > 15 Hz, ++ difference > 20 Hz

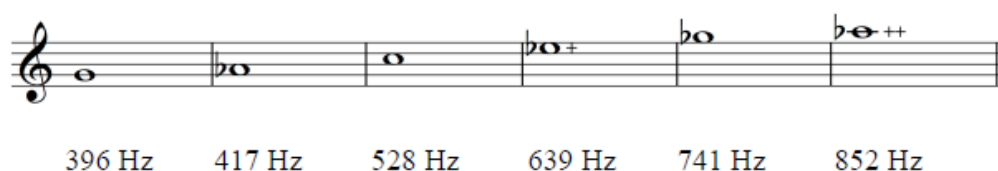


Table 1

One Octave Sample of Musical Frequencies (Hz)

Pitch:	C	D	E	G	A	C
Track 1 A = 444 Hz Equal Temperament	264	296.34	332.62	395.55	444	528
Track 2 C = 523.25 Hz Pythagorean Interval	261.63	294.33	333.12	392.44	441.50	523.25
Track 3 C = 528 Hz Pythagorean Interval	264	297	334.13	396	445.50	528
Track 4 A = 440 Hz Equal Temperament	261.63	293.68	329.63	392	440	523.25

Note. Bold indicates a solfeggio healing frequency

Table 1 shows the frequency sets used in this study. There are two tuning systems: equal temperament, represented by track four, is the standard Western tuning system that has been in use for around 200 years (Farnsworth, 1969). Track two begins with the same pitch but the frequencies are slightly higher, or sharp in musical terms. This is the Pythagorean interval tuning. The Pythagorean interval is considered pure, whereas the intervals of equal temperament were compromised to fit 12 tones within an octave. Looking closer at the Pythagorean intervals, D and G are approximately 0.5 Hz higher than equal temperament, while the differences with E and A are closer to 1.5 Hz. The frequencies in the first track have been raised from the standard, A = 440 to A = 444, and remain in equal temperament. In doing so, C becomes 528 Hz, a solfeggio healing frequency. However, starting from the same pitch, 264 Hz, and applying the Pythagorean intervals (track three), G moves from 395.55 Hz to 396 Hz, and there are now two solfeggio healing frequencies. Regarding these minute adjustments in frequency, French musicologist and Hindu scholar Alain Daniélou (1995) insisted, “Only by respecting such subtle differences can the edifice of sounds become the image of reality and one of the ways of spiritual realization” (p. 8). This study explored these fine variations in tuning and their impact on consciousness. To directly investigate the calming and healing effects of musical frequency and interval during meditation practice, participants meditated with four versions of the same music containing slight differences in frequency. Data was collected through qualitative interviews and examined using interpretative phenomenological analysis to determine which frequencies were the most calming.

Method

Research Design Overview

I composed meditation music that emphasized consonant intervals and solfeggio healing frequencies. Perfect fifths were heard in the opening theme and throughout the entire piece of music (see Figure 4). The primary theme introduced major sixths (see Figure 5), followed by the use of perfect fourths in the final theme (see Figure 6). The primary theme was structured around the notes G and C, which produced the solfeggio healing frequencies of 396 Hz and 528 Hz, respectively, in the Pythagorean interval, C = 528 Hz tuning.

Figure 4

Musical excerpt: opening theme



Next, I built four “frequency keyboards” by recording each pitch individually from a frequency generator and assigning it to the appropriate key through a music sampler program. I then performed the music on a Musical Instrument Digital Interface (MIDI) controller, which triggered the frequencies. The same MIDI performance was applied to each frequency keyboard, making pitch the only variant between the tracks. A single meditation lasted nine minutes, totaling 45 minutes for the five practices.

Figure 5

Musical excerpt: primary theme



Figure 6

Musical excerpt: final theme



Participants were sent the meditation music as a .mp3 file and asked to journal after meditating in the space of their choosing, with each of the four versions and once in silence. The music tracks were numbered 1–4 without indication of tuning or interval. One week was given to complete this task. Following the exercises, an interview was conducted remotely to assess the research question through the personal experience of each participant.

Study Participants

Researcher Description

Music has been a substantial part of my life for 30 years. I received a Bachelor of Music from Northern Illinois University in 2001 and a Master of Music from Western Michigan University in 2003. As a professional musician, I have toured with major artists, recorded music for film and television, and released four albums of original compositions. Having many transcendent experiences throughout my life as a musician, I wholeheartedly agree that music, as sound and vibration, has the potential for powerful healing.

My previous musical background, as well as the study participants, or really anyone outside of India, has only dealt with Western equal temperament tuning. In preparation for this research project, I generated a musical scale using Pythagorean intervals and compared it to the equal temperament equivalent. The Pythagorean frequencies were slightly higher or sharp, leading me to expect my ear to perceive them as more intense, aggressive, or bright. To my surprise, the series of pitches felt calm, gentle, and harmonious, further encouraging my belief that this adjustment in tuning would be significant to this study. To ensure the validity of the findings, conclusions were drawn directly from participant responses.

Participants

Seven participants contributed to this research project. Participants' ages ranged from 26–69 years, consisting of three males, three females, and one who identified as nonbinary. Five of the participants meditated regularly, with three having previous experience as meditation instructors. Four participants had musical training and were active as performing musicians or songwriters.

Researcher-Participant Relationship

All participants knew me prior to the study. Each of these relationships was in good standing and free from tension, allowing for a deeper level of openness and trust during the interview process. To safeguard against conflict of interest, the interview questioning was limited to the research questions, with nothing personal being discussed. Each participant was treated with the same kindness and respect. Consent was voluntary, and the participants were free to withdraw at any time for any reason.

Participant Recruitment

Recruitment Process

Study participants were contacted by phone and given a brief description of the research project. Those open to participating were sent an email with instructions, the four music tracks, and a consent form. Eight individuals expressed interest, with seven committing to the study. The research purpose was stated as an investigation of how musical interval and tuning affect meditation. Tracks were numbered 1–4 so the sequence was consistent, and the participants would be unaware of which frequencies they were listening to. If requested, these details were given to the participants after completing the interview. In place of using names, each participant was assigned a number corresponding to their interview order.

Participant Selection

I intentionally selected participants from the musician and Buddhist communities to

which I belong. A background in music, meditation, psychology, or a combination thereof served as criteria for this purposive sampling method. The qualitative data was collected via remote interviews, which took place between November 6th–12th, 2022.

Data Collection

Data Collection Procedure

The data for each participant originated from a single interview lasting approximately 20 minutes on Google Meet. In all, 132 minutes of data was collected. Questioning followed a semi structured interview format centering on the participants' general experience meditating with the music. They were asked if a particular track felt more calming than the others, if music was preferred to silence, and their state of mind before the practice. The research goal was to document the transpersonal experience of the participants and the role music played in attaining that state.

Recording and Data Transformation

Audio recordings of each interview were made using a digital handheld recorder. These files were exported to a computer and transcribed through the dictation function of Microsoft Word. To ensure accuracy, I listened to the recorded interviews repeatedly, making the necessary corrections to the written transcripts. Quotations were double-checked with the transcripts and audio recordings. Repeated words and some filler words were omitted.

Analysis

Themes were generated and refined using interpretative phenomenological analysis (IPA). This methodology concentrated on meanings prescribed to the personal experience of each participant (Smith & Eatough, 2021). Relying on descriptive qualitative data, IPA provided insight into participants' thought processes and emotional engagements by interpreting experiential meaning in two stages. This "double hermeneutic" approach first considered the participant's interpretation of the event, which was then interpreted by the researcher with the intention of accurately conveying the participant's meaning from their unique perspective (Smith, 2019; Smith & Eatough, 2021). IPA presented broad themes highlighting general commonalities within the data while supportive, individualized views were expressed through direct quotation. For a main theme to be taken into account, it had to be found in at least four of the seven interviews. This decreased to two or three interviews for secondary themes.

Findings

Interpretative phenomenological analysis revealed two main themes: music quiets the mind, and music is calming and healing. Three secondary themes also emerged: heightened awareness and connection, sensations of warmth and resonance, and music being distracting.

Music Quiets the Mind

By placing their attention on the music, participants were able to achieve higher levels of concentration, which led to deeper states of meditation. Participant #6 explained:

If I'm able to focus on the music, it takes me away from all the other distractions...it really just sent me into a deeper state...for sure I felt that part of it sent me a different sensation than it would be without the music.

Without effort, Participant #6 felt taken by the music to a deeper, more concentrated state of mind. This implied that an element of submission or giving oneself to the music made this transaction possible. Conversely, Participant #3 recalled that the music had a stabilizing effect, stating, "it anchors that part of my brain that would otherwise wander, be distracted by sounds outside, or my own thoughts." The image of an anchor was an interesting contrast to the feeling of being transported. While music brought Participant #3 a firmer sense of grounding within herself, Participant #6 had a self-transcendent experience. For those who had difficulty meditating in silence, music acted as a meditation tool, providing a specific place to focus their attention.

Music is Calming and Healing

As music quieted the minds of the participants, they found the music to be calming and healing. This was especially true for the 528 Hz track, which contained two solfeggio healing frequencies. Regarding his experience with this version, Participant #2 commented: I think I had a deeper quality of meditation while listening to that track, like if you sit into a deep sofa and it feels like you're really settled into it. I felt I was comfortably and calmly in a deeper state of meditation while listening to that track. The comparison to a deep sofa evoked the sensation of being completely supported and relaxed. It could also be recognized as true serenity without worry or concern. This tuning brought the same peace of mind to Participant #3 who shared:

This is the first one that I felt affected my psyche. After I was able to calm down, I had a mild, pleasant feeling. I was feeling frustrated earlier in the day, and this neutralized it. And I felt pleasant, calm, soft, happy when I was done.

The act of calming allowed for a complete release of stress and frustration. Music was able to shift the mind from a destructive loop to a place of healing. Participant #7 had a similar experience, confessing, "I feel more able to look at why I'm sad and uncomfortable after doing that." Music had the means to encourage presence and calmness of mind, guiding its listener to the healing and oneness that exists within.

Heightened Awareness and Connection

In addition to the music being calming and healing, a few participants reported changes in awareness. This heightened awareness extended beyond the body and, in one instance, transcended it. Participant #2 described the experience as "simultaneously feeling very centered and settled in the body, but also having that awareness of what's going on around you." Blurring the line between subject and object, the experiencer and environment were unified in nonduality. For Participant #6, this awareness reached a state of transcendence in which she felt "connected to something bigger than me." Participant #6 was the only one who reported a spiritual experience of this magnitude. Her personal spiritual beliefs may have contributed to this realization.

Sensations of Warmth and Resonance

Participant #2 and Participant #3 experienced sensations of warmth and resonance with the music. Participant #2 was synesthetic, allowing him to perceive sounds as colors, and each track activated it differently. The A = 444 track was the most dramatic, with Participant #2 describing it in this way: I began to see a lot of oranges, and reds, and

yellows, almost like a really rich sunrise or sunset. It was really beautiful, and it felt like a warm blanket coming over me as I was doing the meditative process.

This type of visual stimulus might have been distracting for some meditators. However, the warm blanket suggested detachment and peace with the event rather than engagement that would detract from the meditation itself. Participant #2 continued, "I felt the first track was extremely soothing. There was something about it that resonated with my body in a physical way and emotional way as well." Participant #3 expressed feelings of warmth and resonance with the A = 440 track. Although it was a different tuning from Participant #2, this suggested a relationship between the two sensations. Participant #3 recalled her experience: Something about the frequencies here felt euphoric like I had sympathetic resonance. I had a feeling of aliveness, being even and centered and anchored. I wrote, lower chakra energy that manifested as warmth that spread evenly throughout my body. Calm bliss. Music has the ability to interact with the body as well as the mind. Being interconnected, physical sensation was another path to the presence of mind.

Music is Distracting

The possibility was considered that some may prefer silence to meditating with music. This was the case for Participant #1. While others mentioned they were distracted by the music at times, each of them was able to calm their mind eventually. Participant #1 was alone in citing the music as a deterrent to meditation practice. He reasoned, "I was paying attention to the notes, and that drew my attention away from my centering." Participant #1 admitted he had a very active mind and minimal meditation experience, which may have been responsible for this outcome.

Discussion

The findings show that meditation music had a calming or healing effect for six of the seven participants. The results were mixed regarding the music tracks themselves. For example, A = 444 track was an intense experience for Participant #2, but only a subtle experience for Participant #3. In turn, the A = 440 track had a strong effect on Participant #3, while Participant #2 recounted their experience as mild. Most of the data followed this trend; what may have been a positive experience for one participant might be neutral or not beneficial for another. That being said, four of the six participants who preferred meditating with music chose a 528 Hz track as the most impactful. The five participants who responded strongly to the 528 Hz Pythagorean tuning unanimously described it as calming and healing. This discovery was significant given track three was the only version containing two solfeggio healing frequencies. Each of the other tunings had one participant report feeling anxious or unsettled.

These results were supported by the previous studies that assisted in formulating the research aim for this project. Vibration from singing bowls produced a calming and relaxing effect during a sound healing session and when preceding meditation (Goldsby et al., 2017; Landry, 2014). This study agreed, determining the majority of those interviewed found the music calming and preferred meditating with music to silence.

Music containing 528 Hz brought people to a deeper state of relaxation than music without this healing frequency (Akimoto et al., 2018).

When asked which version was the most significant, four of the six participants who preferred meditating with music chose a 528 Hz track.

Consonant musical intervals generated less neurological activity than dissonant intervals (Foss et al., 2007). The music I composed for this project was structured around consonant interval ratios consisting of octaves (2/1), perfect fifths (3/2), perfect fourths (4/3), and major sixths (27/16) with the intention of creating a calming piece of music appropriate for meditation.

Stillness of mind and self-transcendence were common characteristics of meditative experience (Osis et al., 1973). The shifts in awareness and feelings of connection communicated by the participants fall under these categories. The participant's state of mind prior to meditation was the wild card of this study. Three of the participants felt their mood that day might have been a factor in their ability to meditate. This could skew the data by misrepresenting which track was most effective in calming the mind. It also raised the question if an individual's state of mind prior to meditation had a greater influence on the practice than the music itself. This study was also limited by its small, purposive sampling method and recorded music.

A questionnaire could be administered in a mixed methods approach to better assess participant mood before and after the intervention. Collecting supplementary biometric data may prove useful in quantifying the qualitative data. It would be exciting to see what is possible in a larger context with live music. The length of the intervention could be extended from nine minutes to 30 minutes or more. Additionally, it would be worthwhile to measure the long-term benefits over weeks of regular sessions.

Summary

This project was an exciting first step to better understanding the calming and healing power of music. The findings of this study concluded 528 Hz and the Pythagorean intervals consistently induced calmness and a deeper state of meditation, as well as heightened awareness, connection, and sensations of warmth and resonance among the participants. These results align with the transformative characteristics attributed to music by Greek and Chinese philosophers, which have been verified in recent music therapy research. Furthermore, this discovery suggests that the healing properties of music can be maximized through frequency and interval, awakening the transformational qualities of sound and establishing a direct line to the transpersonal.

Next Steps

An extraordinary opportunity exists for musicians who are also trained in psychology. In his book *Psychosynthesis*, Roberto Assagioli (1965) proposed, "In the future, the development of musical therapy may make it possible for musicians, who are also psychologists or doctors, to compose special music aiming at definite therapeutic effects" (p. 256). Considering the spiritual implications of such a union, the field of transpersonal psychology would provide a wonderful avenue for scientific exploration along these lines. Various writings on the psychology of music, and research examining

the ability of music to engage emotions, excite meaning, and expand consciousness need to be investigated and assimilated by someone well versed in both the languages of music and science. Should this person be a composer of music, the psychological benefits of such a pursuit would be substantial and profound.

Most music is made for entertainment purposes, which lack transpersonal applications. There is a need for music created with the intention of healing. To my knowledge, no one is writing music using solfeggio frequencies and Pythagorean intervals. The results of this study show incredible potential for a new kind of music that can be used to calm, heal, and connect.

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