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Exploring Sound Waves through a Frequency Study of the Ambience Music Weightless by Marconi Union

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ABSTRACT

This study explores the creation process of "Weightless," a relaxation music piece by Marconi Union, with a focus on its compositional elements and how frequencies are manipulated. The aim is to deepen the understanding of both educators and undergraduate students regarding the use of Digital Audio Workstations in composing music, thereby promoting digital literacy within 21st-century music education. The research employs a descriptive qualitative method, utilizing an exploratory approach and content analysis.Through this analysis, it becomes clear that "Weightless" effectively incorporates slow tempos, minimalistic textures, and gradual changes in dynamics to create a relaxing atmosphere. The frequency analysis highlights the importance of low frequencies (ranging from 20 to 200 Hz), which contribute to a sense of depth and tranquility. In contrast, mid and high frequencies are carefully balanced to ensure they do not overwhelm the listener. Additionally, the loudness analysis reveals a smooth dynamic range, with an average level of -13.9 LUFS and no sudden peaks, which guarantees a pleasant listening experience across various playback devices. Overall, these findings emphasize the critical role of precise frequency manipulation and loudness control in producing effective relaxation music, providing valuable insights for both music composition and education.

KEYWORDS

Music Relaxation
Music Composition
Frequency
Ambience

INTRODUCTION

The increasingly busy human life, especially in big cities, often makes people feel pressed by time while they are also faced with various life problems waiting to be overcome. This certainly triggers the emergence of stress in humans. Stress is one of the challenges that humans often face in big cities when living a busy and busy life. (Sonya et al., 2023; Whiting et al., 2021). Humans often feel trapped in endless routines and find it difficult to find time for rest and recovery. This condition can certainly have a negative impact on a person's physical and mental health, disrupting life balance and quality of life. Therefore, it is important to be aware of the importance of stress management and find ways to cope with the stress that arises in order to live a better, balanced and quality life.

Music has been believed for centuries to have the power to restore the human soul. In line with the development of technology and the advancement of civilization, over the past few decades the practice and healing through music has been empirically tested (Bourne & Burke, 2024; Djohan, 2006). Music has a place as a holistic therapy, because it directly touches on the cognition, affection, and psychomotor aspects of human beings (Alimi

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Selmani, 2024; T. Zaatar et al., 2024; Toader et al., 2023). Studies have shown that listening to music has benefits for lowering heart rate and stress hormone levels (Modran et al., 2023), Thus, music has been used to reduce stress and anxiety for many years. Although music has long been used in therapy, few relaxation music can actually help the community and support the medical therapist in recovering his or her patients (Sonya et al., 2023). One of the relaxation music compositions that has been widely used in music therapy is "*Weightless*", by the British *ambient* music group Marco Union in collaboration with Lyz Cooper (the initiator *of the British Academy of Sound Therapy*) (Passman, 2016). In fact, in the last 9 years the official video of "Weightless" has been viewed more than 110 million times, millions of *likes* and thousands of comments. Forbes Online Media even named "*Weightless*" as the best relaxation music in the world. Some research and information from Time magazine also labeled this 8 minute 10 second piece of music as the Best Invention of 2014 (Neporent, 2023; PRnewswire, 2014). A study from Mindlab UK validated the claim that the *ambient music* "*Weightless*" ordered by Radox Spa was more soothing than other relaxation songs/music, and compared the relaxing effect of "*Weightless*" with a relaxation massage. The result is that this music is able to reduce heart rate by up to 18.6%, stress level by 61%, and relaxation score by 73% (while massage is only 67%) (Mindlab, 2013; Schäfer et al., 2013; Thayill & Shetty, 2019).

The creation of artworks involves the process of creation, karsa, and taste. All of this joins in creation, where creativity, exploration and innovation are influenced by emotional experiences (Passman, 2016). However, reason and reasoning also play an important role as time goes on. Therefore, steps are needed to strengthen the paradigm and expand the knowledge of the resulting artwork. Talking about the development of the world of musical art, of course, it is inseparable from a cultural change that continues to occur around the world, and occurs at any time throughout the civilization. This situation allows for efforts to renew, influence each other, and 'adopt' each other between cultures (Raban & Thasmai Dhurumraj, 2023). When a value or information or message wants to be expressed in a certain cultural form, it is transformed or improved through a certain cultural form/expression (Andriyanto, 2020; Pramana et al., 2023).

In today's digital era, the creation of musical works, both compositions and arrangements, is increasingly developing with the existence of music technology (Ayuningtari & Marianto, 2023). Music technology is often used to create musical works, this is often known as music production. Because the use of technology is able to make it easier, cheaper, and even possible something impossible to be possible, especially in producing music (Andriyanto, 2021). Burgess (2013) said that music production is the addition of technology used to composition and orchestration. This is to get optimal results from the overall composition, and orchestration (Lestari, 2019). Music production is not only representative but also an art in itself. For this reason, in conducting music production, mastery of the use of music technology is as important as the science of composition and arrangement.

This study wants to see in depth the work through the analysis of the music through the frequency using the software mentioned in the methodology and this research will provide detailed information about the song by Marco Union which will be analyzed every second, so that it will provide complete information on this relaxation song.

Relaxation music has long been recognized as an effective tool for reducing stress and improving mental and physical well-being. One of the main functions of music is its ability to create a relaxing effect on its listeners (Sonya et al., 2023). With a combination of soft melodies, calm rhythms, and harmonious tones, relaxation music has the unique ability to

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stimulate a relaxation response in the human body. Soft rhythms and melodies are able to help calm the mind and body, so they are often used in a variety of contexts to reduce stress and increase feelings of calm (Pramana et al., 2023; Yanti et al., 2016). Along with the times, there is a type of relaxation music introduced by Brian Eno, a producer/composer who is famous as a pioneer of *ambient* music in the 1970s. Eno has released a number of albums that influenced the development of *ambient music*, such as "*Music for Airports*" (1978) and "*Apollo: Atmospheres and Soundtracks*" (1983). Eno's approach to *ambient* music often involves the use of rich sound textures and deep atmospheres to create a deep and meditative atmosphere. Thus *ambient* music, can be classified as relaxation music (Laksono et al., 2018). This ambient genre music is a type of instrumental music that is produced using electronic devices such as computers, synthesis, and others. This music is characterized by its creator as music that is suitable for creating an atmosphere or atmosphere that suits the *mood* and a calm environment.

When listened to attentively, this relaxing/*ambient* music can help lower heart rate, reduce blood pressure, and reduce levels of stress hormones such as cortisol. Relaxation music can affect heart rate, blood pressure, as well as stress hormone levels in the body, thereby significantly contributing to the recovery process from stressful states. This is supported by the findings of various scientific studies that show that listening to music regularly can help individuals to recover from stress and achieve a state of relaxation (Kamagi, 2021). In addition, relaxation music can also improve concentration, facilitate meditation, and aid in better sleep (Kamagi, 2021). The different types of relaxation music (Rentfrow et al., 2011), from calming instrumental music to soothing nature sounds, allow individuals to choose the one that suits their preferences and needs. As such, relaxation music is not only entertainment, but also a valuable tool in achieving balance and holistic well-being. With the wide variety of relaxation music available—from soft instrumental tunes to the tranquil sounds of nature—individuals can select the type that resonates most with their preferences and needs (Neporent, 2023). Whether seeking a moment of peace after a hectic day or using music as a regular wellness practice, relaxation music offers a holistic tool for achieving balance. This versatility underscores its growing importance not just as a source of enjoyment, but as an essential part of maintaining mental and physical health in a fast-paced world.

Previous studies in the use of this song as a relaxation test material did not examine in detail the in-depth analysis of the music from the beginning of the tempo, the relationship between frequency and frequency, tempo changes and how much tempo changes in each second. Marconi Union is one of the most popular British *ambient* music groups that emerged at the beginning of the 21st century. Marconi Union was founded in 2003 after musicians Jamie Crossley and Richard Talbot met while working in a Manchester record store. Since their debut album with *Under Wires* and *Searchlights* in 2003, their music has been widely accepted. In 2005 they signed with All Saints Records, they were appointed by Brian Eno to supervise *the remastering* of his work. They then released *All Saints*' work, *Distance*, which came out in Europe in October 2005 (and then in the US in February of the following year). Marconi Union also published *A Lost Connection* digitally through *their own MU Transmission* in 2008. One year later, the group's fourth album (Tokyo) appeared on their fourth label (Binemusic). The label also released the techno-influenced Glassworks EP in 2010 (Brown, 2021). The group rose to fame for their October 16, 2011 release composition "*Weightless*", a collaboration with Lyz Cooper of the British Academy of Sound Therapy and Radox Spa designed to reduce stress (Mindlab, 2013). This 8-minute work features a guitar, piano, and manipulated recording techniques. This is punctuated by low

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notes that are said to cause trance-like circumstances. "*Weightless*" was created to help reduce anxiety and heart rate in patients. It was reported in a study conducted by Mindlab at the Sussex Innovation Center in Brighton that listening to the song reduced patients' anxiety by 73%, to 11% better at encouraging relaxation than other relaxation music. and a 6% increase when compared to massage (Mindlab, 2013).

The song was recognized by Time Magazine, which included Marconi Union in the list of the Best Inventors of 2014 (PRnewswire, 2014). "*Weightless*" went on to become popular on *streaming platforms*, including a ten-hour version of "Weightless" uploaded to YouTube, and eventually appeared on Billboard's Electronic and New Age charts. Despite the success of "Weightless", the Marconi Union group avoided playing it live, viewing it as a separate project from the performing arts (Brown, 2021). Continuing to move towards a purer ambient genre, Marconi Union kicked off *their Ambient Transmission* series with 2011*'s Beautifully Falling Apart*, followed by the album *Weightless* in 2012. In the same year keyboardist Duncan Meadows joined the group Marconi Union as a *full-time member* (Brown, 2021). Furthermore, this group routinely releases singles or albums in the ambient genre almost every year. In 2021, they released the album *Signals.*

METHOD

This study employs a combination of spectral and frequency analysis techniques (Deepaisarn et al., 2023) to explore the sound waves in Weightless by Marconi Union. The analysis focuses on examining the frequency spectrum, amplitude dynamics, and how these acoustic elements contribute to the calming effect of the ambient composition (Mindlab, 2013; The MindLab, 2012). The methodology is structured into three main phases: data collection, frequency analysis using Fast Fourier Transform (FFT), and amplitude analysis (Field, 2019; Kirk, 2023).

1. Data Collection

The audio data for Weightless was collected in its highest available quality (uncompressed WAV format) to ensure precision in the analysis. The song was imported into specialized audio analysis software, including Audacity and MATLAB, for further investigation (Azalia et al., 2022; Budiawan et al., 2023). These tools allow for accurate visualization of the sound waveforms, frequency distribution, and other acoustic parameters that are central to the study.

2. Frequency and Spectral Analysis

To analyze the frequency content of Weightless, a Fast Fourier Transform (FFT) was applied to the audio signal. FFT breaks down the sound into its constituent frequencies, enabling the identification of dominant frequencies, harmonic structures, and subtle tonal variations. MATLAB and Praat software were used for this spectral analysis, providing detailed insights into how different frequency bands contribute to the ambient and calming qualities of the piece. MATLAB excels in the flexibility of sound frequency analysis with advanced scripting capabilities and interactive visualization, while Praat offers an intuitive interface and special features such as spectrum, formant, and pitch analysis, ideal for acoustic studies. The combination of the two complements each other for optimal results. The analysis also investigates the balance between high, mid, and low frequencies, and their evolution over time, revealing how the arrangement of frequencies promotes relaxation (Y. Wang, 2021).

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3. Amplitude and Dynamic Analysis

Amplitude variation across the duration of the track was examined to understand the dynamic range of the composition. The analysis focused on how changes in sound intensity (loudness) influence the listening experience and contribute to the perceived calmness of the music (Kuttruff, 2018). The gradual shifts in volume, subtle crescendos, and decrescendos were mapped to demonstrate the intentional design of sound dynamics in the piece.

This multi-step methodology ensures a thorough examination of the sonic properties of Weightless, linking its acoustic characteristics to its physiological and psychological effects on listeners. The integration of both technical sound analysis and potential empirical testing provides a comprehensive understanding of the impact of this ambient composition.

RESULT AND DISCUSSION

In analyzing the composition of Weightless, several steps are taken, first get a WAV file downloaded from the https://www.youtube.com/watch?v=UfcAVejslrU youtube link. Then the audio of the work is imported into DAW Logic Pro 11 to determine the complexity of the tempo, *loudness level,* stereo *image* level and overall frequency of the work.

Tempo Analyzes

Through a wav audio file imported into the DAW, the tempo is analyzed using *the adapt tempo* feature. This feature is able to adapt to adjust the audio file to the tempo *of the Logic Pro project.* The tempo is obtained based on *the transient detection* of low-pitch beats in the Weightless composition, which is constantly chirping at a frequency of 81Hz (E2).

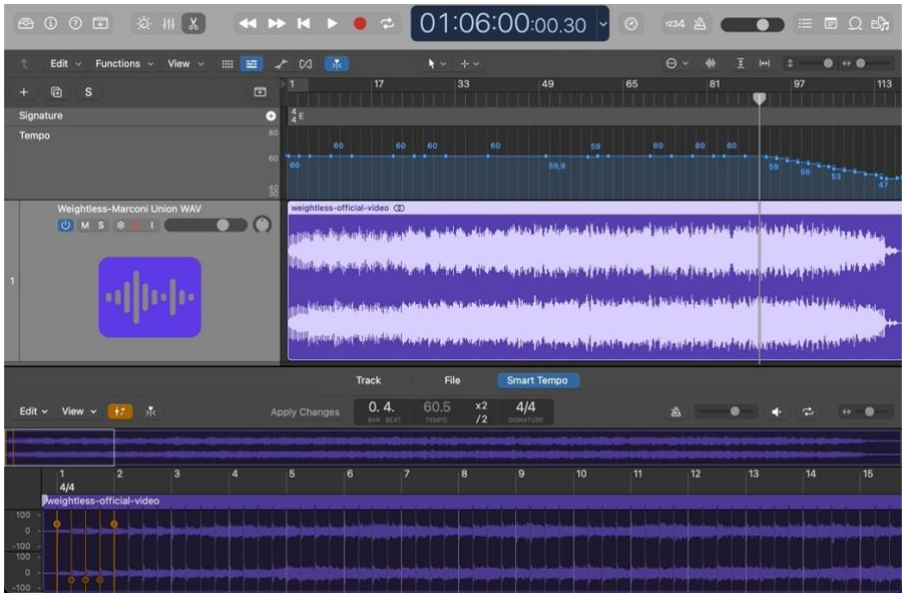

Figure 1. Weightless tempo analysis using *smart tempo.*

Based on *transient analysis*, the average composition of Weightless has a tempo of 60 bpm for 6 minutes and 9 seconds (0:00-6:09), this tempo is similar to the count of 1 second in 1 minute. Then after that Weightless experienced a long slowdown for 2 minutes (6:09-8:09). This slowdown occurs due to a gradual reduction in tempo of 1-1.5 bpm every 8-10

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seconds on average, so that at the end of the weightless tempo work it reaches a slowdown of up to 45 bpm.

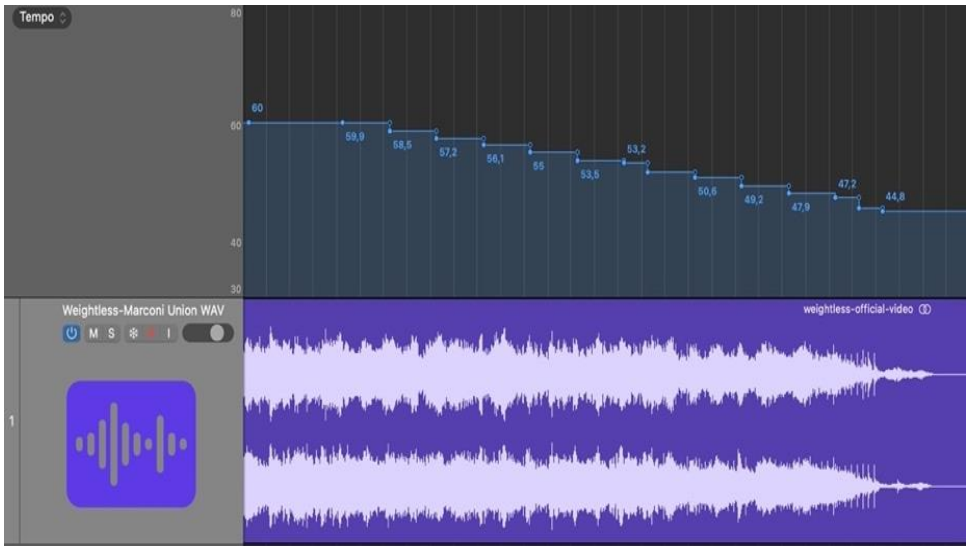

Figure 2. Weightless tempo analysis using *smart tempo*

The tempo change in this music is very slow and the details are paid attention to by the composer, so that the listener hardly feels that the tempo of this work decreases (slow) as time goes on, this is enough to be considered so that this relaxation music can feel like the body is getting more relaxed and the heart rate is getting lower following the tempo in this work, here is a detailed display of the tempo change in the piece.

Table 1. Tempo change on the slowdown of the Weightless composition

Time (minute:second)	Tempo change
6:09	59,9 bpm
6:13	58,5 bpm
6:21	57,2 bpm
6:29	56,1bpm
6:38	55 bpm
6:46	53,5bpm
7:00	51,4 bpm
7:09	50,6 bpm
7:18	49,2 bpm
7:28	47,9 bpm
7:38	47,2 bpm
7:44	45,4 bpm

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Loudness *Analysis*

From the WAV audio data studied, *a loudness analysis* was carried out using *the Fabfilter Pro-L2* limiter plugin.This *plugin* is able to accurately measure *momentary loudness*, which is the level of instantaneous loudness, and *integrated loudness*, which is the level of hardness of the entire work from start to finish with LUFS (*Loudness Unit Full Scale*) units. And able to detect the *loudness range*, which is the variation in the level of hardness in the work with decibel units. In the first 2 minutes of Weightless's work, the Pro-L2 shows a low level of momentary *loudness* in the range of -22LUFS to -17LUFS. After 2 minutes it starts to increase to a momentary range of -16LUFS to -10LUFS for 5 minutes. then in the last 1 minute it began to decline again to the range of -12LUFS to -22LUFS. This shows that the work begins with a gentle dynamic, gradually hardens and then ends with softening. From the *loudness range* of 5.4dB, it can also be seen that the whole work does not have a *momentary loudness* spike that is too contrasting, which can surprise the listener.

Figure 3. Momentary Loudness at the beginning of the composition Weightless.

After sounding in *realtime* from the beginning of Weightless's work to the end, it was found that the average loudness or *Integrated loudness* was -13.9 LUFS with *a maximum truepeak* of -1.3dB, and an average Loudness Range variation of 5.4dB. From this observation, the hardness level of Weightless's work certainly adjusts to the standard rules of the hardness of the *youtube platform*, which is a maximum of -14LUFS (*ITU 1770 Standard*), with *a peak* that is still below -1dB (so there is no distortion). With this level of hardness and a range of variations in violence, of course, it will feel comfortable to listen to and compatible with sound on various audio player devices such as cellphones, *tablets*, *headsets*, *earphones*, small and large speakers.

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Figure 4. Integrated Loudness Overall Weightless Composition.

Sound Width Level *Analysis (Stereo Image)*

The Width Level Analysis in this research was conducted using two key plugins: Voxengo SPAN and Izotope Ozone Imager 2. Each plugin serves a specific function in measuring and visualizing the spatial characteristics of sound, providing complementary insights into how audio occupies the stereo field. Voxengo SPAN, widely used for its precise frequency spectrum analysis, was employed to measure the mid-side image spectrum. It offers detailed statistical data on the stereo width, which is crucial in understanding how sound elements are distributed between the left and right channels. SPAN can break down the sound's mid (center) and side (width) components, allowing for a deeper analysis of how much information is present in the center versus how much is spread across the stereo field. This data-driven approach makes SPAN a valuable tool for ensuring that audio maintains a balanced width without becoming overly narrow or excessively wide, which can lead to phase cancellation issues.

On the other hand, Izotope Ozone Imager 2 offers a more visual and intuitive perspective, allowing users to visually monitor the breadth of sound in real-time. Unlike SPAN, which focuses on numbers and graphs, Imager 2 presents a dynamic visual representation of stereo width. This enables sound engineers and composers to immediately grasp how sound elements are positioned spatially across the stereo field. The plugin can highlight whether certain frequencies or instruments are too centered or too wide, providing a graphical view that complements the statistical data from SPAN. This visualization is particularly useful when adjusting the stereo image to create a sense of depth, space, or movement in the mix. A key feature shared by both plugins is the correlation meter, a vital tool for assessing phase relationships between the stereo channels. The correlation meter indicates whether the left and right channels are in phase (which ensures clarity and width) or out of phase (which can cause phase cancellation and a loss of sound quality). SPAN's correlation meter provides a precise numerical representation, while Imager 2 gives a more immediate, visual indication of the phase coherence. Maintaining positive phase correlation is essential in achieving a wide yet cohesive stereo image without compromising the overall audio quality.

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The combined use of Voxengo SPAN and Izotope Ozone Imager 2 enables a comprehensive analysis of sound width. By leveraging both statistical data and real-time visualization, the research provides a robust method for evaluating and enhancing the spatial dynamics of sound. This dual approach not only ensures that the audio maintains its intended width and balance but also allows for creative adjustments that enhance the listener's experience by creating a sense of space, depth, and immersion in the mix. Thus, the collaboration between these two plugins offers a holistic understanding of stereo imaging, blending precision with visual insight to optimize sound design and mixing processes.

Figure 5. *mid-side image* and *weightless composition* correlation meter.

Based on the Voxengo Span *mid-side* spectrum , it can be seen that the mid and side have more or less the same frequency information, but there is a weakening of the low and high frequencies on the sides. Meanwhile, the mid has a more dominant loudness with a slightly wider range of low and high frequencies (30Hz-15KHz). In addition, through the Span it is also measured that the *correlation meter* shows in the range area of 0.4 which means that there is no phase-canceling of Weightless audio, so it is safe to play on mono speakers. The Ozone Imager 2 Plugin also shows the same thing, where *the correlation meter* shows that the audio is in the area of 0 to +1. This is reinforced by a polar sample spectrum signal that shows the dominant audio in the center or mid area, which makes the audio more focused in the center area. And it can be concluded that Weightless's work does not have too wide an audio width.

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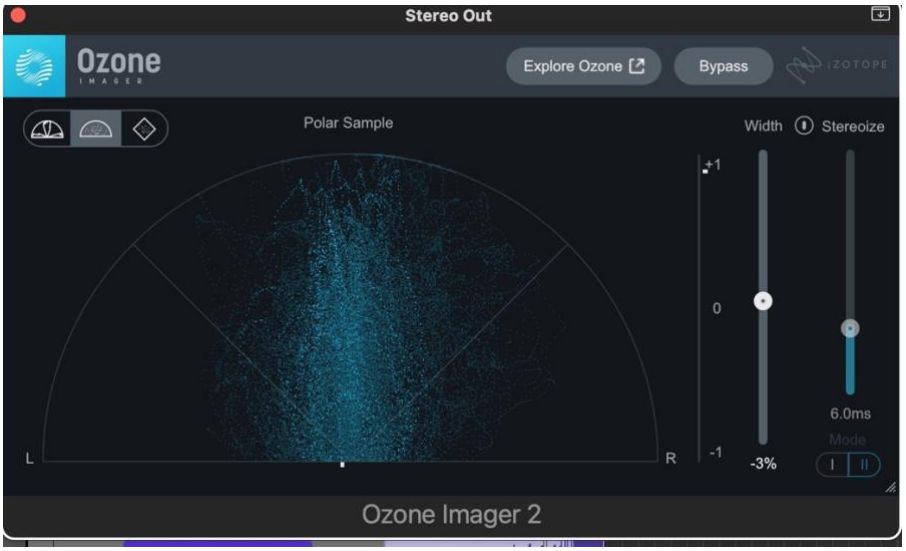

Figure 6. Visual polar sample and correlation meter Weightless composition.

Frequency Analysis

To detect the frequency of the Weightless composition is used the Fabfilter Pro-Q3 plugin and also Voxengo Span. The Fabfilter Pro-Q3 shows a wide and even frequency spectrum similar to the frequency of *pink noise*. Evenly distributed frequencies are often encountered in daily life such as *noise* during heavy rain or *noise* in air conditioning devices.

Figure 7. frequency range on Weightless composition.

From the frequency detection of the Pro-Q3, it can be seen that *the tuning* in this composition is at A4=432Hz. tuning which is often used in relaxation music in general. Data shows that music tuned at 432 Hz can lower heart rate than music tuned at 440 Hz (Calamassi & Pomponi, 2019). It can also be seen that some dominant notes appear (*note spikes*) with quick *attacks*, as well as long *decay* and *sustain*. Some of these tones are found in various frequency ranges, starting from low 81Hz, Mid low 150Hz and 216Hz, mid high

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432Hz, 880Hz, and 1.6KHz and High 3.1KHz. This long note is often found in various relaxation music. Notes that have a long *decay* and sustain tend to make listeners feel comfortable and more relaxed. The tone with a long decay sounded by Weightless is similar to the sound of saron, bonang, demung, kenong or gong instruments in gamelan devices.

Figure 8. Visual *frequency-dominant spikes* weightless composition

Using the average *mode display feature* on Voxengo, you can find out the appearance of the dominant long tone/note spike, the following is a list of *frequency/note spikes* in the Weghtless composition.

Table 2. Frequency/note spikes Weightless Music Composition

Time	Tone	Frequency (A4=432 Hz)
1:28	D5-D4	576.65-288.33
1:31	F3-A3	171.44-216.00
1:32	G4-D4	384.87-288.33
1:35	A3	216.00
1:40	A4	432.00
1:51	A4	432.00
1:52	D4	288.33
1:57	D5	576.65
1:58	D4	288.33
2:09	A4	432.00
2:21	A4	432.00
2:22	D4	288.33
2:27	A4	432.00
2:30	F3-A3	171.44-216.00
2:31	G4-D4	384.87-288.33
2:38	A4	432.00
2:57	A4	432.00

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3:01	G4	384.87
3:08	A4	432.00
3:26	A4	432.00
3:30	G4-D4	384.87-288.33
3:38	A4	432.00
3:39	D4	288.33
3:46	A4	432.00
3:47	D4	288.33
3:52	D5-D4	576.65-288.33
4:03	A4	432.00
4:15	A4	432.00
4:16	A4	432.00
4:21	D5	576.65
4:22	D4	288.33
4:25	G4	384.87
4:33	A4	432.00
4:51	A4	432.00
4:55	G4-D4	384.87-288.33
5:02	A4	432.00
5:12	A3	216.00
5:14	A4	432.00
5:15	D4	288.33
5:20	A4	432.00
5:25	G4	384.87
5:32	A4	432.00
5:44	A4	432.00
5:45	D4	288.33
5:50	A4	432.00
5:54	G4-D4	384.87-288.33
6:02	A4	432.00
6:03	D4	288.33
6:08	A3	216.00
6:13	A4	432.00
6:14	D4	288.33
6:19	A4	432.00
6:31	A4	432.00
6:32	D4	288.33
6:43	A4	432.00
6:44	D4	288.33
6:49	A4	432.00
6:53	G4	384.87
6:56	A4	432.00
7:01	A4	432.00
7:02	G4	384.87
7:12	A4	432.00
7:13	D4	288.33

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7:18	A4	432.00
7:22	D4-G4	288.33-384.87
7:30	A4	432.00
7:31	D4	288.33
7:37	A3	216.00

The table above is the frequency of occurrence of long notes in Marconi Union's *Weightless* music. Based on the table, the long notes that appear are simple and repetitive between the notes D, F, G, and A which are part of the pentatonic scale of the D minor chord. The use of pentatonic scales is commonly found in lullabies and folk songs that are able to provide a sense of calm.

DISCUSSION

The analysis of tempo in music, especially in compositions designed for relaxation or meditation, offers valuable insights into how rhythmic structure influences listener perception and emotional response. In this discussion, we explore the tempo analysis of *Weightless*, an ambient composition, using Logic Pro's "Adapt Tempo" feature, which is designed to adjust the tempo of an imported audio file based on the detection of transients, or sharp changes in sound energy. By examining the changes in tempo throughout the composition, we can gain a deeper understanding of how tempo manipulation contributes to the intended emotional and psychological effects of the music

Analyzing *Weightless* Tempo

In this study, the audio file of *Weightless* was imported into Logic Pro, where the "Adapt Tempo" feature was used to analyze and adjust the composition's tempo (Hammerschmidt et al., 2021). This feature allows the DAW to align the tempo of the project with the audio file by detecting the transients, which, in this case, are low-pitch beats at a frequency of 81Hz, corresponding to the note E2. The detection of these transients provides a basis for analyzing the rhythmic structure of the piece, as low-pitched beats often serve as the foundational pulse in ambient music, driving the listener's perception of tempo and rhythm (Nie et al., 2024). According to the analysis, *Weightless* maintains an average tempo of 60 beats per minute (bpm) for the first 6 minutes and 9 seconds of the piece (McDonough & Herczyński, 2023). This tempo closely mirrors the natural rhythm of 1 second per beat, which has a calming, clock-like effect on the listener (Geambaşu et al., 2020). The use of a consistent 60 bpm tempo is not arbitrary—research has shown that tempos within this range can promote relaxation by aligning with the body's natural rhythms, such as resting heart rate and breathing patterns. Thus, the choice of tempo in this section likely plays a role in creating the soothing, meditative atmosphere that *Weightless* is known for. However, the composition does not maintain this steady tempo throughout its entire duration. After the 6-minute mark, the tempo begins to decelerate gradually. Over the next 2 minutes, from 6:09 to 8:09, the tempo decreases at a rate of 1 to 1.5 bpm every 8 to 10 seconds. This gradual slowdown brings the tempo down to 45 bpm by the end of the piece. This deceleration is significant, as it creates a sense of time slowing down, which enhances the listener's feeling of weightlessness—a key thematic element of the composition (Stefanija & Stanevičiūtė, 2020). The gradual reduction in tempo is seamless, avoiding abrupt shifts that could disrupt the meditative state the music aims to induce.

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The Role of Tempo in Perception and Emotional Response

The tempo choices in *Weightless* are instrumental in shaping the listener's emotional response and perception of time. The consistent 60 bpm tempo in the first section of the composition helps establish a stable rhythmic environment that promotes relaxation. As previous studies on the psychology of music have suggested, tempos in the range of 60 bpm are closely associated with states of calm and restfulness (Schäfer et al., 2013). This connection between slow tempos and relaxation is further amplified by the use of low-pitch beats, which tend to have grounding, calming effects on the listener due to their resonance with the body's natural rhythms (Whiting et al., 2021).

The gradual deceleration in tempo later in the composition serves to deepen this calming effect. By slowly reducing the tempo, the composer effectively manipulates the listener's perception of time, creating a sensation of timelessness or suspension. This slowing of tempo, which aligns with theories of how slower rhythms influence relaxation and introspection, invites the listener to enter a more reflective, meditative state. The reduction in bpm from 60 to 45 bpm by the end of the piece aligns with the concept of "slowing down" not just in music, but in mental processes, encouraging a transition from active listening to passive absorption of the soundscape (Srayamurtikanti & Sunarto, 2022).

Technical Considerations in Tempo Detection

The use of Logic Pro's "Adapt Tempo" feature highlights the importance of technological tools in modern music analysis (Zhu et al., 2023). By relying on transient detection, particularly at lower frequencies such as 81Hz (E2), Logic Pro is able to accurately map the tempo of *Weightless*. This technological approach provides a level of precision that is essential for understanding the subtle variations in tempo that contribute to the overall effect of the composition (Wendzich & Andrews, 2021). The focus on low-pitched beats in the transient detection process is significant because these frequencies often serve as the anchor points for rhythmic perception (Rowland et al., 2019), especially in ambient music where higher-pitched rhythmic elements are less prominent (Field, 2019). The ability of the "Adapt Tempo" feature to track gradual changes in tempo, such as the deceleration observed in *Weightless*, offers a more nuanced understanding of how tempo evolves throughout the piece. The gradual nature of the tempo reduction is a key element in the composition's design, and the use of technology to capture this subtle shift allows for a deeper analysis of how tempo manipulation can affect the listener's experience (Budiawan & Martyastiadi, 2020; Kayne, 2022). Without such tools, detecting these gradual changes in bpm would be far more difficult, especially in a piece that is as ambient and texture-focused as *Weightless*.

The loudness and frequency analysis

The audio piece "Weightless" provides valuable insights into the dynamic structure and sonic design of the work. Utilizing the FabFilter Pro-L2 limiter plugin, the analysis highlights key elements such as momentary loudness, integrated loudness, and loudness range, which play a crucial role in shaping the overall listening experience. FabFilter Pro-L2 is a highly precise tool for measuring momentary loudness, which refers to the instantaneous volume level at any given point, and integrated loudness, which averages the loudness across the entire track, using LUFS (Loudness Unit Full Scale) as the measurement standard (Cunningham et al., 2017; Winer, 2017). Additionally, the plugin captures the loudness range—the variation in loudness levels throughout the piece—allowing a deeper

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understanding of how the dynamic shifts create emotional impact (Johnstone, 2001). The analysis begins by examining the first two minutes of "Weightless," where the momentary loudness is relatively low, ranging from -22 LUFS to -17 LUFS. This soft dynamic level establishes a gentle and calming introduction, drawing the listener into the sonic landscape without overwhelming them. As the piece progresses past the two-minute mark, the loudness gradually increases, peaking between -16 LUFS and -10 LUFS over the next five minutes. This shift creates a sense of progression and intensity, leading the listener through a more engaging and energetic phase of the composition (Carnovalini & Rodà, 2020; Varankaitė, 2020). However, in the final minute, the loudness gently tapers off, returning to a softer range of -12 LUFS to -22 LUFS. This careful ebb and flow of loudness throughout the track is intentional, guiding the listener through a journey that starts softly, builds tension, and resolves with a peaceful conclusion.

The findings suggest that "Weightless" has been carefully crafted to comply with industry standards while offering a soothing, dynamic listening experience (Budiawan et al., 2023; Damaske, 2008). The smooth progression from soft to moderate loudness, followed by a gradual return to quietness, creates a sense of tranquility and flow, making the track ideal for relaxed listening environments. Moreover, the balanced loudness ensures that the work is versatile, sounding equally good on various playback devices, whether through a phone, headset, or larger audio system. By adhering to platform loudness standards (Schmidt-Jones, 2013) and maintaining an appropriate dynamic range (Mielke & Andrews, 2023), the piece avoids any harshness or distortion, ensuring that listeners are fully immersed in the sound without discomfort.

The frequency analysis also identified an emphasis on the low frequencies around 60 Hz and 120 Hz (Bartel & Mosabbir, 2021; Moore et al., 2016). This adjustment helps to eliminate muddiness and improves the definition of the bass, ensuring that the bassline and drums perform effectively without overpowering the other elements of the composition. This balanced frequency distribution is reflected in the spectral graph generated by Voxengo SPAN, showing no excessive frequency peaks or drastic drops that could lead to an unbalanced audio experience. The earlier loudness normalization ensured that all frequency ranges were processed consistently, keeping the mix cohesive and unified. In addition to the technical aspects, the frequency distribution supports the emotional characteristics of Weightless (He, 2022; Rentfrow et al., 2011).

The dominant low frequencies provide a sense of calm and stability, while the brighter high frequencies add a layer of tranquility and clarity, aligning with the piece's objective to create a relaxing and soothing atmosphere. From a compatibility perspective, the wide and well-balanced frequency distribution ensures that "Weightless" can be enjoyed across various audio devices (Wiflihani, 2021), from small headphones to larger speaker systems. The precise frequency adjustments prevent distortion or loss of detail on devices with different frequency responses, guaranteeing a consistent and satisfying listening experience for all audiences.The frequency analysis of "Weightless" demonstrates that the spectral balance has been meticulously crafted to achieve an optimal harmony between the various audio elements. The effective use of analysis tools and frequency refinement techniques contributes to the high-quality audio, enhancing the artistic goal of the piece by creating an immersive and calming listening experience (Cespedes-Guevara, 2023; Varankaitė, 2020).

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CONCLUSIONS

Music composition “Weightless” reveals a meticulously balanced audio spectrum that enhances both the technical quality and emotional impact of the composition. The use of tools such as LogicPro, Voxengo SPAN and FabFilter Pro-Q3 allowed for a precise and comprehensive assessment, highlighting a well-distributed range of low, mid, and high frequencies. The adjustments made to reduce muddiness and enhance clarity ensure that each element of the composition is clearly defined and harmoniously integrated. This careful balance not only contributes to a comfortable and immersive listening experience but also ensures compatibility across various playback devices. The frequency management aligns with industry standards, particularly in relation to dynamic range and loudness normalization, creating an enjoyable and seamless experience for listeners. The thoughtful treatment of frequencies in "Weightless" serves both artistic and practical purposes, delivering a high-quality audio experience that is emotionally resonant and technically sound.

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