BA (Hons) Creative Music Production

Professional Project

Joseph McGuirk

How Mindfulness Meditation is Affected by Music in which its Psychological, Physiological and Neurobiological Effects are Incorporated.

26th April 2022

Dr. Ruth Moran.

Contents

Abstract

The current research project describes the creation of a musical composition designed to assist effective mindfulness mediation, by incorporating the psychological, physiological, and neurobiological effects of mediation into its construction. The project details the methodological process of the composition's construction, based on research from the growing field of study, and tests its effectiveness in a quantitative study. The project provides a view on music's role within the current mindfulness meditation landscape and reflects on how its effects can improve the meditative experience, and thus increase the accessibility of mediation to a wider audience. The project reveals the need for a larger study on the effects of individual musical elements within a composition, yet provides a theoretical basis from which further research can be investigated.

Introduction

Mindfulness meditation is a field of study and practice that has evolved rapidly over the last fifty years. Modern technologies such as smart phone applications have caused a rapid expansion in the market for meditation accessibility, with companies like Calm and Headspace amassing over 40 million[1] installs since their inception a decade ago. The World Health Organization state a 13% increase in mental health issues in the last decade[2] with anxiety and depression being two of the most common mental conditions across the globe. With the world's attention increasingly focused on ways of achieving better mental health, mindfulness meditation has been adopted as a way to decrease stress and anxiety levels and improve self-esteem.[3] Although apps like Headspace and Calm intend to ease newcomers into a routine of meditative practices through guided courses and visual animations, the current research project looks at ways that music can play a role in aiding a beginner's comfort and focus while starting their meditation journey.

While there have been many theories surrounding music's impact on psychological and physiological functions, background music is often a go-to device used to aid relaxation, focus, or study. *Lo-fi beats* and muted jazz instrumentals are gaining popularity as genres for background music, with streaming giants Spotify paying producers to create music based on musical guidelines,[4] to fit into mood-based playlists. Some theories suggest that eventually music of this type will be created without a need for human decisions or creative input, using artificial intelligence algorithms.

The current research specifically focuses on the creation of a humanised pseudo-algorithm for music that succours effective meditation. Such music should improve a meditator's

---

[1] Quartz Staff. "Why There's So Much Money in Mindfulness." *Quartz,* qz.com/1958593/covid-19-accelerated-the-worlds-embrace-of-meditation-apps/. Accessed 28 Nov 2021.

[2] "Mental Health." *World Health Organization,* www.who.int/health-topics/mental-health#tab=tab_2. Accessed 26 Nov 2021.

[3] Schulte, Brigid. "Harvard Neuroscientist: Meditation Not Only Reduces Stress, Here's How It Changes Your Brain." *The Washington Post,* www.washingtonpost.com/news/inspired-life/wp/2015/05/26/harvard-neuroscientist-meditation-not-only-reduces-stress-it-literally-changes-your-brain/. Accessed 2 Dec 2021.

[4] Ingham, Tim. "Spotify is Making Its Own Records… And Putting Them on Playlists" *Music Business Worldwide,* www.musicbusinessworldwide.com/spotify-is-creating-its-own-recordings-and-putting-them-on-playlists/. Accessed 29 Nov 2021.

comfort and enhance the psychological and physiological effects of meditation. For these reasons this music is labelled *adjacent* music for the duration of the project. As opposed to background music (which is generally chosen based on genre preference and is not intended to be the primary focus of the listener) *adjacent* music is created objectively, based on research indicative of the current landscape of the mindfulness mediation, and justify musical choices like rhythm, tempo, modality based on their effects on the human brain and body. The project tests the ability of an objectively constructed piece of music, on the focus and awareness of listeners via the use of the Sustained Attention Response Task and analyses its effects.

Literature Review

Undertaking a project to produce *adjacent* music for mindfulness meditation means understanding the nature of what it is a participant aims to achieve from the act. A knowledge of the psychological and physiological effects of mindfulness meditation on the human body, alongside an ability to construct music in a way that conduces or enhances these effects, is crucial. The current chapter studies an array of literature to aid an understanding of these effects, and to strategically incorporate them into the *adjacent* music composition.

As mindfulness and meditation are practices which archaeologists have discovered evidence for, dating as far back as approximately 6000 years ago,[5] a general idea of what mindfulness meditation is has become part of the common vocabulary. Still however, no scientific definition has been agreed upon for the practice.[6] Widely accepted conceptions of mindfulness meditation emanate from the work of Doctor Jon Kabat-Zinn, who has been hailed the "initiator of meditation studies."[7] For this reason, Kabat-Zinn's paper *Mindfulness-Based Interventions in Context: Past, Present, Future* (2003) will be used to define and contextualise what mindfulness meditation is, for the duration of the current research project. Kabat-Zinn's paper is a reflection on the modern landscape of mindfulness and its emergence in clinical settings. Although mindfulness and meditation are ideas that are commonly practiced concurrently, Kabat-Zinn draws a line between them. He describes mindfulness as an awareness, and it is this that he determines "the heart"[8] of the act of meditation. Kabat-Zinn proposes that mindfulness is "the awareness that emerges through paying attention on purpose, in the present moment, and non-judgementally, to the unfolding of experience moment by moment."[9] It is here that one of the foundations of the current research project is

---

[5] Hagan, Ekua. "An Overview of Meditation: Its Origins and Traditions." *Psychology Today,* www.psychologytoday.com/ie/blog/meditation-modern-life/201307/overview-meditation-its-origins-and-traditions. Accessed 27 Nov 2021.

[6] Pascoe, Michaela C., et al. "Psychobiological Mechanisms Underlying the Mood Benefits of Meditation: ANarrative Review." *Comprehensive Psychoneuroendocrinology,* vol. 6, May 2021, p. 2.

[7] Čakire, Santa. Vanags, Edmunds. "Meditation Effect on Brain Function Using EEG in Randomized ControlledStudies: Meta-Analysis." *Baltic Journal of Psychology,* vol. 23, issue 1/2, 2020, p. 140.

[8] Kabat-Zinn, Jon. "Mindfulness-Based Interventions in Context: Past, Present, and Future" *ClinicalPsychology: Science and Practice,* vol 10, issue 2, summer 2003, p. 145.

[9] Kabat-Zinn, Jon. "Mindfulness-Based Interventions in Context: Past, Present, and Future" *ClinicalPsychology: Science and Practice,* vol 10, issue 2, summer 2003, p. 145.

established; that to be mindful is to be aware. The paper acknowledges that the origins of modern meditation stem from various Buddhist teachings (Theravada, Mahayana, and Vajrayana) yet the importance of attention and awareness to the definition implies an independence of the modern practice from any religious beginnings. This piece of research aids the reasoning behind musical choices in all aspects of the compositions. The music must supplement or enhance the participant's ability to focus and remain aware throughout.

Establishing a definition for mindfulness alone does not reveal the rise in popularity of the act of meditation, nor does it fully grasp what an *adjacent* music composition should try to achieve. It is just as beneficial to know what mindfulness is as it is to understand its effects on the mind and body. It is for this reason that *Psychobiological Mechanisms Underlying the Mood Benefitsof Meditation: A Narrative Review* (2021) by Michela C. Pascoe et al. was studied. In this article, the authors conduct a narrative review of twenty-four metanalytic and systematic studies of meditation's impact on psychology, physiology, and neurobiology. Conclusions can be drawn from the results about the goal of *adjacent* music. On a psychological basis the review finds that meditation improves attention and memory and increases self-compassion and meta cognition. Meditation results in brain changes in regions related to emotion regulation and is also shown to influence a range of physiological processes - decreasing blood pressure, heart rate, cortisol,and cytokine levels.[10] While the authors use these results to propose that meditation reduces distress by impacting the processes stated above, the findings are the basis for a range of decisions relating to the musicality of the current research project. As the current project aims to create music that supports mindfulness during meditation, it is logical to assume that it would be beneficial for such music to produce similar effects in the participant, such as slowing down the heart rate, reducing cortisol levels and increasing focus and awareness.

Hans-Joachim Trappe's article *The Effects of Music on the Cardiovascular System and Cardiovascular Health* (2010) reviews the body's physiological response to music in a variety of aspects. Trappe looks at music in a clinical setting, referring to studies on its effects on patients before and after open-heart surgery. He notes that music can have a greater effect on patients' anxiety in both preoperative and postoperative settings, than midazolam - a benzodiazepine, sedative medication. A study based around a 30-minute regimen of listening to music after surgery showed a significant decrease in cortisol levels versus a non-music

[10] Pascoe, Michaela C., et al. "Psychobiological Mechanisms Underlying the Mood Benefits of Meditation: A Narrative Review." *Comprehensive Psychoneuroendocrinology,* vol. 6, May 2021, p. 3.

control group. This links music's effects to those of mindfulness meditation, explained in Pascoe et al.'s study above. Trappe states that the greatest effect is seen with meditation or classical music,[11] while genres like techno and heavy metal have adverse effects. He relates this to meditation music's traditionally slow composition, which can generate feelings of spiritual reflection. It is therefore probable that a slow and pleasant approach to the creation of the *adjacent* music, with minimal attention on a continuous rhythm (as is traditionally the case in techno and metal music) will correlate with the physiological responses to meditation stated above.

In his book *This is Your Brain on Music* (2006) Daniel Levitin similarly discusses the human response to music in a variety of ways. It compliments Pascoe et al.'s paper in the current body of research, by explaining how music produces some similar effects on our brain to those mentioned above. Levitin describes the cerebellum – the part of the brain primarily concerned with movement, coordination, and motor skills – as being involved in the tracking of the pulse of music. It is this pulse that drives our autonomous ability to predict similar events in the pattern of the music (commonly referred to as groove). Adding to this, Levitin references studies and experiments by neurologist, Jeremy Schmahmann, that have linked the cerebellum to emotion, through its link to the amygdala,[12] which controls emotional function and is the core of processing "fearful and threatening stimuli."[13] This is central to what is known as the fight, flight, freeze response. This directly influences the current research project. The idea that emotional activities lead to motor movements (like how the sight of a threatening animal instigates a reaction to run) could also link sudden movements in an *adjacent* music piece, to a greater sense of awareness and focus. Levitin describes how a rat who is exposed to a rhythmically stable sound source above his hole in the ground, may assume that it is a tree branch swinging in the wind after realising it is not in danger. This is known as habituation. However once there is an intensity or frequency change in the rhythm, the rat begins to notice its surroundings. Because human response to groove in music is largely unconscious,[14] it is logical to assume that changes in rhythm or tempo, or the

[11] Trappe, Hans-Joachim. "The Effects of Music on the Cardiovascular System and Cardiovascular Health." *Heart (British Cardiac Society),* vol 96, no. 23, p. 1871. doi:10.1136/hrt.2010.209858

[12] Levitin, Daniel. *This is Your Brain on Music*. Dutton Penguin, 2006, p. 171.

[13] Baxter, Mark G. Croxon, Paula L. "Amygdala and Emotional Faces." *Proceedings of the National Academyof Sciences,* vol. 109, no. 52, pp. 22180.

[14] Levitin, Daniel. *This is Your Brain on Music*. Dutton Penguin, 2006, p. 188.

introduction of new sounds and timbres throughout an *adjacent* music composition, should trigger a similar reflex, and thus instantiate an awareness in the participant.

This proposal is echoed in the results of Baoxia Liu and Valerie J. Rice's *A Pilot Study Investigating Preferred Background Sounds During Mindfulness Meditation: What would youlike to hear?* (2021). Researching mindfulness to incorporate into the wellbeing of US army veterans, the authors created a pilot study to compare background sounds and silence on conducive meditation environments. Heart rate coherence (patterns of heart rate variation) and user preference were used to conclude which of seven samples (one sample of music with a distinct melody, three samples of music with no distinct melody, one sample of nature sounds with embedded alpha brainwave pulse, one sample of alpha waves alone and the last being silence). Participants were split between a beginner meditator group and an adept meditator group based on coherence scores. Results found that for the beginner group and the total group of participants, the three samples containing music without a distinct rhythm were rated in the top three selections for background sound while meditating. For the adept group alone, two of these three samples along with silence, were in the top three. The results show a greater preference from those more experienced in meditation to practice in silence, while beginners or less active meditators preferred music. The authors make clear that it was the music without a distinct melody category that was preferred, and not the two other samples. They state that although participants found the other samples relaxing, it may not have been conducive to meditation. The authors also break down the traits of the preferred music, stating that the three pieces were composed to slow down brainwaves and induce an alpha brainwave state on the participant and were all performed on the piano.[15] The composer of the Alpha Music pieces – John Levine intended to "free one from habitual listening patterns."[16] The three pieces use altering patters of rhythm and arrhythm. They use compositional techniques of tension and release such as cadences and use a selection of one or a combination of multiple tonal scales. This supports the claim based on Levitin's work that slight variations in the music should be conducive to focus and attention.

Liu and Rice's study may also provide preliminary evidence to support the notion that music can induce an alpha brainwave state through brainwave entrainment. *Meditation Effect on*

[15] Liu, Baoxia. Rice, Valerie J. "A Pilot Study Investigating Preferred Background Sounds During Mindfulness Meditation: What would you like to hear?" *Work*, vol. 63, issue 2, 2019, p. 160.

[16] Liu, Baoxia. Rice, Valerie J. "A Pilot Study Investigating Preferred Background Sounds During Mindfulness Meditation: What would you like to hear?" *Work*, vol. 63, issue 2, 2019, p. 160.

Brain Function Using EEG in Randomized Controlled Studies: Meta-Analysis (2020) by Santa Čakire and Edmunds Vanags demonstrates that meditation itself can produce a statistically significant effect on alpha brainwave function. Therefore, this research legitimises the inclusion of an alpha wave inducing effect in the *adjacent* music compositions. The authors conduct a meta-analysis to explore the effect of meditation on alpha brain wave function. This study also emphasises the difference between mindfulness meditation and relaxation. Referencing a study by Tang et al.,[17] the authors show that integrative body-mind training (a form of mindfulness meditation) produced less anxiety and had more of an effect on psychological variables in an experimental group than relaxation. This again supports anecessity for the *adjacent* music to instantiate awareness and attention in the participant, to be conducive to mindfulness meditation. Although the authors note a limited number of total studies available, (due to the recentness of the area of study, and a decision to restrict selected studies to a number of criteria)[18] they conclude that meditation has a statistically significant effect on alpha wave function.

Ulrich Kirk's 2018 article *On-the-Spot Binaural Beats and Mindfulness Reduces Behavioural Markers of Mind Wandering* shows that a form of brainwave entrainment known as binaural beats, can reduce mind wandering by a similar degree to mindfulness meditation. Binaural beats are an auditory illusion produced when listening to two slightly different frequencies in each ear via headphones. While listening, your brain produces a new frequency, known as the binaural beat. This tone is the difference of the two original frequencies and is often used to replicate a brain wave state. Kirk's study involved a test called Sustained Attention to Response Task (SART). He tested groups of students after a 15-minute mindfulness meditation, a 15-minute exposure to binaural beats, and finally non-intervention control group. The results show that the meditation and binaural beats group improved on their initial SART scores by 20%, while the control group did not improve. A reduction in mind-wandering proves how these two interventions can improve focus. Kirk's research, however, focuses on 15-minute interventions before attempting the SART test. He notes how further research may explore how mind-wandering is affected while completing a cognitive task during an intervention. The current research project aims to show if an

[17] Liu, Baoxia. Rice, Valerie J. "A Pilot Study Investigating Preferred Background Sounds During MindfulnessMeditation: What would you like to hear?" *Work*, vol. 63, issue 2, 2019, p. 161.

[18] Čakire, Santa. Vanags, Edmunds. "Meditation Effect on Brain Function Using EEG in RandomizedControlled Studies: Meta-Analysis." *Baltic Journal of Psychology*, vol. 23, issue 1/2, 2020, p. 146.

adjacent music composition can result in a reduction of mind-wandering. An incorporation of a binaural beat in the alpha wave region of 8-12Hz will be considered in the construction of the adjacent music, to potentially help induce an effect on alpha wave function. The methodology that Kirk uses in his testing phase will be adopted and adapted for the current study, to analyse the effect of the *adjacent* music on participants.

Mindfulness meditation is a practice is a practice that can be difficult to appreciate as a beginner. Many ofthe popular mindfulness apps in recent months provide guided meditations to offer newcomers a place to begin their mindfulness journey. Headspace suggest finding a quiet space where youcan sit comfortably with a straight back and commit to the act of meditation.[19] However, the franticness of modern western society can impose feelings of discomfort in people looking to dedicate even ten minutes to the act.[20] James Kellaris and Robert Kent's paper *The Influence of Music on Consumers' Temporal Perceptions* (1992) shows ways that *adjacent* music can improve participants comfort when meditating and support feelings of productivity about the act. Their study focuses on consumer psychology, particularly the effect of the musical property– modality,[21] on listeners' estimates of time duration; their assumptions being that shorter perceived duration of time spent in queues and on hold, would increase customer satisfaction. They conducted a study on 150 subjects who were exposed to three versions of a composition. The composition imitated music found in youth-orientated retail settings at the time. The three versions represented major, minor, and atonal modalities. The participants also rated the "affective character" of each composition. The major and minor modes both produced higher positive affect than the atonal composition.[22] The results found a statistically significant difference between the perceived duration and actual duration for all three compositions. The longest perceived duration was for exposure to the major composition, a shorter perceived duration for the minor composition, and the shortest perceived duration for the atonal composition. However, the differences between minor and atonal modes were not statistically significant. The authors

[19] Puddicombe, Andy. "How To Meditate in Ten Minutes." *Headspace,* https://www.headspace.com/articles/how-to-meditate-in-ten-minutes. Accessed 27 Nov 2021.

[20] Mineo, Liz. "With Mindfulness, Life's in the Moment" *Harvard Gazette,* news.harvard.edu/gazette/story/2018/04/less-stress-clearer-thoughts-with-mindfulness-meditation/. Accessed 27 Nov 2021.

[21] Modality is the tonal quality of music in reference to an eight-note scale starting from a given note.

[22] Kellaris, James J. Kent, Robert. J. "The Influence of Music on Consumers' Temporal Perceptions: Does Time Fly When You're Having Fun?" *Journal of Consumer Psychology,* vol. 1, issue 4, 1992 p. 372.

conclude that music can influence subjective experience of time and modality influences these perceptions. The paper links these findings to Ornstein's 1969 storage size model, whereby perceived duration is a function of the amount of memory dedicated to storing stimulus information encountered during a period.[23] According to Ornstein, a greater number of environmental changes means a longer perceived duration. Because listeners may devote more attention to pleasant sounding music (or music with higher positive affect) more information is processed when exposed to such music and therefore produced a longer perceived duration in Kellaris and Kent's study. This study suggests that the modality of the *adjacent* music can influence the participants satisfaction with the practice, and therefore increase the chance that it would be attempted again. In the current research project therefore, minor modes will be considered over major and atonal modes in the *adjacent* music's construction. Minor and atonal modes produced statistically insignificant differences on participants' perceived duration, yet minor modes can be used without the danger of having a less positive affect on the participant.[24]

The above literature centres the creation of *adjacent* music on what it is about mindfulness meditation that is important. While the material studies a range of physiological and psychological responses to both sound and meditation, they connect directly to the construction of the *adjacent* music in the current research project. A participant's ability to remain aware and focus while listening to the music is essential to its purpose. It should also attempt to induce an alpha brain wave state and reduce their perceived duration. In the current research project therefore, the music will include varying rhythms, minor modalities, and other musical characteristics to induce a positive reaction from a meditation experience.

[23] Kellaris, James J. Kent, Robert. J. "The Influence of Music on Consumers' Temporal Perceptions: Does TimeFly When You're Having Fun?" *Journal of Consumer Psychology,* vol. 1, issue 4, 1992 p. 367

[24] Kellaris, James J. Kent, Robert. J. "The Influence of Music on Consumers' Temporal Perceptions: Does Time Fly When You're Having Fun?" *Journal of Consumer Psychology,* vol. 1, issue 4, 1992 p. 374.

Methodology

The creator of *adjacent* music must consider the effects of all musical characteristics on the mind and body of the meditator. To achieve effective results, it is logical to assume that the most efficacious compositions, affect the meditator in ways that closely resembles those of the meditation itself. The facilitation of the focus and awareness of the listener is at the heart of the current project's methodology. The current methodology will outline the production of the *adjacent* music composition based on the literature above, and will test its effectiveness in aiding mindfulness. The methodology for the current body of research will use objective decisions to influence the creative workflow. It will follow broadly the methodology of production and testing.

Initially the adjacent music was to be composed on the piano, to resemble John Levine's compositions in Liu and Rice's study. However, a decision was made to hide a constant pulse in the music based on Levitin's book, to limit the listeners' habituation. As a result, a percussive instrument like the piano was deemed unsuitable for the current research project. Instead, an electric guitar was used and altered via guitar pedals and post-processing to create an ambient drone. This drone-type sound is a popular timbre in meditation music, the likes of which Trappe stated reduces anxiety and increases self-reflection.[25] It was therefore deemed appropriate to use as the main carrier of harmony throughout the composition. It's slow Attack Decay Sustain Release (ADSR) envelope meant that while it was played to a metronome, the pulse of the music is still somewhat imperceptible. It also influences the intensity of the music to produce a slower, peaceful effect. The mode of F# Dorian was selected as the primary key for the composition. F# Dorian is minor mode and was chosen with the aim of decreasing perceived time for listeners, while still producing a positive effect, based on Kellaris and Kent's paper. The intention here was to use musical functions to increase comfort in beginner meditators, as they can find it uncomfortable when unaccustomed to the process.[26] The arrangement of the piece was built around a vamp between the chords F# minor7 and E major7. This choice of chords can repeat without dramatic tension due to a lack of harmonic motion or cadence. This was recorded to build an

[25] Trappe, Hans-Joachim, "The Effects of Music on the Cardiovascular System and Cardiovascular Health." *Heart (British Cardiac Society)*, vol 96, no. 23, p. 1871. doi:10.1136/hrt.2010.209858

[26] Mineo, Liz. "With Mindfulness, Life's in the Moment" *Hardvard Gazette*, news.harvard.edu/gazette/story/2018/04/less-stress-clearer-thoughts-with-mindfulness-meditation/. Accessed 27 Nov 2021.

ambient starting point, while allowing for dramatic tension with other chordal movement later in the piece. The incorporation of the vamp was intended to lull the listener into a sense of habitual listening, and to induce a subtle *startle reflex* (as mentioned in Levitin's book) at various points by creating unexpected changes. For example, at 2:05, a chordal change to D major 7 followed by A major introduces a strong cadence and was used for this reason. Sporadic instrumentation changes were also incorporated to *startle* the listener. Percussive guitar plucks, chimes, synth sounds, and processed guitar harmonics were introduced at varying points in the arrangement. An interview with Headspace's Audio Director – Scott Sorenson influenced the arrangement of the composition. Sorenson's advice for the creation of focus music was to "use your instincts"[27] while "being objective."[28] The arrangement, therefore, wasn't structed traditionally, rather the piece was developed instinctively and used patterns of rhythm and syncopation to disrupt autonomous listening. Dynamic changes were made to increase this effect. Swells were created by layering elements such as the drone guitar, synth pads and reverb (for example the build at 1:15) and elements were taken out or replaced to create breaks and quieter sections (such as the change at 2:45). Because the primitive regions of the brain attempt to make musical predictions based on expectation,[29] rhythmic, harmonic, and dynamic changes throughout the composition were constructed to increase awareness in the listener, based on Levitin's idea of habituation and the startle reflex. To enhance the alpha brainwave inducing effect of mindfulness meditation, in line with Čakire and Vanags' analysis, binaural beats were included in the *adjacent* music. A binaural beat was created between 93Hz and 102Hz using two sine-wave tone generators panned left and right. These tones create a binaural beat in the alpha frequencies of 8-14Hz, (9Hz in this case) and were chosen based on their musicality within the composition – 93Hz being the root frequency of F# in the western musical scale. Not only were binaural beats included to influence brainwave function, but also as Kirk's study proves their ability to reduce mind-wandering, which in the current research project is fundamental to the level of awareness in the listener. Sorenson's analogy liking *adjacent* music to a "blanket of sound"[30] for the listener resulted in a rain sound recording being included in the composition. Rain was chosen as it is considered a non-threatening nature sound, which have been shown to comfort

[27] Sorenson, Scott. Text message to Author. 9 Feb. 2021.

[28] Sorenson, Scott. Text message to Author. 9 Feb. 2021.

[29] Levitin, Daniel. *This is Your Brain on Music*. Dutton Penguin, 2006, p. 187.

[30] Sorenson, Scott. Text message to Author. 9 Feb. 2021.

listeners and reduce anxiety.[31] Rain also produces a frequency response close to that of white noise. White noise can mask noises from the outside world,[32] and therefore should reduce external distraction.

The second aspect of the current methodology was the testing phase. The testing phase was adopted from Ulrich Kirk's study, to offer some quantitative insight into the effect of the constructed musical composition. The SART test was at the heart of this methodology. SART testing provides an incidental insight into the levels of mind-wandering of its participants. Higher mind-wandering levels convey lower levels of focus and heightened habitual thinking, and therefore the SART test was deemed a practical method of testing the effect of the *adjacent* music. The SART is a Go/NoGo task whereby participants respond to stimuli presented on a screen for 250ms after which are masked for 900ms. The stimuli shown were a continuous array of digits ranging from 0-9. Participants were asked to respond by pressing the spacebar to each stimulus except the digit 3. Each SART test lasted approximately 6 minutes and results were calculated at the end. Errors where the spacebar was pressed while the stimulus '3' was presented were referred to as NoGo errors. NoGo errors reflect that the task is being performed autonomously, rather than in a controlled, focused manner and therefore were regarded as the most important result from the study.

In the current study, a testing day was organised at the Sound Training College, Dublin and involved students from multiple courses based in the audio production industry. 12 participants present on the day took part. A room in the college was selected and prepared with six computers, each running an instance of the PsyToolkit SART test, created by Professor Gijsbert Stoet.[33] Three of the computers contained an attached pair of Audio Technica ATH M50x headphones while the other three did not. Participants were asked to sit at a random computer, and to put the headphones on if available. All participants were then asked to follow the instructions displayed and to carry out the task. This methodology was chosen to randomly select an intervention group (with headphones) and an active control group. The current study consisted of six participants in each group. While in Kirk's initial

---

[31] Todd, Eric. "How Nature Sounds Comfort Patients." *PDi,* www.pdiarm.com/blog/nature-sounds. Accessed 29 Nov 2021.

[32] Thorpe, JR. "Here's What Happens In Your Brain When You Hear White Noise." *Bustle,* www.bustle.com/p/what-white-noise-does-to-your-brain-according-to-experts-19271146.

[33] Stoet, Gilburt. "Sustained Attention to Response Task." *PsyToolkit*,www.psytoolkit.org/experiment-library/sart.html#_introduction. Accessed 15 Nov 2021.

study, participants were exposed to the intervention for a period before carrying out the SART, based on his recommendations for further research, and a desire to analyse the *adjacent* music's effect on a listener's ability to carry out cognitive tasks (ie. mindfulness meditation) the current study opted for participants to be exposed to the intervention while performing the SART. Participants with headphones listened to an audio file of the *adjacent* music composition, while the control group were exposed to the sound of the room and its participants. This was intended to mimic the environmental distractions meditators may commonly experience to while practicing at home.

Due to the design of the current methodology and in an attempt to attract as many participants as possible on the day, participants were not asked to perform a Perceived Stress Scale (PSS), as was the case in Kirk's study. Participants were not asked to respond subjectively to any aspects of the test, to decrease the total time needed for students to participate. Rather, the percentage of NoGo errors were calculated for each participant and were the only metrics analysed in the current project.

Analysis

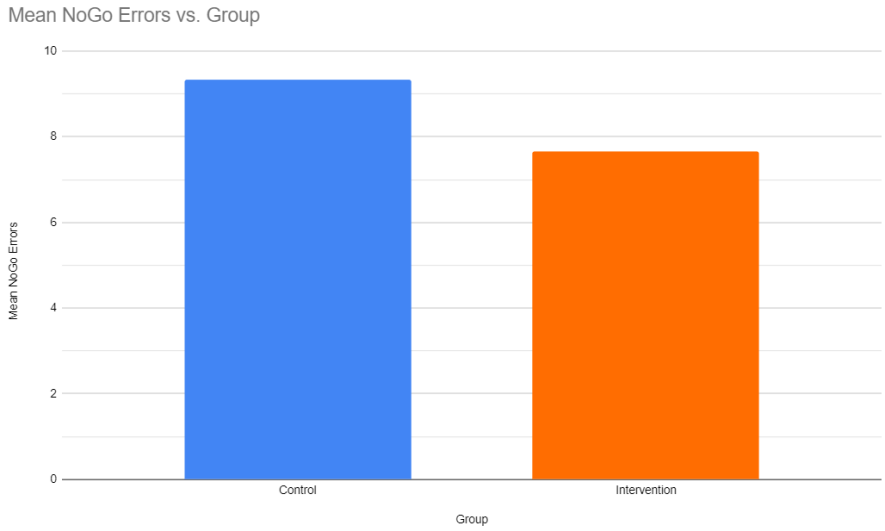

Fig. 1[34]

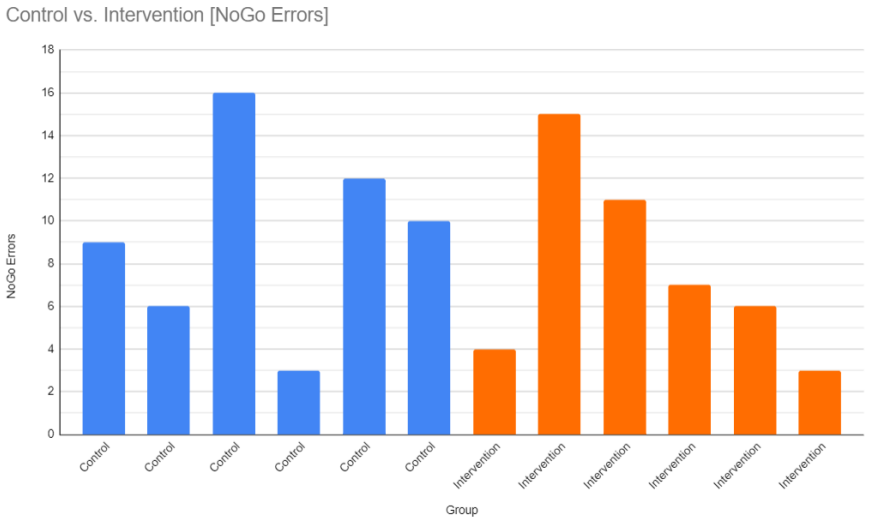

Fig. 2[35]

The methodological process of the current project has led to an interesting point on the trajectory of the research. While every step has been taken to create a piece of practical *adjacent* music, and to test its ability to increase focus and awareness in the listener, the results of the testing phase of the current project [Fig. 1 and 2] do not clearly reveal its true

[34] Fig. 1 displays the mean NoGo error result of participants in each group. NoGo trials occurred 25 times per participant.

[35] Fig. 2 displays the individual results of participants in each group. NoGo trials occurred 25 times per participant.

effect on users. The following chapter aims to reflect on the results of the methodological decisions taken throughout the process.

Although a correlation can be seen between the lower mean NoGo result of the intervention group and the impact of the *adjacent* music, [Fig. 1] the results of the testing are not statistically significant. Results varied greatly between participants in both groups [Fig. 2] and as a result, evaluation of the methodology indicate areas of weakness. The scope of the current project (in direct comparison to Ulrich Kirk's study) meant that some choices for the testing phase were not thorough enough to examine the full effect of the *adjacent* music. The lack of qualitive data, for example, means that individual elements of the music's effect cannot be fully interpreted. Asking participants to estimate a duration time for the test may have proved insightful in relation to the Dorian mode of the music, an aspect included in the methodology, based on Kellaris and Kent's study. There might have been a difference between the control and intervention groups here. Asking participants for notable, or points of preference throughout the composition could have provided a deeper understanding of methodological elements that aided or hindered their focus - the binaural beats or the white noise for example. It is now clear that the inclusion of a PSS for participants should have been included, as was the case in Kirk's examination. As psychological stressors can have an impact on levels of distraction,[36] it is likely the case that less stressed participants have better overall focus and therefore, the musical intervention may not affect them as much as participants higher on the stress scale. This is especially important in the current project as participants were not asked to attempt the SART twice, as was the case in Kirk's study. In an attempt to increase the number of participants, students were often asked to participate directly after leaving a class (where they may have just attempted a stressful exam or endured a long lecture). It was not noticed initially that this factor could have influenced their ability to focus. This understanding is essential to the current research in this area as it likely accounts for the similarly diverse NoGo results of both groups. Initially it was thought that the NoGo results alone would provide enough quantitative data to analyse the full effect of the musical composition. Having applied the above methodology it has become apparent that an analysis of the timing of NoGo errors throughout the SART would have greatly improved the clarity of the results. The lack of this area of testing means no links can be made to NoGo errors and musical changes in the *adjacent* music. Having applied the above methodology it

[36] Kirk, Ulrich. "On-the-Spot Binaural Beats and Mindfulness Reduces Behavioral Markers of Mind Wandering." *Journal of Cognitive Enhancement,* vol. 3, 26 Nov 2018, p. 187.

is clear that further quantitative and qualitative data would offer much more insight into the music's effect.

In the testing phase of the project, important issues arose around the testing environment. It was initially thought that having participants complete the SART in a room with each other, without major interventions to reduce noise or external distraction (other than the headphones for the intervention group) would capture an environment like that of someone dealing with similar distractions while meditating. Having applied this methodology, it is clear that a more calming or solitary environment for participants would have been more suitable and accurate to the current research.

Meaningful learning did however arise even though the results of the testing returned insignificant results. While constructing the music, effort was made to apply Levitin's concept of a *startle* reflex within the composition by incorporating rhythmic, harmonic, and dynamic changes throughout. These changes were one of the main elements intended to direct the listener's attention from a state of unconscious deviation, back to an awareness of the task at hand. Although the results do not indicate specific aspects of the composition's musical construction that were imperfect, insignificant results could be explained by the dramatic nature of some musical changes in the piece. Levitin's concept describes how rhythmic changes can impact habituation. While it was initially concluded that a similar impact would occur through additional musical qualities, such as harmonic and dynamic movement, it has been identified that the dynamic changes in the *adjacent* music, such as at 1:15 and 2:25 may in fact negatively impact focus. This may be explained due to the fact that a dramatic increase in loudness could trigger a fight or flight response more intense than the subtle *startle* that was intended. This is like how Sorenson describes music that is "too interesting"[37] as impractical for focus music. Subsequently it has been thought that dynamic changes are likely more obtrusive than rhythmic and harmonic changes. This understanding could be useful to future stages of the research, and *adjacent* music with a more consistent dynamic level may be more functional. It may be important to discover the specific physiological and psychological impacts of these different musical attributes.

Although not a major influence on the contents of the *adjacent* music, a useful adjustment in its construction was the instinctual element of the arrangement. Taking Sorenson's advice will be useful to the development of the project as it allows for smooth continuation in the

[37] Sorenson, Scott. Text message to Author. 9 Feb. 2021.

flow of the music. In the current project, the adjacent music was bound to approximately six minutes, to last the length of the SART test. However, should a composition need to be longer (which is likely in future stages of the research due to the progression of meditators and their ability to remain mindful for longer periods) Sorenson's instinctive method for creating *adjacent* music allows for practical oscillations in the music while remaining objective about its purpose.

Discussion

Although insignificant test results were not the desired outcome of the current research project, the undertaking of the project has revealed significant insight into how music can influence listeners' focus and awareness when it comes to the mindfulness meditation landscape, such as the impact of modality on time perception, the ability of sound to induce an alpha brainwave state in the listener, and the positive impact of binaural beats on sustained attention. While the current project did not result in a perfect list of guidelines for the creation of an *adjacent* music compositions, knowledge of the physiological and psychological responses to music and their link to similar responses to mindfulness meditation, will be important to future research in the area.

The current project and research enabled the creation of a musical composition in an objective manner, which in essence was a main priority of the project. However, while the current research project focused on one musical composition, it should be noted that an objective approach to the creation of music of this kind can result in a multitude of results; such is the nature of any process involving creativity. Thus, even should the results have shown a positive statistical significance between the performance of the two groups in the SART, the initial idea that a set of objective guidelines could be created for *adjacent* music is at the mercy of subjective creative decisions, nevertheless.

One of the most significant learnings of the current research project is the importance of thoroughness in the construction of both qualitative and quantitative assessment. The absence of qualitative data hindered some aspects of the results such as how individual elements of the musical construction affected the participants, rather than the composition as a whole. This as a result leaves a gap as to where improvements can be made on specific musical aspect of the project.

Conclusion

The current project has looked at the current mindfulness landscape, and music's role in improving the accessibility of meditation to a wider audience. The current project examined how theoretical research in the field can aid the creation of a music that succours effective mindfulness meditation. It has resulted in an objective creation in a traditionally creative field. Although the full effectiveness of the *adjacent* music composition cannot be fully determined due to limitations in the testing design, with changes to its design, the current project can reveal the full effectiveness of an *adjacent* music piece.

Should the project be undertaken again, attention should be focused on analysing the effects of individual musical elements, to gain insight into the effectiveness of the composition as a whole. This should be done by adjusting the design of the testing by incorporating both qualitative and quantitative approaches. Ideally with a larger emphasis on the testing, more participants would be tested and a methodology closer to that of Ulrich Kirk should be followed. Testing both groups twice, the addition of a PSS measurement and a subjective response to various aspects of the test from participants would improve the project and the area of research.

The practice could be improved by analysing more than one instance of *adjacent* music. Compositions created with the above objectives in mind will still undoubtedly be influenced by creative expression. In addition, comparing an *adjacent* music piece to music selected by the participant as *background* music for the SART could be important to analyse how subjective preferences like style and genre can affect a listener's ability to remain aware.

Although a wish for clear and results is reasonable, sometimes the most learning comes from analysing flaws in a project. As was the case with the current research, the methodology was grounded in theoretical learning and thus, conclusions drawn at the beginning of the process are still held strong. Insignificant results signify a need for adjustments and an expansion of the methodological process; however, major learning has been made as a result.

Bibliography

Baxter, Mark G. Croxon, Paula L. “Amygdala and Emotional Faces.” *Proceedings of the NationalAcademy of Sciences,* vol. 109, no. 52, pp. 22180

Čakire, Santa. Vanags, Edmunds. “Meditation Effect on Brain Function Using EEG in Randomized Controlled Studies: Meta-Analysis.” *Baltic Journal of Psychology,* vol. 23, issue1/2, 2020, pp. 139-156

Hagan, Ekua. “An Overview of Meditation: Its Origins and Traditions.” *Psychology Today,* www.psychologytoday.com/ie/blog/meditation-modern-life/201307/overview-meditation-its-origins-and-traditions. Accessed 27 Nov 2021.

Ingham, Tim. “Spotify is Making Its Own Records… And Putting Them on Playlists” *MusicBusiness Worldwide,* www.musicbusinessworldwide.com/spotify-is-creating-its-own- recordings-and-putting-them-on-playlists/. Accessed 29 Nov 2021.

Kabat-Zinn, Jon. “Mindfulness-Based Interventions in Context: Past, Present, and Future” *Clinical Psychology: Science and Practice,* vol 10, issue 2, summer 2003, pp. 144-156.

Kellaris, James J. Kent, Robert. J. “The Influence of Music on Consumers’ Temporal Perceptions: Does Time Fly When You’re Having Fun?” *Journal of Consumer Psychology,*vol. 1, issue 4, 1992 pp. 365-376. doi.org/10.1016/S1057-7408(08)80060-5

Kirk, Ulrich. “On-the-Spot Binaural Beats and Mindfulness Reduces Behavioral Markers of Mind Wandering.” *Journal of Cognitive Enhancement,* vol. 3, 26 Nov 2018, pp. 186-192. doi.org/10.1007/s41465-018-0114-z

Levitin, Daniel. *This is Your Brain on Music*. Dutton Penguin, 2006, pp. 165-188.

Liu, Baoxia. Rice, Valerie J. “A Pilot Study Investigating Preferred Background Sounds During Mindfulness Meditation: What would you like to hear?” *Work,* vol. 63, issue 2, 2019,pp. 159-163. Doi: 10.3233/WOR-192917

“Mental Health.” *World Health Organization,* www.who.int/health-topics/mental-health#tab=tab_2. Accessed
26 Nov 2021.

Mineo, Liz. “With Mindfulness, Life’s in the Moment” *Hardvard Gazette,*

news.harvard.edu/gazette/story/2018/04/less-stress-clearer-thoughts-with-mindfulness-meditation/. Accessed 27 Nov 2021.

Pascoe, Michaela C., et al. “Psychobiological Mechanisms Underlying the Mood Benefits of Meditation: A Narrative Review.” *Comprehensive Psychoneuroendocrinology*, vol. 6, May 2021.

Puddicombe, Andy. “How To Meditate in Ten Minutes.” *Headspace,* https://www.headspace.com/articles/how-to-meditate-in-ten-minutes. Accessed 27 Nov 2021.

Quartz Staff. “Why There’s So Much Money in Mindfulness.” *Quartz,* qz.com/1958593/covid-19-accelerated-the-worlds-embrace-of-meditation-apps/. Accessed 28 Nov 2021.

Schulte, Brigid. “Harvard Neuroscientist: Meditation Not Only Reduces Stress, Here’s How It Changes Your Brain.” *The Washington Post,* www.washingtonpost.com/news/inspired- life/wp/2015/05/26/harvard-neuroscientist-meditation-not-only-reduces-stress-it-literally- changes-your-brain/. Accessed 2 Dec 2021.

Sorenson, Scott. Text message to Author. 9 Feb. 2021. See Appendix C.

Stoet, Gilburt. “Sustained Attention to Response Task.” *PsyToolkit,* https://www.psytoolkit.org/experiment-library/sart.html#_introduction. Accessed 15 Nov 2021.

Thorpe, JR. “Here’s What Happens In Your Brain When You Hear White Noise.” *Bustle,* www.bustle.com/p/what-white-noise-does-to-your-brain-according-to-experts-19271146. Accessed 30 Nov 2021.

Todd, Eric. “How Nature Sounds Comfort Patients.” *PDi,* www.pdiarm.com/blog/nature-sounds. Accessed 29 Nov 2021.

Trappe, Hans-Joachim, “The Effects of Music on the Cardiovascular System and Cardiovascular Health.” *Heart (British Cardiac Society)*, vol 96, no. 23, pp. 1868 - 1871.

doi:10.1136/hrt.2010.209858

Appendix A: Text Message Interview with Headspace Audio Director, Scott Sorenson.

Author: *What would you name as your biggest workflow or production tips for focus music?*

Sorrenson: *Thanks for reaching out. I would say the biggest piece of advice is to use your instincts and to be objective about what you are making. Does it accomplish what you are setting out to do? Does the sound create the space for the objective? Also, focus music can be a little tricky. Namely around it being too interesting (catchy) or too boring on the opposite end. You need to find the balance between them. Something that creates a blanket of sound. I compare it to what rain can do in a city. The nice sound can drown out the ambient noises of garbage trucks and cars. But we aren't really listening to rain so to speak. A cocooning effect. Hope that helps.*