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Music As a Sleep Aid: Effects of Types of Music and Prior Musical Experience on Perceived Sleep Quality

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An abstract of
a thesis submitted to the Faculty of Emory College of Arts and Sciences
of Emory University in partial fulfillment
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Abstract

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In the current literature regarding sleep quality, there is a large body of research devoted to the use of music as a sleep aid. Music has been shown to have a better efficacy for sleep improvement than other common sound treatments without the serious side effects of sleep medication. However, most sleep and music studies focus mainly on the sleep; there is a gap in the literature regarding which elements of music improve its efficacy as a sleep aid. The current study sought to examine the relationship between one specific element of music, pitch directionality, and the efficacy of music as a sleep aid. It also further examined relationships between musicianship and sleep quality as well as other components of well-being such as stress reduction. An Initial Survey was administered to 52 participants, and of that sample, 31 participants were administered four conditions of sound before sleep (silence, ambient noise, ascending music, and descending music). The primary hypothesis was that melodically descending music would improve sleep over melodically ascending music. The secondary hypothesis was that higher levels of musicianship will result in lower sleep quality with the presence of music. The tertiary hypothesis was that higher reported levels of musical engagement during the COVID-19 pandemic would result in lower reported stress levels during that time. Our results showed that the reported sleep quality scores for each sleep-sound condition were not significantly different from one another and that musicianship did not have a significant predictive effect on sleep quality in any condition. One subcomponent of musical engagement showed a significant predictive effect on reported stress such that as musical engagement increased, stress increased as well. Therefore, the results of the study did not support any of the hypotheses. However, an exploratory analysis showed several significant differences in mean survey scores and sleep sound condition responses between the Psychology department-affiliated students and the Music department-affiliated students. Possible future directions involve examining other technical elements of music in relation to sleep quality as well as reexamining the question of pitch directionality using the objective data lens of a controlled sleep lab environment.

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Introduction

Background

In 2015, modern musician Max Richter composed an 8-hour-long piece he called “Sleep” with the sole intention of lulling the majority of his audience to sleep as they listened (Swatman, 2015). This masterpiece illustrates the fascination that artistic and psychological experimenters have with how music affects sleep. Sleep is an essential biological process that is responsible for information integration, memory consolidation, cellular restoration, and neurological waste management (Foster & Kreitzman, 2017). Poor quality of sleep interrupts these processes. With inadequate sleep, physical health is compromised through dysregulation of hormone levels; mental health sees negative impacts through increased vulnerability to external stressors and increased global impairment equivalent to a blood alcohol content of up to 0.1%, a level above even the legal limit for driving (Williamson & Feyer, 2000). The importance of sleep has led to extensive literature examining methods of improving both its quality and shortening the amount of time it takes to fall asleep (sleep latency) for the benefit of overall health. One widely-used, non-pharmacological sleep aid that researchers have explored is music (Trahan et al., 2018), which has been observed to improve subjective sleep experience, efficiency, and latency in adult patients suffering from insomnia (De Niet et al., 2009; Jespersen et al., 2015).

Although some conclusive evidence exists regarding music’s influence on sleep, there is currently a gap in the literature specifically related to the music. Sleep music, music that is created for the sole purpose of improving sleep, is a nebulous concept and is not uniform across psychological studies. There is a marked lack of experimentation with different technical music theory elements of sleep music as well as a limited focus on subjects’ relationship with music despite past literature that shows a difference in musical processing between musicians and nonmusicians. The current study addressed the need for a focus on musical characteristics by specifically examining pitch direction as a predicting variable and its influence on both subjective and objective quality of sleep in an undergraduate student population. Secondarily, it examined the extent to which level of musicianship affects the efficacy of music as a sleep aid for participants. Lastly, it examined the effects of engagement with music on other healthy behaviors such as stress reduction in order to further explore the implications of differential music processing on an individual's well-being.

Sleep is crucial for proper brain maintenance and information integration (Foster & Kreitzman, 2017). It can be measured for both subjective and objective quality. Subjective sleep quality is an individual's perception of their sleep. It is typically measured via self-report questionnaires or surveys and provides qualitative data about the experience of sleep that is inaccessible to researchers by observation, such as a subject's personal feelings. Objective sleep quality includes the length, sleep stage structure, wakefulness, and awake periods of sleep episodes (O'Donnell et al., 2009). Sleep is divided into two different types: rapid eye movement (REM) and non-rapid eye movement (NREM) (Lockley & Foster, 2012). NREM sleep is further subdivided into several distinct stages: N1, or drowsy sleep, N2, or light sleep, and N3, slow wave sleep (SWS), or deep sleep (Lockley & Foster, 2012; Cordi, Ackermann, & Rasch, 2019). REM sleep, a state of heightened physiological brain activity, has been implicated in emotional processing and nondeclarative memory (Wagner, Gais, & Born, 2001; Plihal & Born, 1999). NREM sleep, especially SWS, is important for memory consolidation (Dotto, 1996; Varga et al., 2016).

Both subjective and objective sleep quality are subject to influence by external factors, including music if present. Music is composed of distinct, definable characteristics such as rhythm, tempo, pitch, and consonance. These characteristics are inherently intertwined with stimulus perception and encoded in the context of emotional and physiological influences. They can be measured by analyzing a musical composition for their presence and cause measurable perceptual and physiological phenomena in the brain and body. Pitch is responsible for a large part of emotional encoding in music and speech, with certain intervals denoting either positive or negative valence emotions (Curtis & Bharucha, 2010). It also significantly influences the experience of induced and perceived arousal (Wöllner, Hammerschmidt, & Albrecht, 2018; Curtis & Bharucha, 2010).

A separate measure of musical involvement addressed by this study is musicianship. Musicianship is a multifaceted term that encompasses a person's musical involvement, exposure, and technical training (Müllensiefen et al., 2014). It can be measured externally through musical proficiency, awareness, and understanding, or internally through neurological responses to pitch and technical elements, as musicians have a more finely tuned perception of music (Crespo-Bojorque, Monte-Ordoño, & Toro, 2018).

Current Literature Regarding Sleep Music

Because of the importance of sleep in the regulation of both physical and mental health, the current sleep literature is dense with research regarding aids for improving sleep quality. Although efficient, pharmacological sleep aids are subject to desensitization, addiction risk, and costliness, so studies have turned to sleep improvement methods outside of medication (Cordi, Ackermann, & Rasch, 2019; Komoda et al., 2011; Min, Nadpara, & Slattum, 2016). Current literature on the relationship between sleep and music has determined that music is more effective as a sleep aid than ambient sounds, the other commonly used noise-related sleep aid (Ayoub, Rizk, Yaacoub et al., 2005). Cordi, Ackermann, and Rasch (2019) found that sleep music does improve the subjective sleep quality of participants. Furthermore, they found an improvement in objective sleep quality. Subjects spent a reduced amount of time in N1, or light sleep, and were able to fall into deeper and REM sleep, thereby receiving more of the physical and neurological benefits of those sleep stages.

Music used as a sleep aid has also been shown to help prepare the body for sleep in external, psychological ways (Trahan et al., 2018). By becoming part of an individual's typical nightly routine, music becomes a mechanism of conditioning, increasing the subjective sleep propensity of the brain and body. Additionally, it helps to muffle the unwanted sounds that are typical of any sleeping environment (Trahan et al., 2018). These external sleep conducive properties work to help to make music a viable source of sleep improvement that is effective, cost-efficient, and accessible.

Issues with the current literature on music as a sleep aid stem from a lack of research focused on the music as opposed to the sleep. Characteristics of sleep music have not been researched beyond a small-scale pilot study that considers only a small number of sleep music pieces (Cordi, Ackermann, & Rasch, 2019). The samples used in different studies of sleep are not uniform, adding additional variables that can change the sleep data for which research studies need to account (Cordi, Ackermann, & Rasch, 2019; Trahan et al., 2018). Studies have not been accounting for the different ways in which unique technical elements of music are differentially processed by the brain. Sleep music must itself be analyzed for efficacy under the umbrella of the broader question of music as a sleep aid in order to fully understand the relation.

Pitch Directionality

The directionality of pitch intervals in music and speech is a deciding factor in how those intervals are represented by the brain. The sound of a word or phrase spoken in a specific emotional context is multidimensional, encompassing semantics, syntax, tone, and pitch in order to convey a full spectrum of meaning; the brain is able to use frequency following responses (FFRs), instances of neural activity that happen in relation to hearing sound, to faithfully encode those dimensions and ascribe meaning to them for future repetitions in conversation (Kraus & Nicol, 2018). This pitch-centered sound repertoire of language is constructed by experience and is a very necessary part of communicating emotion and intention. The encoding of communicative pitch is so integral to conveying meaning in language that recent literature has found that individuals automatically associate pitch intervals and the direction in which they move with specific emotions even when they stand alone outside of the context of normal conversation (Curtis & Bharucha, 2010). Studies have shown that ascending pitch is associated with high arousal emotions while descending pitch is associated with low arousal emotions (Curtis & Bharucha, 2010).

In addition to associations with arousal, pitch directionality has also been established as a cross-modal neural correlate of visuospatial height (Spence, 2011). According to past literature, higher pitches and ascending pitch directionality are associated by the brain with an upright position and rising movement, while lower pitches and descending pitch directionality are associated with a downward position and falling movement (Spence, 2011). In their 2016 study, Carnevale and Harris found that the presence of music could bias individuals' perception of ambiguous movement as rising or falling depending on whether the music was ascending or descending respectively.

These correlations between pitch and psychological perceptions have not been addressed in the sleep and music literature to date. Sleep studies do not take into account the data regarding emotional, neurological, and physiological encoding of the music theory of sleep music pieces

(Cordi, Ackermann, & Rasch, 2019). More speculation about the relationship between music and sleep exists than concrete evidence, although the authors of several past studies have brought up questions about relationships between pitch and other brain functions without any further study (Curtis & Bharucha, 2010; Kraus & Nicol, 2018). There are clear differences between music intended for sleep and music intended for wakefulness; those differences exist in the observable technical space of music composition and can easily be explored. This study aimed to do so by isolating one music theory characteristic of sleep music, namely pitch directionality, and examining whether the primary direction of the intervals has any effect on the efficacy of the music for improvement of sleep quality.

Musicianship

Processing of music by the brain differs depending on an individual's level of musicianship as well as the frequency and kind of their interactions with music. Typically, trained musicians are much more sensitive to minute differences in sound processing than nonmusicians. Due to an enhanced precision of the auditory cortex as a result of technical musical studies and practice, musicians are more sensitive to differences in pitches and sets of pitches than nonmusicians, which allows them to understand the pitch-encoded emotions on a more detailed level (Proverbio, Orlandi, & Pisanu 2016). There is also a recorded influence of musical expertise on auditory processing of consonance versus dissonance (Crespo-Bojorque et al., 2018); consonance is typically easier to perceive than dissonance, but the more precise neurological musical processors of musicians can hear the dissonant differences with which nonmusicians have a more difficult time (Proverbio, Orlandi, & Pisanu 2016). These findings indicate that musical training enhances the extraction of information from relevant auditory stimuli.

Musicians' enhanced response to sound cues is not limited to music; rather, it is intertwined with their processing of speech. Their brains are able to respond faster and with greater perceptual accuracy to sound cues in the speech that they hear (Kraus & White-Schwoch, 2016). They are also more resilient against disturbances from background noise, which allows them to more fully focus on the speech coming from the people with whom they are talking (Kraus & White-Schwoch, 2016). Their conversational responses are improved solely by virtue of having a neural pitch processing advantage earned from technical training.

This combined evidence for musicians' enhanced processing of several categories of meaningful sounds furthers the argument that musicians will respond differently than nonmusicians in the presence of music in proximity to sleep behaviors. Previous research has indicated that people with higher musical engagement tend to be more likely to use music to aid sleep, but of those with a higher musicality, most experience higher stress, poorer sleep quality and worsened sleep efficiency (Trahan et al., 2018). As of yet, the sleep and music literature has not examined possible differences in efficacy between the typical sleep-sound environments (silence, ambient noise, music) in correlation to an individual's level of musicianship.

Pandemic Musical Activities

Musical interaction and engagement encourages social and emotional interaction (Schall, Haberstroh, & Pantel, 2015). It has the capacity to restore a previously declining sense of personal agency to individuals via activation of a resilient function of the brain: musical expression. Personal agency has been on the decline since the start of the current global pandemic (Williams et al., 2020), so use of this musical pathway in the brain has the potential to work against that decline to return some sense of control to individuals. Additionally, studies have shown that the structures of the brain that handle music processing are the most resilient to deterioration from neurodegenerative disorders (Fusar-Poli et al., 2018), meaning that the ability to connect with and even create music may survive long past the degeneration of other cognitive functions. This preservation has led researchers and clinicians to view music as their way into the minds of afflicted individuals; if unresponsive patients can engage in mental and physical activity through music, perhaps music can function as a gateway through which other treatment methods can enter.

Multiple explorations of this idea have determined two categories of music therapy (MT): active MT and receptive MT, sometimes referred to as passive MT (Schall, Haberstroh, & Pantel, 2015) Active MT involves the patient in the process of interacting with music during a therapy session by having them sing, dance, play a musical instrument, etc. Receptive MT, though still centered around the patient, involves only the act of listening to music and experiencing it from a passive observer standpoint. Subsequent actions are not encouraged or discouraged, but in some cases, participants will become more animated and responsive as an immediate result of simply having music in their ears (Music & Memory, 2011). Typically, both types of MT are used in tandem for the same patient, and the activities slated for inclusion differ based on the environment, the caregivers, the study at hand, and the desired outcome.

One major reason behind the importance of research regarding music therapy is that music, especially the experience of listening to music, has been proven to reduce stress levels (Yehuda, 2011). This reduction of stress has the potential to actively engage with music listeners in order to promote resilience during times of turmoil. Given the experience of the COVID-19 pandemic, it is possible that engaging with music on a regular basis could improve perceptions of the pandemic and help bolster resilience and daily functioning to a sense of normality, thereby improving sleep quality even outside of the context of sleep music.

Hypotheses and Predictions

The primary purpose of the current study was to determine whether pitch directionality in sleep music affects subjective and objective quality of sleep. The secondary purpose of this study was to observe whether or not individual levels of musical involvement and musicianship affect the efficacy of music as a sleep aid for musicians. A third purpose was to examine whether musical engagement has any impact on stress related to the COVID-19 pandemic. The planned data collection is currently ongoing, so the analyzed data for this thesis are only a part of the full data set that will be available at the end of this study.

Our primary hypothesis is that listening to melodically descending music before sleep will improve subjective quality of sleep over listening to melodically ascending music before sleep. A low arousal physical, mental, and emotional state is more conducive to sleep, leading us to believe that descending melodic patterns would improve the efficacy of sleep-specific music over ascending melodic patterns. The correlation between pitch direction and visuospatial elevation makes it possible to consider that a sample of sleep music created with primarily descending pitches would be associated by the brain with the recumbent position of the body that is typical of sleep and thus prepare the body for the lowered visuospatial elevation of sleep behaviors.

Our secondary hypothesis is that higher individual levels of musical involvement and musicianship will negatively affect the efficacy of music as a sleep aid. We will also be testing exploratory hypotheses regarding how level of musicianship stands in relation to the study variables (e.g. effects of pitch directionality). We predict that because of musicians' ability to glean more information from sound cues and thus keep their brains more active during music than nonmusicians, as well as their heightened attention to for sound in general, the efficacy of music as a sleep aid will be significantly diminished for participants with a higher level of musicianship.

Our tertiary hypothesis is that engagement in musical activity during a quarantine period results in lower levels of stress related to the pandemic. We predict that by restoring a declining sense of personal agency in the midst of a pandemic, music has the potential to reduce stress levels and return daily functionality to a more stable sense of normal as well as improve general perceptions of the pandemic situation in order to foster a stronger sense of resilience. This improvement of general well-being would have the potential to improve sleep quality in a wider range of ways than the use of sleep music at bedtimes.

Materials and Methods

Procedures

The study was divided into two parts. The first part (the Initial Survey; see Table 1) consisted of an initial survey that asked questions about demographic information, typical sleeping habits using the SQS and the AIS, level of musical involvement using the Gold-MSI and the STOMP, chronotype using the MCQ and the rMEQ, pandemic musical activities via a self-report questionnaire written by the author, COVID-related stress using COVID-19 Stress Measure, and lighting conditions using a self-report questionnaire written by Paul Moon. It also included questions about chronotype and specific musical involvement in the pandemic. Several of the surveys were included to gather additional data for other exploratory and planned analyses at a later time after the conclusion of this project. The survey took an average of 30-45 minutes to complete. Researchers evaluated the results of the survey for eligibility and contacted viable participants for the second part (Experiment; see Table 2). Participants from the departments were compensated differently; SONAS participants were given one academic credit for completion of the survey, and non-SONAS participants were given $10 as compensation.

The second part of the study (the Experiment) consisted of four conditions of sound (no stimulus, ambient noise, ascending music, descending music) before sleep. Each participant experienced all four conditions of sound (within-subjects manipulation). These samples were self-administered by participants on four consecutive nights. Participants were instructed by the researchers to set up their audio on a device that could play the audio sample in full each night and could be situated near them as they fell asleep. They were instructed to set the volume level at a volume at which they would feel comfortable falling asleep; to gather more information on what level of volume participants were using to fall asleep, they were instructed to measure their volume level using the application Decibel X and record the volume level on a separate survey. The average volume level at which participants listened was 49.4 dB and the standard deviation was 16.4. To control for confounding variables such as weekly schedules, test conditions were administered on Monday, Tuesday, Wednesday, and Thursday of one week. Friday, Saturday, and Sunday were not used in order to account for differences in weekday and weekend nights of sleep. The order in which participants completed the four conditions across the nights was randomized for each participant. The morning following each sound-sleep condition, participants filled out a survey evaluating their subjective sleep quality and documenting the episode in a sleep log. Participants from the departments were again compensated differently; SONAS participants were given three additional academic credits for completion of the conditions, and non-SONAS participants were given an additional $30 as compensation.

Design

The primary objective of this study was addressed using a within-subjects, experimental research design to determine whether the directionality of pitch had an effect on its efficacy as a sleep aid. The secondary objective of this study used a within-subjects, cross-sectional, correlational design to determine whether level of musical involvement impeded the use of music as a sleep aid. The tertiary objective of this study was addressed using a within-subjects, cross-sectional, correlational design to determine whether pandemic music interactions impacted stress levels related to the COVID-19 pandemic. All statistical analyses were run in SPSS Statistics Base Edition with an alpha level of .05.

Participants

Participants were recruited via a convenience sample taken from the Emory SONA System and Music Department faculty emails. Interested candidates were redirected from

SONAS or provided a link in an email to our informed consent survey. Within the informed consent survey, participants were given information about background literature, variables, procedures, and potential risks and benefits. They were also informed of eligibility criteria for the sleep-sound conditions of the second part of the study. All participants provided electronic consent to take part.

For this project, 53 undergraduate students from the Emory University student population were recruited for the Initial Survey of the current study. Participants were at least 18 years old, and ages ranged from 18 to 22 years (M = 19.4, *SD* = 1.1). Students were primarily first years in the university (43.4%, *n* = 23), and the dominant major reported was Music (18.9%, *n* = 10). The study sample had a majority of women (55.8%, *n* = 29) and East Asian and White/Caucasian subjects (East Asian: 39.6%, *n* = 21; White/Caucasian: 39.6%, *n* = 21), and it was divided nearly evenly into students affiliated with the Music department (50.9%, *n* = 27) and students affiliated with the Psychology department (49.1%, *n* = 26).

Of the study sample of 53 participants for the Initial Survey, 31 students participated in the sleep-sound conditions of the Experiment of the study. The researchers recruited a sample size of 31 participants; data collection is still ongoing with an end goal of 50 participants because that number is a sample size typical of studies involving music and sleep based on analyses of past literature (e.g., Wang, Sun, & Zang, 2014). Participants were at least 18 years old, and ages ranged from 18 to 22 years (M = 19.4, *SD* = 1.1). Students were primarily first years in the university (38.7%, *n* = 12), and the dominant majors reported were Music and Biology (Music: 19.4%, *n* = 6; Biology: 19.4%, *n* = 6). The study sample had a majority of women (51.6%, *n* = 16) and East Asian subjects (41.9%, *n* = 13), and it was again divided nearly evenly into students affiliated with the Music department (51.6%, *n* = 16) and students affiliated with the Psychology department (48.4%, n = 15).

Music students were recruited through email correspondence with the Emory Music Department faculty, who disseminated the study information to potential participants, and psychology students were recruited via the Emory SONA System, an undergraduate recruitment system for psychological studies run by the university. Exclusionary criteria included non-Emory University affiliation, current sleep medication or disorders, and/or significant hearing impairment based on self-report. Inclusionary criteria included access to a device that could play musical samples and access the surveys. All participants spoke English fluently. This study has been approved by the Emory University Institutional Review Board (IRB approval code 00001748).

Materials for Initial Survey

Demographic information. This survey includes questions about age, gender, race/ethnicity, academic year, and academic major(s). It also asks about access to smartwatch technology for objective sleep quality measures, but these data were not ultimately used for the present study due to how small the sample size of the study population was that had the technology available to use. These questions constituted the first part of the Initial Survey (see Appendix A).

Typical patterns of sleeping behavior. Typical sleeping habits were assessed using the Sleep Quality Scale (SQS; Yi, Shin, & Shin, 2006; see Appendix B) and the Athens Insomnia Scale (AIS; Soldatos, Dikeos, & Paparrigopoulos, 2000; see Appendix C). The SQS is a 28-item questionnaire that establishes a baseline and evaluates the quality of regular sleeping patterns over six domains: daytime symptoms, restoration after sleep, problems initiating and maintaining sleep, difficulty waking, and sleep satisfaction (Yi, Shin, & Shin, 2006). The SQS includes questions such as “I have difficulty falling asleep” and “Poor sleep makes me lose interest in work or others.” Participants respond to each question with “rarely,” “sometimes,” “often,” or “almost always,” and they are given a score from 0-84, with higher scores indicating worse sleep quality. Eight items are reverse coded. Participants are considered to have normal sleep quality if they scored a 42 or below. If they score above that range, their data are marked for possible confounding variables such as underlying sleep-related disorders. The SQS has a reported Cronbach’s alpha of α = .92, indicating excellent internal consistency (Yi, Shin, & Shin, 2006). The AIS is an 8-item self-assessment of any sleep difficulty experienced at least three times per week during the last month (Enomoto et al., 2018). Sample items include “**Sleep induction** (time it takes you to fall asleep after turning off the lights)” with possible responses of “No Problem,” “Slightly delayed,” “Markedly delayed,” and “Very delayed or did not sleep at all.” This measure is used in the current study to identify potential symptoms of insomnia or any regular patterns of sleep disturbance. Participants are given a score from 0-24, with higher scores indicating high likelihood of insomnia. Participants were considered to be at no risk for insomnia if they scored a 6 or below (Soldatos, Dikeos, & Paparrigopoulos, 2003). Similar to the SQS, if they scored above that range, their data was marked for possible confounding variables such as presence of insomnia. One participant was excluded from data analyses as their AIS score was so high that it was considered an outlier by the Grubb’s test for outliers, meaning they have severe sleep quality issues by this measure. The AIS has a reported Cronbach’s alpha of α = .89, indicating good internal consistency (Enomoto et al., 2018).

Musical exposure and involvement. Musical exposure and involvement were assessed using the Goldsmith Musical Sophistication Index (Gold-MSI; Müllensiefen et al., 2014; see Appendix D) and the Short Test of Music Preferences (STOMP; Rentfrow & Gosling, 2003; see

Appendix E). The Gold-MSI is a 42-item questionnaire of musical expertise that measures musical interest, perceived emotional evocation, and self-reported technical skill. It includes questions such as “I spend a lot of my free time doing music-related activities” and “If somebody starts singing a song I don’t know, I can usually join in.” Items are scored on an equally weighted, 7-point Likert scale with “1” indicating “totally disagree” and “7” indicating “totally agree.” Higher individual scores on the Gold-MSI indicate higher levels of musicianship and vice versa. It has a reported Cronbach’s alpha of $\alpha = .82$, indicating good internal consistency (Müllensiefen et al., 2014). The STOMP is a 14-item measure that asks for a rating of enjoyment of different musical genres, such as classical and blues. Reliability for the STOMP could not be assessed because it is not a scale. This survey was included to gather additional data for other exploratory and planned analyses in the near future.

Chronotype. Chronotype was assessed using the Reduced Morningness-Eveningness Questionnaire (rMEQ; Di Milia et al., 2013; see Appendix F) and the Munich Chronotype Questionnaire (MCTQ; Di Milia et al., 2013; see Appendix G). The rMEQ is a subjective evaluation of chronotype that places people into three dimensions based on their score: morning (<12), neither (12-17) and evening (>17). It includes questions such as *“Approximately* what time would you get up if you were entirely free to plan your day?” and “During the first half hour after you wake up in the morning, how do you feel?” The MCTQ is considered to be an objective evaluation of chronotype that differentiates between weekdays and weekends. It does not have specific cutoff points, as denoted by the literature (Di Milia et al., 2013); rather, it provides information on sleeping habits as related to chronotype. Reliability for the MCTQ could not be assessed because it is not a scale. These surveys were included to gather additional data for other exploratory and planned analyses in the near future.

Pandemic music activities. Pandemic music activities were assessed using the Pandemic Musical Activities Survey (PMAS), a self-report questionnaire constructed by the current researchers, that asks about musical instruments played, virtual music events attended, and virtual music events participated in during the quarantine (see Appendix H) as well as the Pandemic Musical Perceptions Survey (PMPS), a self-report questionnaire constructed by the current researchers that asks about perceptions of musical interaction in the pandemic (included in the Gold-MSI due to similar question structure; see Appendix D). The questions for both surveys were written by the author as a measure of musical involvement adapted for the pandemic. It includes questions such as "Did you play any musical instruments (including voice) during the quarantine?" and "Did you **attend** any virtual music events (virtual concerts or musicals, live streamed musical performances, online groups related to music, jam sessions with friends)?" Pandemic musical perspective was assessed using the Pandemic Musical Perspective Survey, a self-report questionnaire consisting of items 31-33 added to the Gold-MSI (see Appendix D) that asks about perceptions of musical involvement during the pandemic.

Stress related to COVID-19. Stress related to COVID-19 was assessed using the COVID-19 Stress Measure (CSM; Ellis, Dumas, & Forbes, 2020; see Appendix I). The CSM is an 8-item self-report questionnaire that measures COVID-19 related stress. Items are scored on an equally weighted, 4-point Likert scale with "1" indicating "not at all" and "7" indicating "very much." Individual scores on the CSM were considered a continuous measure for this study, with higher scores indicating higher levels of COVID-19 related stress.

Sleep environment lighting conditions. Sleep environment lighting conditions were assessed using a self-report questionnaire that asks about daily lightning conditions in the pandemic and typical artificial light exposure (see Appendix J). It includes questions such as

"Since the COVID pandemic I have been socially distancing by staying at least six feet from others" and "Since the COVID pandemic I have spent less time socializing with my friends in person." Participants mark their answers as "yes" or "no." The questions were written by Paul Moon as a measure of lighting exposure adapted for the pandemic. This survey was included to gather additional data for other exploratory and planned analyses in the near future.

Materials for Sleep-Sound Experiment

White noise-sleep condition. The white noise sound sample used was a 10-minute clip of white noise evaluated for lack of pitch by the researchers.

Ascending and descending pitch directionality conditions. The melodically ascending and descending sound samples used were composed by the author and Aliyah Auerbach, who each have extensive background and formal training in music theory and performance.

Morning after sleep survey. *Specific sleep episode quality.* Specific sleep episode quality was assessed using the Groningen Sleep Quality Questionnaire (GSQQ; Meijman et al., 1988; see Appendix J). The GSQQ is a 15-item questionnaire that evaluates subjective quality of the most recent sleep episode. It includes questions such as "I had a deep sleep last night" and "I feel that I slept poorly last night." Participants answered "true" (coded as 0) or "false" (coded as 1) to each item; a score of 8 or higher indicated poor subjective sleep quality (De Weerd et al., 2004). This particular measure was chosen because it is a fairly reliable measure pertaining to the most recent episode of sleep only, as opposed to a lengthier, broader timeline of sleep experiences. It has a reported Cronbach's alpha of $\alpha = .92$, indicating good internal consistency (Meijman et al., 1988).

Sleep log. The sleep log used is the National Sleep Foundation Sleep Diary ("NSF Official Sleep Diary."; see Appendix K), which is a subjective self-report of basic information pertaining to the most recent sleep episode, including hours slept, the approximate time of falling asleep in the evening and waking up in the morning, and any sleep disturbances (e.g. waking up for any unwanted period of time during sleep episode) experienced during the night.

Results

Pitch Directionality Hypothesis

To test the primary hypothesis that listening to melodically descending music before sleep improves subjective sleep quality over listening to melodically ascending music, ambient noise, or silence before sleep, a repeated measures analysis of variance (ANOVA) was conducted. Sleep quality was measured by subjectively reported total scores from the GSQQ (GSQQ; Meijman et al., 1988; see Appendix J). Sphericity for this dataset was violated according to the significance value of Mauchly's Test of Sphericity, so a Greenhouse-Geisser correction of degrees of freedom was applied. The four conditions of sound before sleep did not differentially affect the sleep quality scores of participants. Sleep quality was not significantly different between any of the four conditions ($F(2.24,64.86) = .43$, $p = .76$), as shown in Figure 1. However, there was a significant difference in mean GSQQ score for the condition of ambient noise between the Music department affiliated students and the Psychology department affiliated students ($t(27) = -2.49$, $p = .02$), as shown in Figure 2.

The purpose of the primary hypothesis was to determine whether pitch directionality impacts the efficacy of sleep music on a global scale. It did not take into account participants' individual levels of musicianship and the different ways in which musicians and nonmusicians neurologically process sound, including differences in pitch intervals. The secondary hypothesis was necessary to take into account that difference and determine whether sleep music is differentially processed across the domain of musicianship.

Musicianship Level Hypothesis

To test the hypothesis that higher individual levels of musical involvement and musicianship will negatively affect the efficacy of music as a sleep aid, a simple linear regression was conducted for each of the four sleep-sound conditions. The dependent variable, sleep quality, was measured by subjectively reported scores from the GSQQ. The independent variable, individual level of musicianship, was measured by subjectively reported scores from the Gold-MSI (Gold-MSI; Müllensiefen et al., 2014; see Appendix D**)**. Two participants were excluded due to missing data from the entirety of the Gold-MSI. The sleep quality of participants in each of the four conditions of sound before sleep was not differentially impacted by participants' level of musicianship (silence: $b = .05$, $t(27) = .67$, $p = .79$, see Figure 3; ambient noise: $b = –.20$, $t(27) = 2.04$, $p = .30$, see Figure 4; ascending music: $b = .02$, $t(27) = .57$, $p = .92$, see Figure 5; descending music: $b = –.31$, $t(27) = 2.51$, $p = .11$, see Figure 6). No significant predictive relationship was found between any of the conditions and the Gold-MSI scores (silence: $F(1,27) = .07$, $p = .79$, $R^2 = .00$, ambient noise: $F(1,27) = 1.13$, $p = .30$, $R^2 = .04$, ascending music: $F(1,27) = .01$, $p = .92$, $R^2 = .00$, descending music: $F(1,27) = 2.78$, $p = .11$, $R^2 = .09$). The condition of descending music was close to a trend with a p-value of .11. There was a significant difference in mean Gold-MSI scores between the Music department affiliated students and the Psychology department affiliated students ($t(44) = 2.14$, $p = .04$), as shown in Figure 7.

The purpose of the secondary hypothesis was to determine whether participants' level of musicianship impacts the perception and efficacy of sleep music on a musicianship domain-oriented scale. It did not take into account the assumed environmental shift in sleep quality as a result of the COVID-19 pandemic nor did it explore the role of music in that attitude shift. The tertiary hypothesis was included to further explore the possible relationship between the variables of musicianship and COVID-19 stress and how associations within that relationship could translate to improvements in sleep quality.

Pandemic Musical Behaviors Hypothesis

To test the tertiary hypothesis that engagement in musical activity during the quarantine period was associated with lower levels of stress related to the pandemic, a multivariable linear regression was conducted. The dependent variable, stress related to the COVID-19 pandemic, was measured by subjectively reported scores from the CSM (Ellis, Dumas, & Forbes, 2020; see Appendix I). There were three independent variables for this regression: music behaviors across the lifespan, measured by subjectively reported scores from items 34-40 of the Gold-MSI (referred to as the revised Gold-MSI or rGMSI), pandemic music behaviors, measured by subjectively reported scores from the PMAS, and pandemic music perceptions, measured by subjectively reported scores from the PMPS. Three participants were excluded due to missing data from the CSM that impacted the composite score, and two more participants were excluded due to missing data from the entirety of the CSM. All statistical assumptions were met using the same measures as the secondary hypothesis. Of the three independent variables in the regression, stress related to COVID-19 was significantly impacted by the PMPS scores ($b = .30$, $t(43) = 5.51$, $p = .02$). A significant predictive regression model was found between PMPS scores and CSM scores ($F(3,43) = 3.66$, $p = .02$, $R^2 = .20$, see Figure 10). Stress related to COVID-19 was not significantly impacted by the rGMSI and the PMAS (rGMSI: $b = –.40$, $t(27) = 5.51$, $p = .13$, PMAS: $b = .42$, $t(27) = 5.51$, $p = .05$). There was also a significant difference in means score of the PMAS and the rGMSI between the Music department affiliated students and the Psychology department affiliated students (PMAS: $t(45) = 4.74$, $p < .001$, see Figure 8; rGMSI: $t(45) = 3.72$, $p < .001$, see Figure 9), as shown in Figure 11.

Discussion

Pitch Directionality Hypothesis

We predicted that listening to descending music samples directly before sleep would improve subjective sleep quality over listening to ascending music, as well as over silence and ambient noise. However, as the results show, there was no significant difference between the average GSQQ scores across the sample populations of the four conditions. We made our predictions based on evidence that descending music is associated with both low arousal emotions and low visuospatial elevation. These measures were based upon subjective self-reports as well as external observations in past studies.

A possible contributing factor to the lack of significant difference in sleep quality between the music conditions and the conditions of silence and ambient noise is that the musical samples were completely new for all participants. Although the music samples for this study were composed for the purpose of improving sleep, they are new pieces participants have never heard before. A 2013 study conducted by Eichenlaub et al. showed neurological properties of attention to novel sounds. The presence of novel sounds, such as unexpected names, elicits a measurable brain response from a subject listening during periods of both wakefulness and sleep. This study provided evidence that neurological components of attention cause activity in the brain, thereby inhibiting sleep propensity by exciting the mind into focusing on the stimuli at hand and inhibiting sleep-onset circuitry (Waters et al., 1993). It is unlikely that the participants sat down and acquainted themselves with the musical samples thoroughly before sleep, and even if they had, they were only given the samples about 1-5 days prior to when the study conditions began. The newness of the sound samples may have caused them to fall into that attentional category of "interesting" to participants, thereby exciting the brain and subsequently causing issues in sleep propensity and quality. Regardless of the technical characteristics of the music, if it was too new and interesting for the brain, it may have posed an unintended attentional barrier to better sleep quality.

Although the results were not statistically significant and thus a conclusive link is missing, there were still several intriguing trends in the data that may warrant discussion. Both the silence condition and the ambient noise condition had slightly higher mean scores on the GSQQ, indicating worse sleep quality than the music conditions (silence: m = 3.67, ambient noise: m = 3.27). This trend is not significant as of the current data set, but if ongoing data collection continues to strengthen it, it consistent with previous research that has shown music to both subjectively and objectively improve individuals' quality of sleep over silence and ambient noise (Trahan et al., 2018; Cordi, Ackermann, & Rasch, 2019; Ayoub, Rizk, Yaacoub et al., 2005). Between the ascending and the descending music conditions, the mean of the ascending music condition was slightly lower than the descending music condition (ascending: 3.00, descending: 3.13). Between the music conditions, this slight trend, if it continues to move towards significance, would be contrary to what we hypothesized. A possible reason for the disparity between the potentially emerging trends and our predictions is the emotional content of pitch directionality. Alongside their relation to low arousal emotions, descending pitch intervals have been shown to be associated with negative valence emotions, specifically sadness (Curtis & Bharucha, 2010). Past literature has also shown that more attention is paid both subjectively and objectively to low arousal, negative valence emotions like sadness than to high arousal, negative valence emotions like anxiety or positive valence emotions like happiness (Jeffries et al., 2008). This potential increased attentional factor goes hand in hand with the attentional properties of “interesting” samples described above and may potentially interfere with sleep quality and propensity in the same way.

Musicianship Level Hypothesis

We predicted that higher levels of musicianship would decrease the efficacy of music as a sleep aid, regardless of the characteristics of the music. We made our predictions based on evidence that musicians and nonmusicians process music differently from a neurological standpoint. Musicians have a naturally higher resilience to background noises in their environment from which music is typically used to distract or filter, and this resilience against background noise plays into the global enhancement of sound processing past literature has determined is present in individuals who interact with music to a significant extent (Crespo-Bojorque et al., 2018; Kraus & White-Schwoch, 2016; Proverbio, Orlandi, & Pisanu 2016; Trahan et al., 2018). However, as the results show, there was no significant predictive value of the GSQQ scores across the four conditions by Gold-MSI scores; there was little to no impact of Gold-MSI-measured musicianship level on quality of sleep in these specific conditions.

One potential explanation for the lack of significant results is again the attentional properties of “interesting” samples coupled with differences in immediate processing between musicians and nonmusicians. Musicians are able to perceive and interpret sounds in their environments with more immediate precision and accuracy than nonmusicians (Proverbio, Orlandi, & Pisanu 2016). The newness attentional component may have leveled the playing field of listening. While participants with lower levels of musicianship would be potentially more receptive to music as a sleep aid, they would also be more susceptible to the increased attentional impacts of new sound that inhibit sleep quality as a result of the newness of the sound samples. On the other hand, while participants with higher levels of musicianship could experience music as more disruptive to sleep than helpful, they would also be less susceptible to the increased attentional impact of novel sounds due to quicker processing of the novel sound in their environment. This balance of sleep music efficacy and attentional barriers may have stood in the way of seeing a difference between musicians and nonmusicians in terms of sleep.

Similar to the primary hypothesis, although the results were not statistically significant and thus a conclusive link is missing, there were still several trends in the data that are intriguing to discuss. The closest condition to reaching significance was the descending music condition, and the line of best fit for the scatterplot of that condition shows the steepest slope and the clearest possible trend across all four conditions. According to the trend, as Gold-MSI scores increase, the efficacy of descending music as a sleep aid increases. In exploring possible reasons for this trend, we returned to the literature regarding how pitch directionality is processed from the primary hypothesis. Because musicians are more sensitive to the minute characteristics of the pitches they hear, it is possible that they experienced a stronger perception of the low arousal emotions and low visuospatial height evoked by descending music than the participants with lower levels of musicianship, thereby experiencing more of the beneficial effects of descending music on sleep quality (Curtis & Bharucha, 2010; Proverbio, Orlandi, & Pisanu 2016). Because this trend is close to significance, it is possible that it will reach significance with the introduction of data from more participants in the ongoing data collection process.

Pandemic Musical Behaviors Hypothesis

We predicted that engagement in musical activity during a quarantine period results in lower levels of stress related to the pandemic. We made our predictions based on evidence that engagement in music has been shown to reduce stress levels (Yehuda, 2011). As the results show, there was a significant predictive value of the pandemic musical behavior measures on

CSM scores; specifically, the PMPS measure predicted scores on the CSM. The difference in CSM scores was more so related to subjective experience of musical enjoyment and stress-relief than it was to current or quarantine daily musical behaviors. However, the predictive value of pandemic musical perceptions was contrary to what we hypothesized; participants who had positive perceptions of engaging with music reported higher average stress scores in relation to the pandemic.

A possible explanation for these significant results that are contrary to the tertiary hypothesis is the reason behind participants' increased interest in musical engagement. Two of the three questions from the PMPS measure ask about an increase of interest specifically within the timeframe of the COVID-19 pandemic. It is possible that this increased interest in music comes as a result of an increased baseline stress level, and music is acting as a perceived catharsis from that stress. Even if music is a helpful outlet for the stress experienced, its beneficial effects may not persist beyond periods of active musical engagement. As studies examining MT methods can attest, MT efficacy is characterized by fleeting immediacy. MT methods typically produce an instant effect that slowly wanes as the music is taken away. There is currently little to no evidence for proven long-term MT effects on any symptom categories, and that instability contributes to the confused speculation about what MT actually does (Abraha, Rimland, & Trotta, 2017). This fleeting quality of musical engagement as a therapy method may contribute to the disparity between the original hypothesis and the results observed.

Departmental Analysis of Data

Alongside the primary, secondary, and tertiary hypotheses, we also examined population differences between students recruited from the two departments—the Psychology department via the SONA system and the Music department via email—and whether or not the departmental affiliation impacted survey scores for both the Initial Survey and the Sleep-Sound Experiment. In the data gathered for all three hypotheses, there were significantly different results regarding the ways the students interacted with the surveys and the noise conditions.

The significant difference in means between the Music department affiliated students and the Psychology department affiliated students for the ambient noise condition, displayed in Figure 2, could be explained by the differences in processing of background noise between musicians and nonmusicians (Crespo-Bojorque et al., 2018; Kraus & White-Schwoch, 2016; Proverbio, Orlandi, & Pisanu 2016; Trahan et al., 2018). As shown in Figure 7, Music department affiliated students had higher overall average scores on the Gold-MSI, which is to be expected considering their increased extent of typical engagement with music through their department. Because musicians have higher levels of resilience to background noise, the Music department affiliated students may have been able to filter out the sound of the ambient noise condition, which would be beneficial for both the novel sound attentional impediment component mentioned above and because ambient noise showed a trend towards worse efficacy as a sleep aid.

The significant difference in means between the Music department affiliated students and the Psychology department affiliated students for the PMAS and the rGMSI, displayed in Figure 11, could be explained by past usage of music by musicians during times of stress. A high level of musicianship indicting a higher frequency and rigor of interaction with music by an individual (Müllensiefen et al., 2014). Interacting with music more frequently conditions a person to form musical habits, thereby increasing the interaction with music further (Lally et al., 2010). It is feasible that both because of the presence of a stressful event and additional available time to spend, musicians who more frequently interact with music would continue that interact in order to maintain a sense of normalcy and possibly experience musical catharsis.

Alongside psychological explanations of the departmental differences is one possible difference in motivation related to participant compensation. Psychology department-affiliated students were compensated with academic credit they needed to complete introductory psychology courses; they were given one credit for the Initial Survey and three additional credits for the Sleep-Sound Experiment. Music department-affiliated students were compensated with $10 for the Initial Survey and an additional $30 for the Sleep-Sound Experiment. It is possible that these different methods of compensation prompted different levels of motivation in the two populations. Academic credit is very useful for completing courses, but it does not have generalizable application beyond the scope of that class. Doing well in an introductory psychology course can have lasting benefits on a participant's academic career, but the academic credit offered is only a small portion of the overall score required to do well in the class. On the other hand, $10-$40 has significant, generalizable application in the world. It can be used beyond the scope of the current study in whatever way is most beneficial to participants. It could potentially have been seen as a greater reward, which would have increased the stakes of the Initial Survey and the Sleep-Sound Experiment, thereby increasing the motivation of participants to focus and provide better results on their study portions. Thus, it is possible that compensation led to some of the differences in the populations because of the difference in motivation with which participants approached the study.

Limitations

There are several notable limitations of this study. Due to the nature of the pandemic as well as the timeline of this project, bringing participants into a controlled sleep lab environment for data collection was not feasible impossible. Sleep is very individualistic and influenced by a number of different environmental factors, and since those factors could not be controlled for, there do exist influences from external, unrelated factors on the sleep quality data. Lack of a controlled sleep lab environment also meant there was no feasibly accurate measurement method available to gather information regarding objective sleep quality; participant responses were based solely on their self-reported measures. However, many research studies regarding sleep do utilize sleep lobs and subjective measures to probe variables that impact and improve sleep (Trahan et al., 2018; Cordi, Ackermann, & Rasch, 2019). The sleep quality measures used in this study were researched prior to data collection to ensure acceptable reliability and validity (SQS; Yi, Shin, & Shin, 2006; Soldatos, Dikeos, & Paparrigopoulos, 2000; Meijman et al., 1988). We endeavored to address some of the other external factor variability by meeting with each participant individually to explain the sound sample setup as well as provide answers to questions about the process. Those meetings allowed for a uniform delivery of instructions as well as a physical check of the sound setup by the researchers over Zoom. Although we were not able to control for volume, we did gather data regarding the volume at which participants felt comfortable falling asleep so that we would have an idea of how loudly each sample was playing during the period of sleep latency and to ensure that the volume did not exceed a healthy volume for sleep music. Another limitation was the small sample size of the study as compared with previous literature regarding sleep and music. Experimental sleep and music studies typically pull from larger pools, ranging from about 100 to 500 participants, and metanalyses of the literature combining those studies result in data from about 300 to 600 participants (Alapin et al., 2003; Cordi, Ackermann, & Rasch, 2019; De Niet et al., 2009; De Weerd et al., 2004; Jespersen et al., 2015; Trahan et al., 2018). That limitation is somewhat temporary as more data is being collected from participants for this experiment throughout the completion of this thesis, which will allow for an increase in effect size and more ways of evaluating potential results. One final limitation with this study is that while a significant body of past literature exists related to sleep quality and propensity and different methods of improvement, there has been a shift in sleep behaviors and experience as a result of the COVID-19 pandemic. Individuals have reported negative impacts to their sleep quality, propensity, and duration during the time period of the pandemic (AASM, 2020). The effects of the pandemic are still being studied and experienced, so the efficacy of methods such as music for improvement of sleep quality may be impaired to a more significant extent than is currently known in the literature.

Implications of Sleep Music Research

The study of the efficacy of music as a sleep aid is important for the improvement of sleep quality across the general population. Sleep has been heavily implicated in both physical health via information integration, memory consolidation, cellular restoration, and neurological waste management and mental well-being via "life satisfaction; feelings of happiness, sadness, anger, stress, and pain; and a sense of purpose and meaning in life" (Foster & Kreitzman, 2017). With an improvement of sleep quality comes an improved global functionality for everyday life. Little research has been conducted specifically regarding the efficacy of music as a sleep aid, and within that literature pool, even less research has examined the specific technical elements of music that have the potential to greatly impact the efficacy of sleep music. Because the beginnings of sleep music research have shown the possibilities of improved efficacy, it is important to continue pursuing sleep music studies in order to determine the differences present.

Another important aspect of sleep music study implications is the accessibility of music as a sleep improvement method. Many treatment methods for sleep disturbances and disorders are expensive and difficult to obtain, leaving many individuals without a viable option for improvement of sleep quality and a globally impaired sense of functionality as a result. There have also been shown to be correlations between use of sleep medication and serious negative side effects, such as symptoms of insomnia and depression and increased risk of falling during wakefulness in populations over the age of 65 (Komoda et al., 2011; Min, Nadpara, & Slattum, 2016). Music is a significantly less costly, lower-risk treatment methodology with the potential to significantly improve sleep quality. As more information is uncovered regarding which aspects of music best increase its efficacy as a sleep aid, it will be easier to analyze currently existing pieces for those elements and compile samples from past compositions in order to create and discover the best sleep music available.

Alongside the accessibility of music as a sleep aid, music is also an accessible therapeutic option for other domains of life and functionality. As more research goes into the technical elements of music and how they differentially affect the mind and the body, music could be able to be more efficiently and efficaciously able to improve overall well-being. These findings would further the field of music therapy, which has produced significant, observable results in returning to patients with cognitive disorders their sense of agency yet does not have concrete, quantitative findings to back those results (Abraha, Rimland, & Trotta, 2017; Matthews, 2015; Music & Memory, 2011; Schall, Haberstroh, & Pantel, 2015).

Conclusion

The overall results of this experiment do not show a significant relationship between pitch directionality and the efficacy of music as a sleep aid nor does it show significant impacts of musicianship and musical engagement on sleep or other domains of general well-being. Pitch directionality does not appear to be differentially involved in the efficacy of music as a sleep aid, as neither descending music nor ascending music was implicated in better sleep quality over ambient noise, or silence. Level of musicianship does not significantly impact the efficacy of music as a sleep aid. Experiences with musical engagement during a pandemic do not account for a significant reduction of perceived stress regarding that pandemic. However, there are significant differences between the two departmentally affiliated populations, with Music department students reporting better sleep quality, higher levels of musicianship, and more involvement in music throughout the pandemic.

In terms of future experiments, there are many more technical elements of music and their relation to sleep quality that could be examined within the context of a controlled sleep lab environment. One important technical relationship for future discussion is consonance and dissonance, which are heavily considered in literature regarding neurologically processed elements of speech and music (Crespo-Bojorque et al., 2018; Orlandi, & Pisanu 2016). Considering the data from this experiment, I would like to return to the question of pitch directionality and its possible implications in sleep quality but from an objective perspective using sleep lab technology and measures in order to determine whether there is an objective difference in sleep episodes between the different conditions even if it is imperceptible from a subjective standpoint. I would also like to examine the relation between level of musicianship and overall patterns of sleep behaviors and perception across a lifespan, as there are many factors of differentially processed sound perception in musicians that could have a variable effect on sleep quality.

Department (DPT)	# of Subjects (Initial Survey)	# of Subjects (Experiment)	SQS	AIS	Gold-MSI (Survey)
Music	26	16	30.48	5.45	192.70
Psychology	26	15	32.92	6.08	186.75
Total	52	31	31.80	5.78	189.45

Table 1. A descriptive statistics table for participants for the study as a whole with information regarding the average scores from the SQS and the AIS.

SD (SQS)	Range (SQS)	SD (AIS)	Range (AIS)	SD (Gold-MSI)	Range (Gold-MSI)
10.01	50.00	2.97	13.00	38.57	149.00

Table 2. A descriptive statistics table detailing the standard deviation and range of scores from the SQS, the AIS, and the Gold-MSI.

DPT	GSQQ SD (Silence)	GSQQ Range (Silence)	GSQQ SD (Ambient Noise)	GSQQ SD (Ascending Music)	GSQQ SD (Descending Music)	Gold-MSI (Experiment)
Music	16	2.67	2.13	1.73	2.47	214.13
Psychology	15	4.93	4.50	4.29	3.79	197.86
Total	31	3.67	3.27	3.00	3.13	206.28

Table 3. A descriptive statistics table for participants for the primary and secondary hypotheses of the study with information regarding the average scores from the GSQQ for each condition and the Gold-MSI.

SD (Silence)	Range (Silence)	SD (Ambient Noise)	Range (Ambient Noise)
3.29	13.00	2.74	11.00

Table 4. A descriptive statistics table detailing the standard deviation and range of scores from the GSQQ from the silence and ambient noise conditions.

SD (Ascending Music)	Range (Ascending Music)	SD (Descending Music)	Range (Descending Music)
3.60	13.00	3.06	13.00

Table 5. A descriptive statistics table detailing the standard deviation and range of scores from the GSQQ from the ascending and descending music conditions.

Department	# of Subjects	PMAS	rGMSI	PMPS	CSM
Music	26	8.48	29.95	15.81	21.29
Psychology	26	4.64	22.44	13.76	21.76
Total	52	6.39	25.87	14.70	21.54

Table 6. A descriptive statistics table for participants for the tertiary hypothesis of the study with information regarding the average scores from the PMAS, rGMSI, PMPS, and CSM.

SD (PMAS)	Range (PMAS)	SD (rGMSI)	Range (rGMSI)
3.41	10.00	7.92	34.00

Table 7. A descriptive statistics table detailing the standard deviation and range of scores from the PMAS and the rGMSI.

SD (PMPS)	Range (PMPS)	SD (CSM)	Range (CSM)
3.72	16.00	4.12	18.00

Table 8. A descriptive statistics table detailing the standard deviation and range of scores from the PMPS and the CSM.

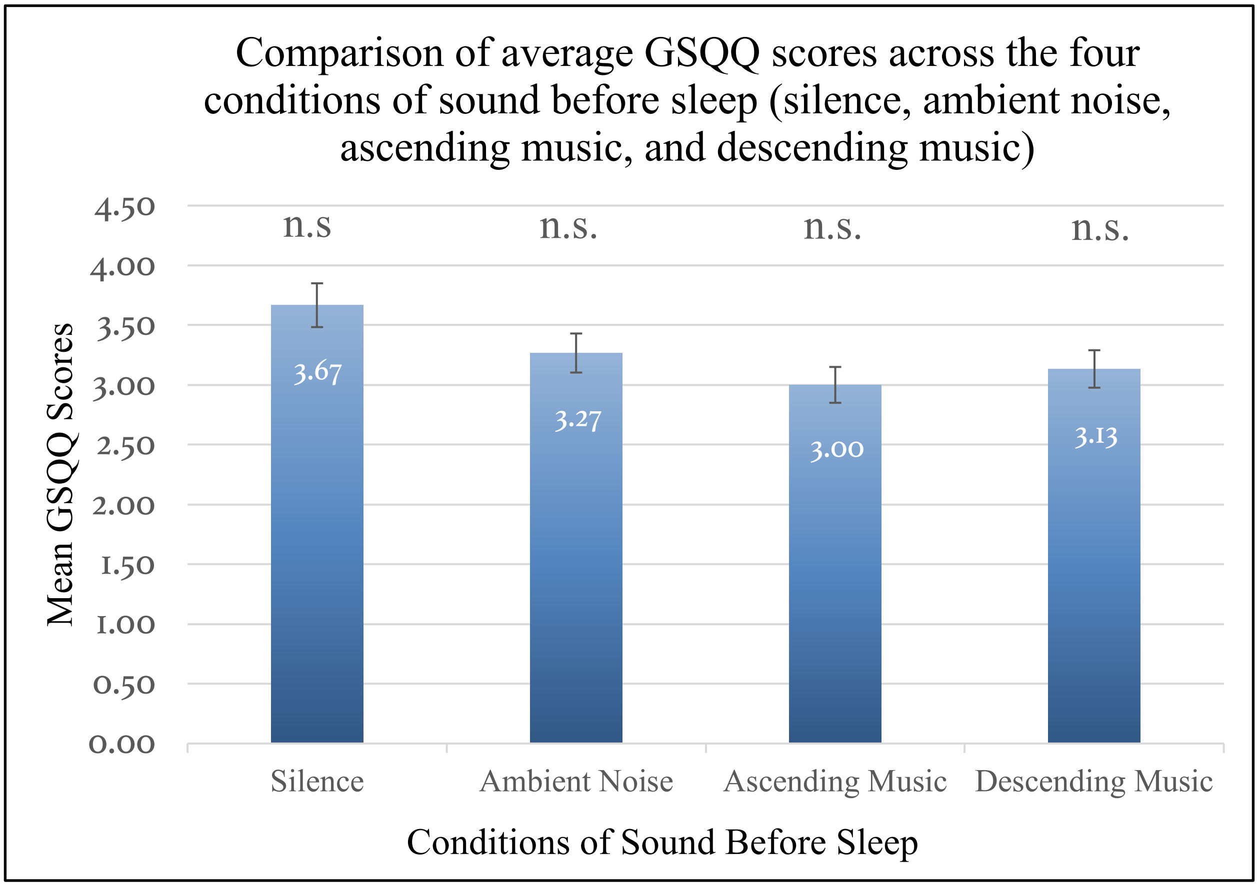

Figure 1. A comparison of average GSQQ scores across the four conditions of sound before sleep (silence, ambient noise, ascending music, and descending music). A repeated measures ANOVA test was conducted to determine whether there was a difference in means. It indicated no significance different for the mean of GSQQ scores across the four conditions. The error bars are +/- one SEM.

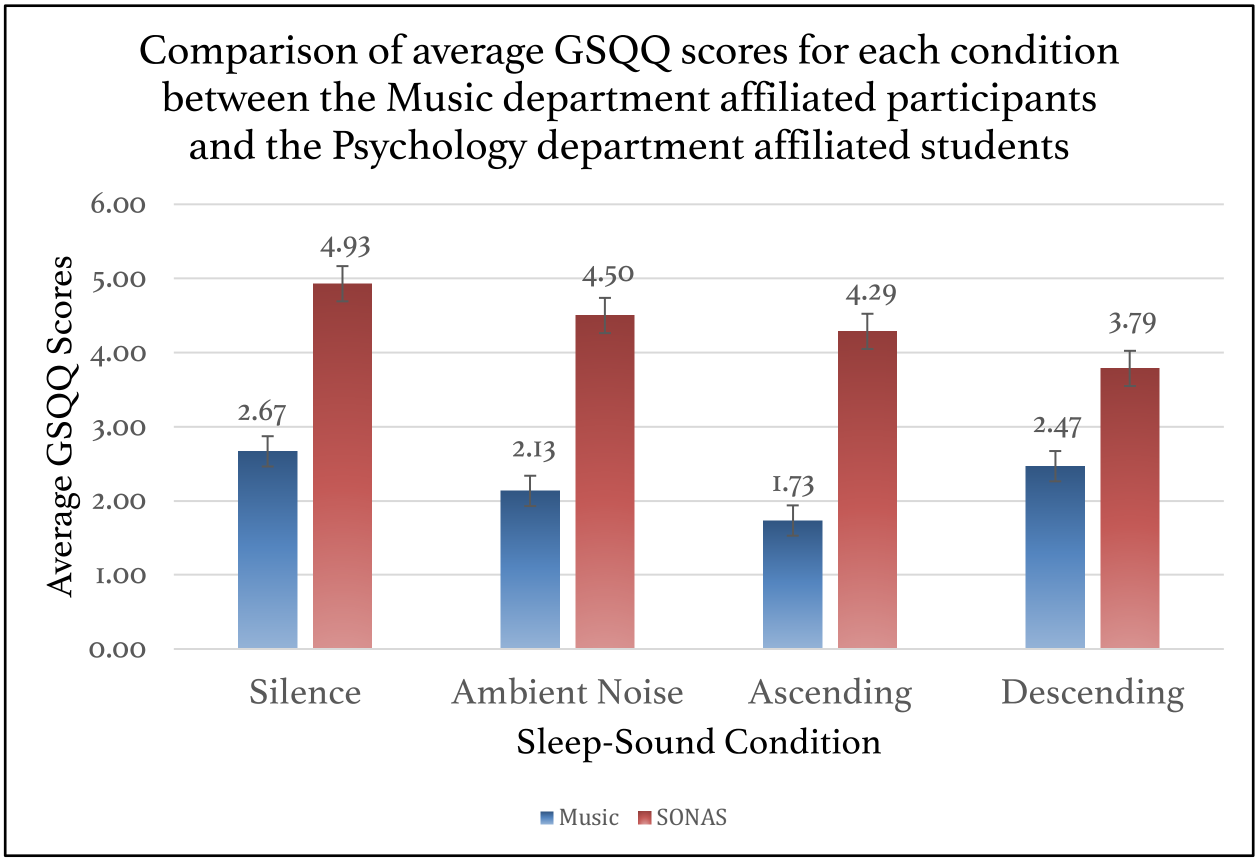

Figure 2. A comparison of average GSQQ scores across the four conditions of sound before sleep (silence, ambient noise, ascending music, and descending music) between the Music department affiliated students and the Psychology department affiliated students. An independent samples t-test was conducted to determine whether there was a significant difference in means between the two groups across the four conditions. It indicated a significant difference in means for the ambient noise condition ($t(27) = -2.49$, $p = .02$). The error bars are +/- one SEM.

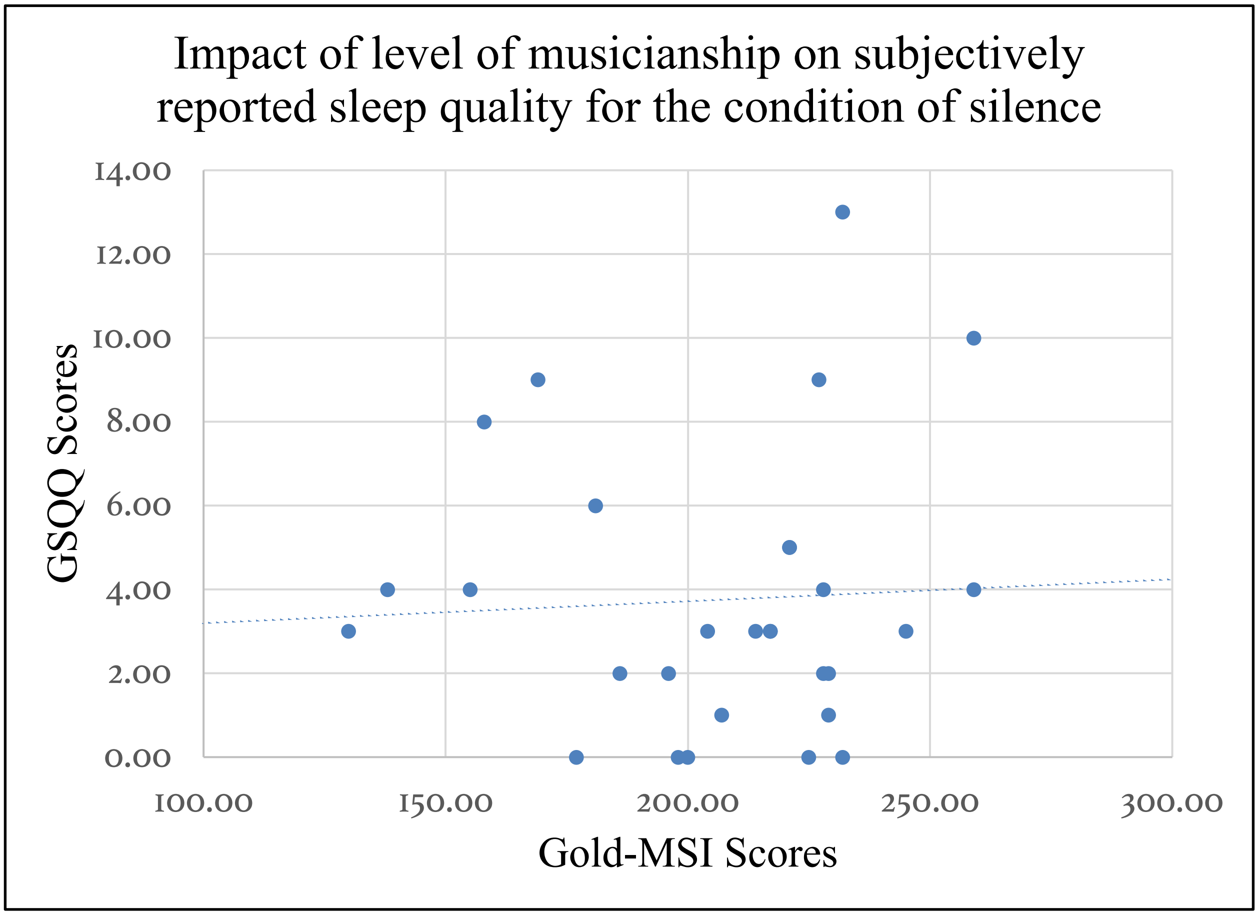

Figure 3. An indication of the impact of level of musicianship, as measured by the Gold-MSI, on subjectively reported sleep quality, as measured by the GSQQ, across individuals. A simple linear regression was conducted to determine whether Gold-MSI scores significantly impacted sleep quality for the condition of silence. It indicated no significant impact in this condition.

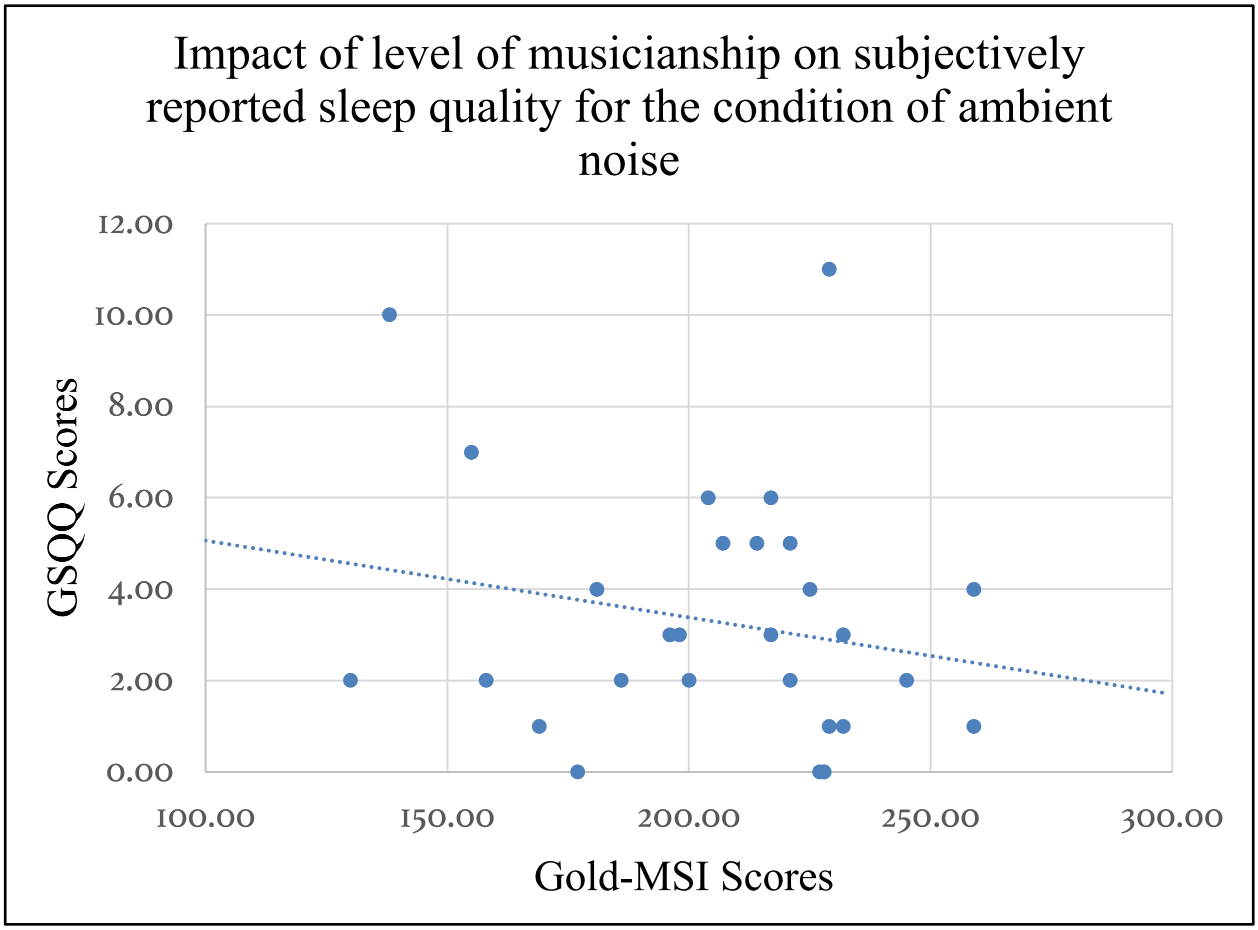

Figure 4. An indication of the impact of level of musicianship, as measured by the Gold-MSI, on subjectively reported sleep quality, as measured by the GSQQ, across individuals. A simple linear regression was conducted to determine whether Gold-MSI scores significantly impacted sleep quality for the condition of ambient noise. It indicated no significant impact in this condition.

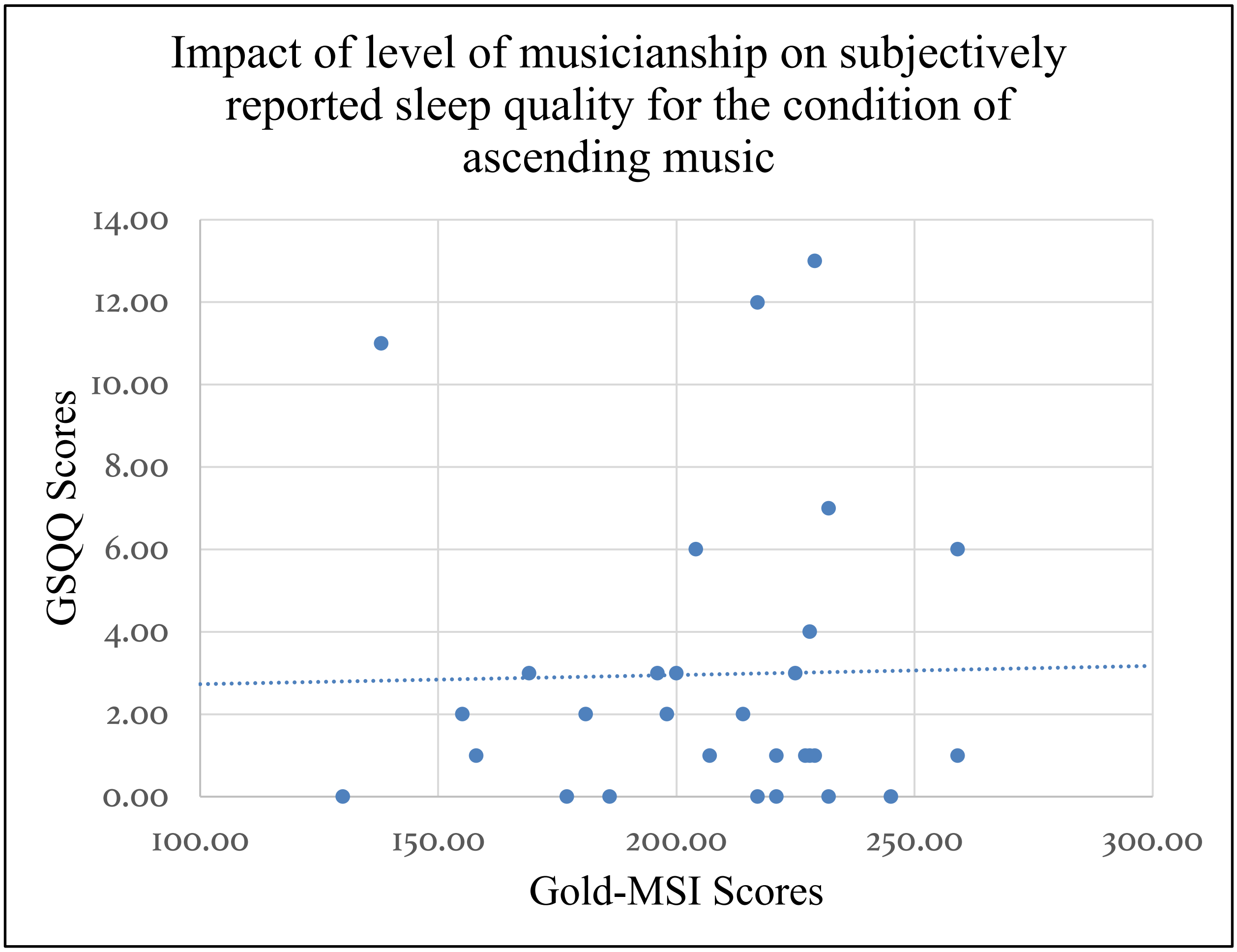

Figure 5. An indication of the impact of level of musicianship, as measured by the Gold-MSI, on subjectively reported sleep quality, as measured by the GSQQ, across individuals. A simple linear regression was conducted to determine whether Gold-MSI scores significantly impacted sleep quality for the condition of ascending music. It indicated no significant impact in this condition.

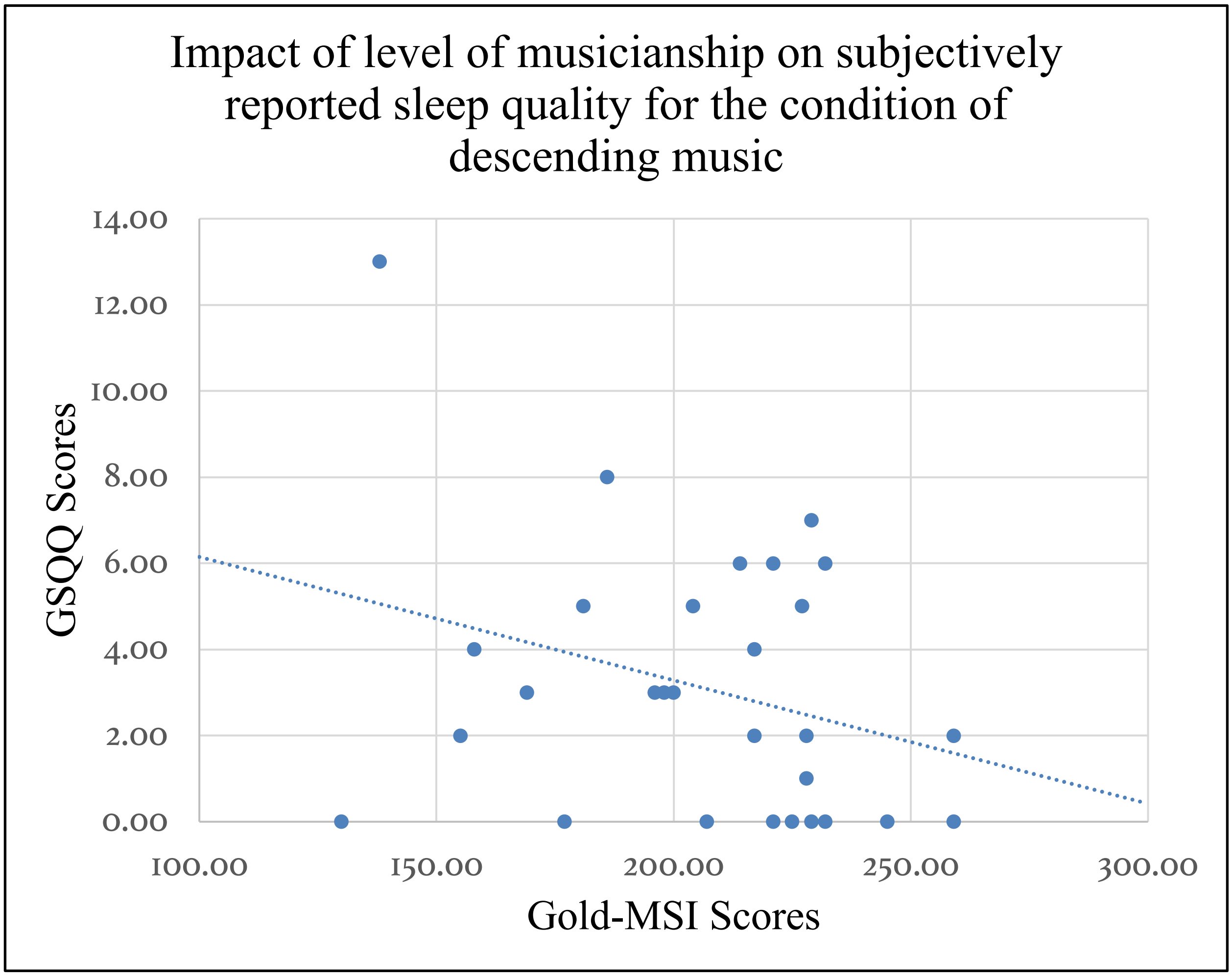

Figure 6. An indication of the impact of level of musicianship, as measured by the Gold-MSI, on subjectively reported sleep quality, as measured by the GSQQ, across individuals. A simple linear regression was conducted to determine whether Gold-MSI scores significantly impacted sleep quality for the condition of descending music. It indicated no significant impact in this condition.

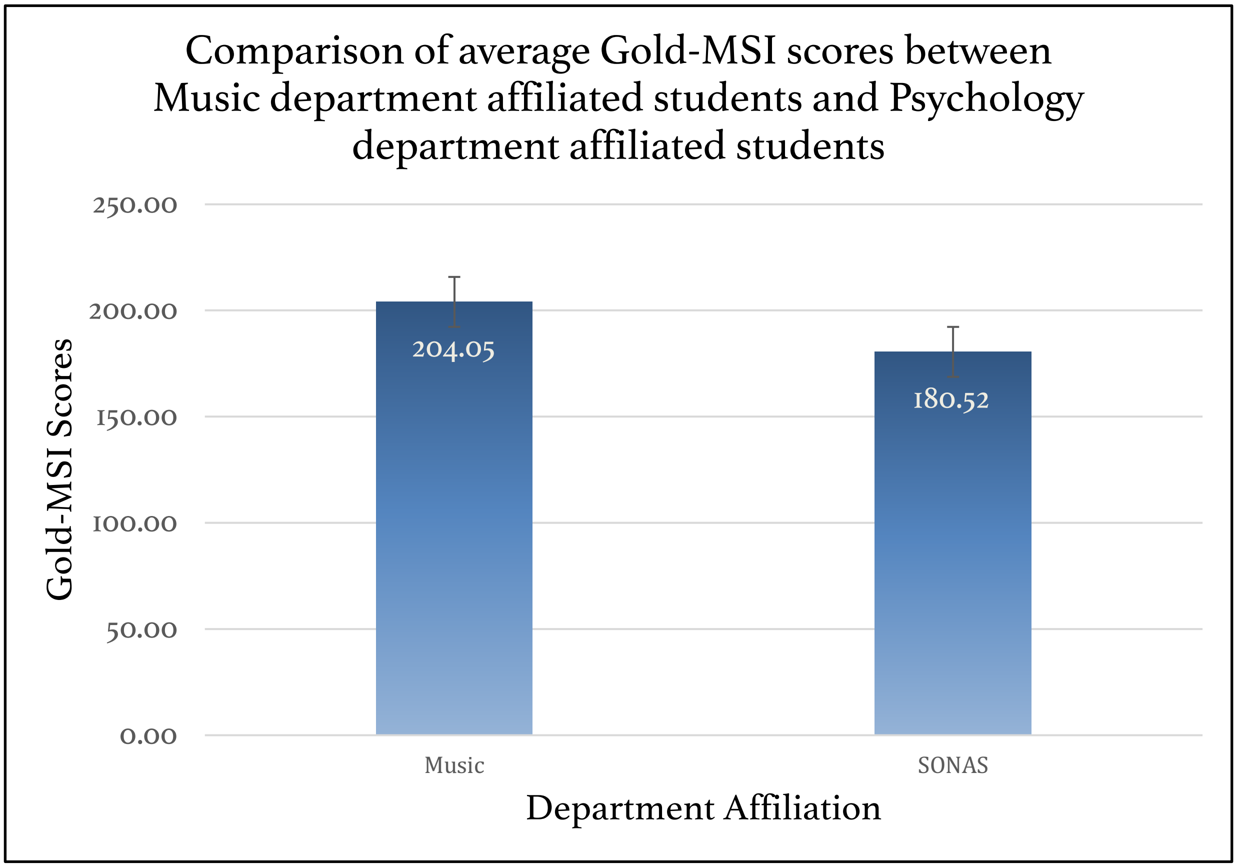

Figure 7. A comparison of average Gold-MSI scores between the Music department affiliated students and the Psychology department affiliated students. An independent samples t-test was conducted to determine whether there was a significant difference in means between the two groups within this measure. It indicated a significant difference in means for the Gold-MSI ($t(44) = 2.14$, $p = .04$). The error bars are +/- one SEM.

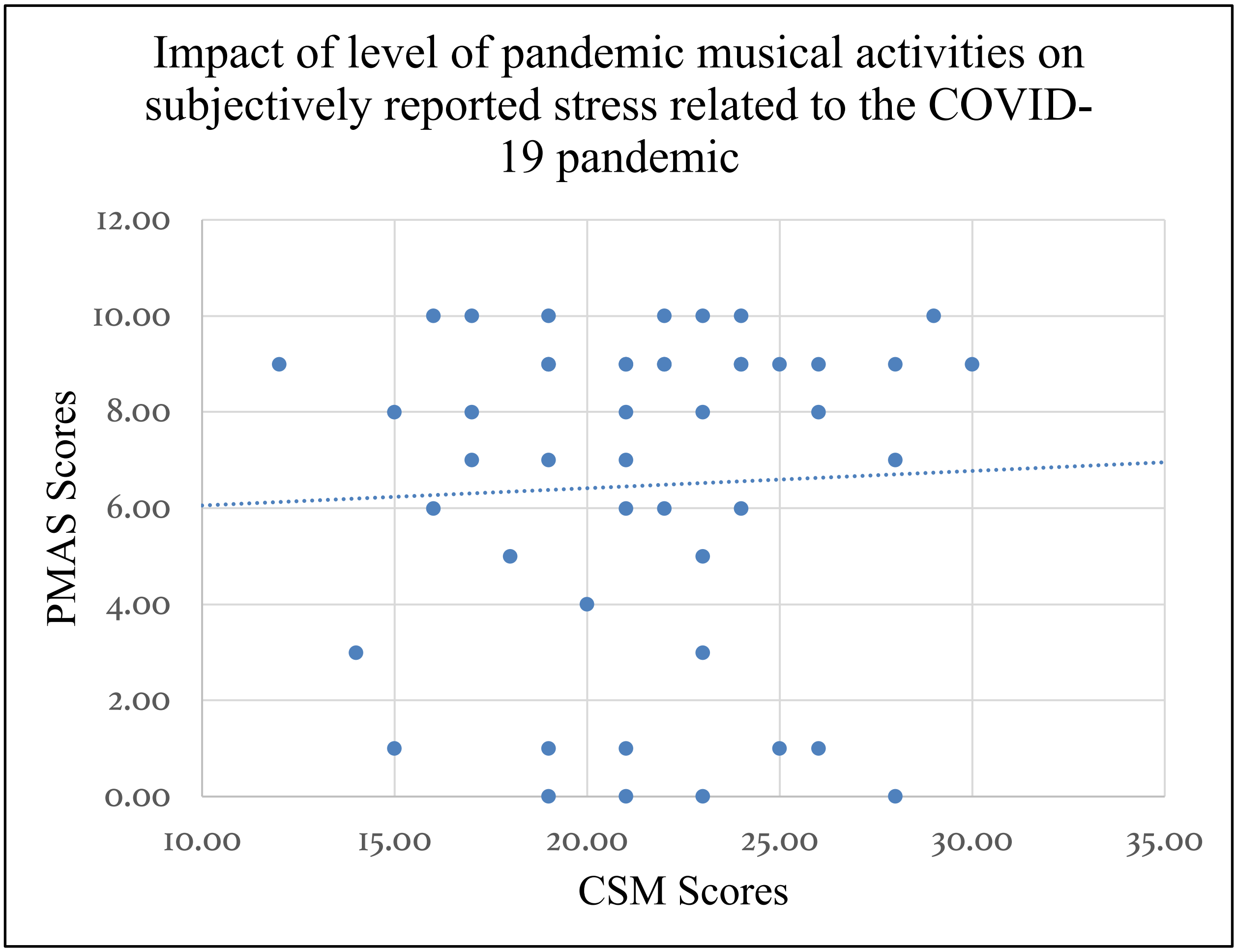

Figure 8. An indication of the impact of pandemic musical activities, as measured by the PMAS, on subjectively reported stress related to the COVID-19 pandemic, as measured by the CSM, across individuals. A multiple linear regression was conducted to determine whether PMAS scores significantly impacted stress level. It indicated no significant impact in this condition.

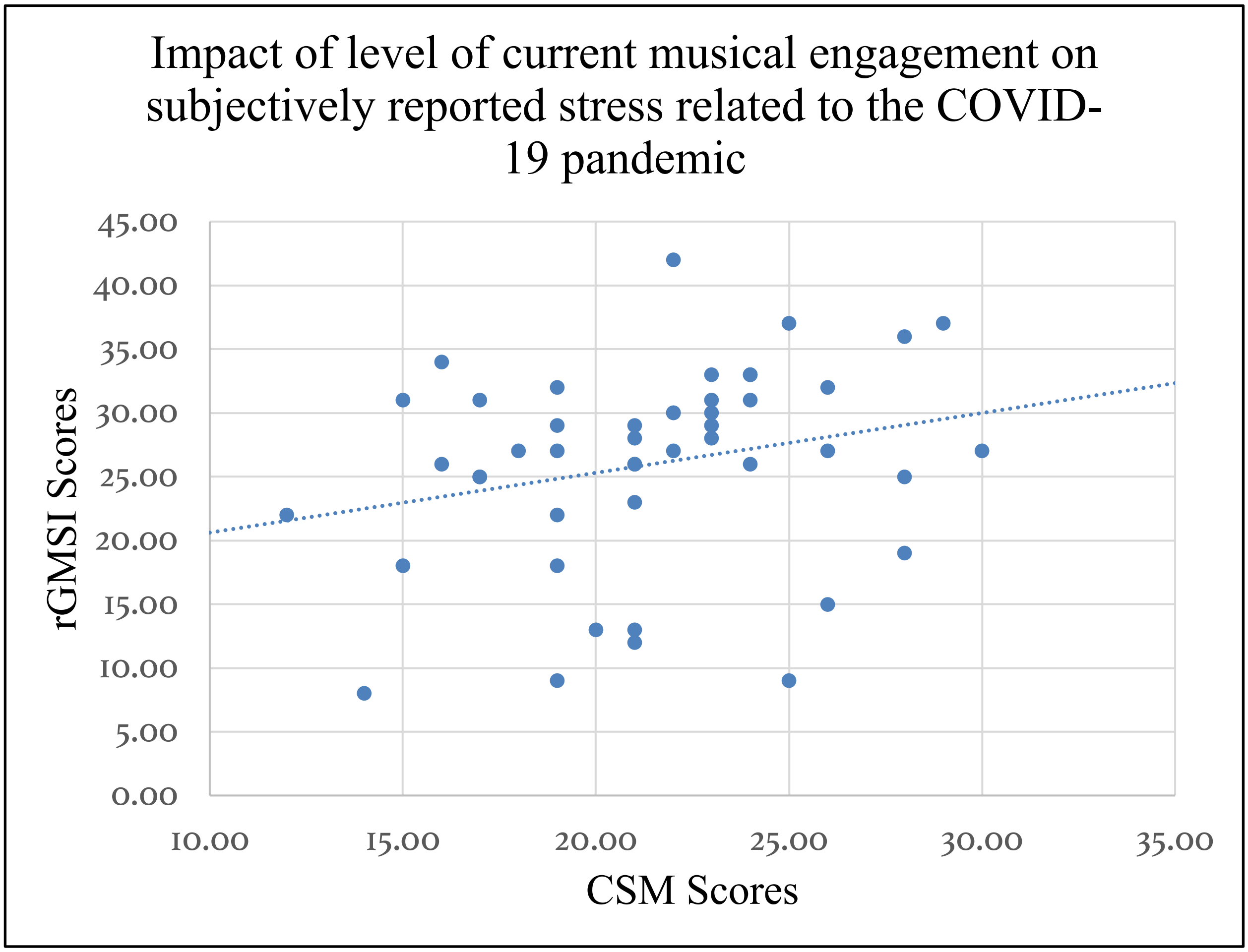

Figure 9. An indication of the impact of pandemic musical perceptions, as measured by the rGold-MSI, on subjectively reported stress related to the COVID-19 pandemic, as measured by the CSM, across individuals. A multiple linear regression was conducted to determine whether rGold-MSI scores significantly impacted stress level. It indicated no significant impact in this condition.

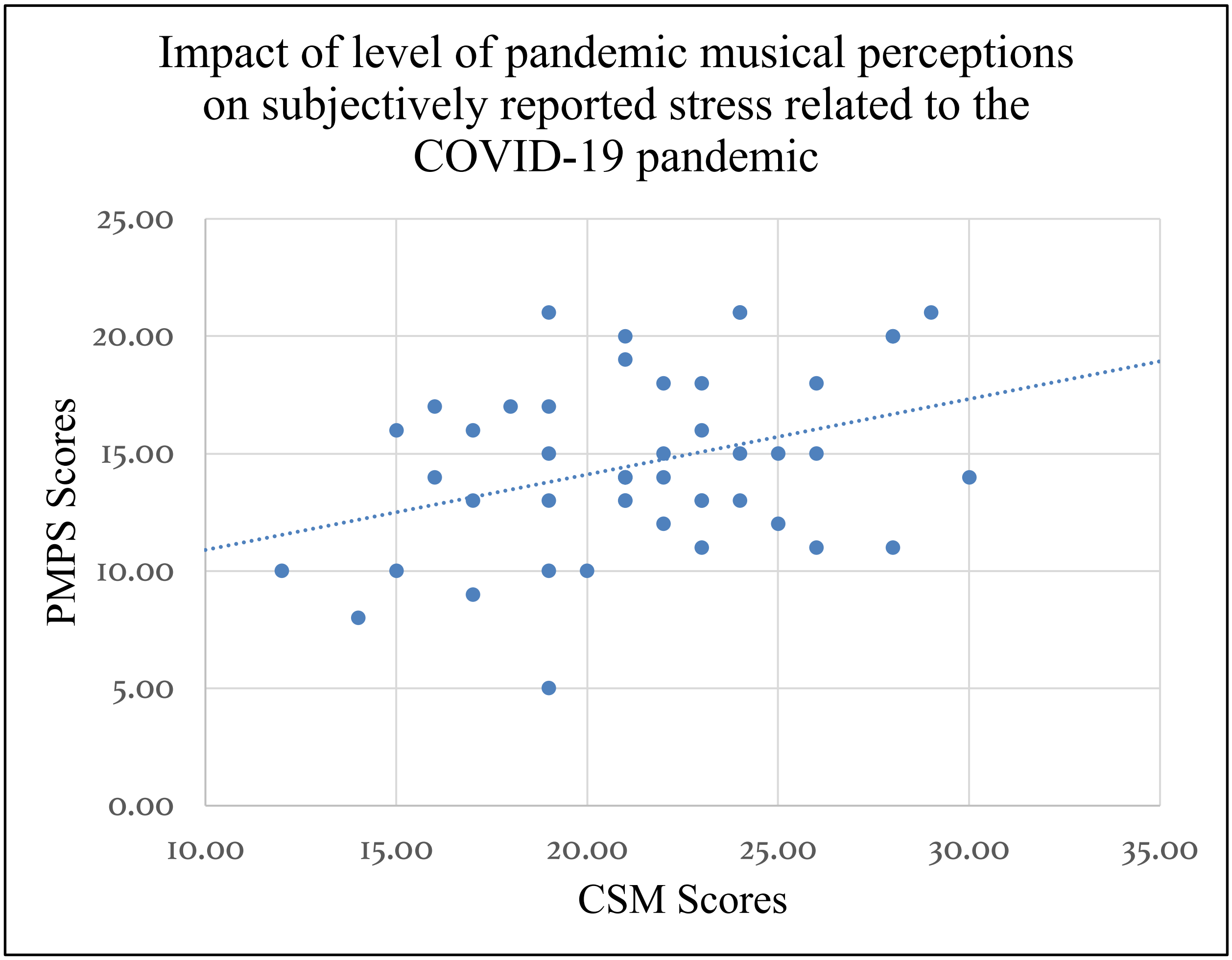

Figure 10. An indication of the impact of pandemic musical perceptions, as measured by the PMPS, on subjectively reported stress related to the COVID-19 pandemic, as measured by the CSM, across individuals. A multiple linear regression was conducted to determine whether PMPS scores significantly impacted stress level. It indicated a significant impact in this condition. A significant regression equation was found ($F(3,43) = 3.66$, $p = .02$, $R^2 = .20$).

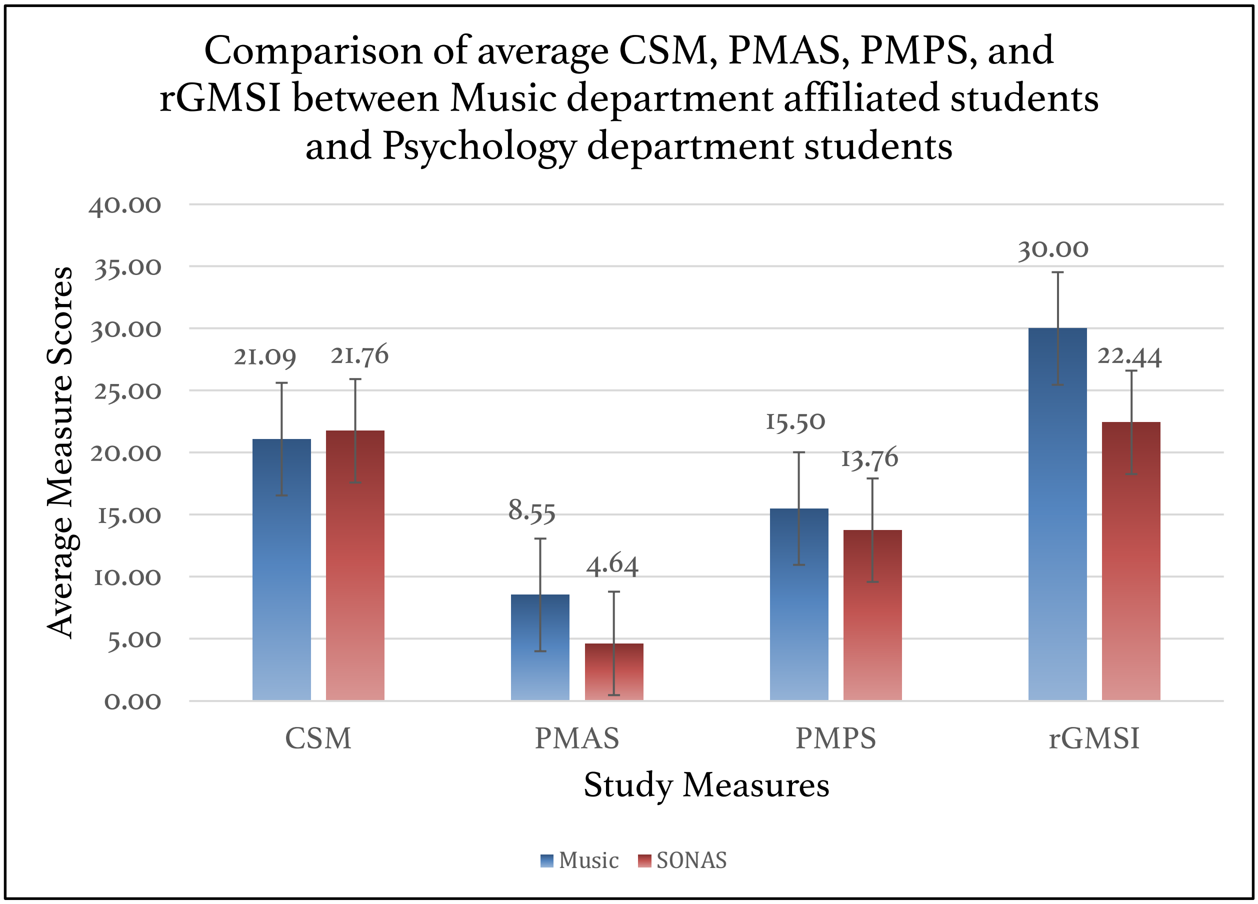

Figure 11. A comparison of average scores for the CSM, PMAS, PMPS, and rGMSI between the Music department affiliated students and the Psychology department affiliated students. An independent samples t-test was conducted to determine whether there was a significant difference in means between the two groups across the four measures. It indicated a significant difference in means for the PMAS ($t(45) = 4.74$, $p < .001$) and the rGMSI ($t(45) = 3.72$, $p < .001$). The error bars are +/- one SEM.

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Appendix A: Demographic Information

Please mark or write down your answer to each of the following questions.

1. **Age:** _______

2. **Gender:**

_____ Woman

_____ Man

_____ Other

_____ Prefer not to specify

3. **Academic Year** (choose one): Freshman Sophomore Junior Senior

4. **Academic Background or Major(s)**: ______________________________

5. **Race/Ethnicity**

_____ White/Caucasian

_____ Black/African American

_____ East Asian

_____ South Asian

_____ Middle Eastern

_____ Hispanic/Latino

_____ Native American, American Indian, or Alaskan Native

_____ Other or Mixed: ________________________________ (please specify)

6. **Do you regularly use a smartwatch (Apple watch, FitBit, etc.) that can record sleep data?** (choose one): Yes No

7. **If you said yes to question 6, what type?** _________________________________

Appendix B: Sleep Quality Scale

The following survey is designed to determine the quality of sleep you have had for the past month. Read each question carefully and check the closest answer.

Examples:
Rarely: None or 1-3 times in the past month
Sometimes: 1-2 times a week
Often: 3-5 times a week
Almost Always: 6-7 times a week

		Rarely	**Sometimes**	**Often**	**Almost Always**
1	I have difficulty falling asleep.				
2	I fall into a deep sleep.				
3	I wake while sleeping.				
4	I have difficulty getting back to sleep once I wake up in the middle of the night.				
5	I wake up easily because of noise.				
6	I toss and turn.				
7	I never go back to sleep after awakening during sleep.				
8	I feel refreshed after sleep.				
9	I feel unlikely to sleep after sleep.				
10	Poor sleep gives me headaches.				
11	Poor sleep makes me irritated.				
12	I would like to sleep more after waking up.				
13	My sleep hours are enough.				
14	Poor sleep makes me lose my appetite.				
15	Poor sleep makes it hard for me to think.				
16	I feel vigorous after sleep.				

17	Poor sleep makes me lose interest in work or others.				
18	My fatigue is relieved after sleep.				
19	Poor sleep causes me to make mistakes at work.				
20	I am satisfied with my sleep.				
21	Poor sleep makes me forget things more easily.				
22	Poor sleep makes it hard to concentrate at work.				
23	Sleepiness interferes with my daily life.				
24	Poor sleep makes me lose desire in all things.				
25	I have difficulty getting out of bed.				
26	Poor sleep makes me easily tired at work.				
27	I have a clear head after sleep.				
28	Poor sleep makes my life painful.				

Appendix C: Athens Insomnia Scale

Instructions

This scale is intended to record your own assessment of any **sleep difficulty** you might have experienced.

Please check the items below to indicate your estimate of any difficulty, provided that it occurred at least **three times per week** during the **last month**.

1. Sleep induction (time it take you to fall asleep after turning off the lights)	No problem	Slightly delayed	Markedly delayed	Very delayed or did not sleep at all
2. Awakenings during the night	No problem	Minor problem	Considerable problem	Serious problem or did not sleep at all
3. Final awakening earlier than desired	No problem	Slightly earlier	Markedly earlier	Much earlier or did not sleep at all
4. Total sleep duration	Sufficient	Slight insufficient	Markedly insufficient	Very insufficient or did not sleep at all
5. Overall quality of sleep (no matter how long you slept)	Satisfactory	Slight unsatisfactory	Markedly unsatisfactory	Very unsatisfactory or did not sleep at all
6. Sense of well-being during the day	Normal	Slightly decreased	Markedly decreased	Very decreased
7. Functioning (physical and mental) during the day	Normal	Slightly decreased	Markedly decreased	Very decreased
8. Sleepiness during the day	None	Mild	Considerable	Intense

Appendix D: Goldsmith Musical Sophistication Index

Please circle the most appropriate category:	1 Totally Disagree	2 Strongly Disagree	3 Disagree	4 Neither Agree nor Disagree	5 Agree	6 Strongly Agree	7 Totally Agree
1. I spend a lot of my free time doing music-related activities.	1	2	3	4	5	6	7
2. I sometimes choose music that can trigger shivers down my spine.	1	2	3	4	5	6	7
3. I enjoy writing about music, for example on blogs and forums.	1	2	3	4	5	6	7
4. If somebody starts singing a song I don't know, I can usually join in.	1	2	3	4	5	6	7
5. I am able to judge whether someone is a good singer or not.	1	2	3	4	5	6	7
6. I usually know when I'm hearing a song for the first time.	1	2	3	4	5	6	7
7. I can sing or play music from memory.	1	2	3	4	5	6	7
8. I'm intrigued by musical styles I'm not familiar with and want to find out more.	1	2	3	4	5	6	7
9. Pieces of music rarely evoke emotions for me.	1	2	3	4	5	6	7
10. I am able to hit the right notes when I sing along with a recording.	1	2	3	4	5	6	7
11. I find it difficult to spot mistakes in a performance of a song even if I know the tune.	1	2	3	4	5	6	7
12. I can compare and discuss differences between two performances or versions of same piece of music.	1	2	3	4	5	6	7
14. I have never been for talents as a musical performer.	1	2	3	4	5	6	7
15. I often read or search the internet for things related to music.	1	2	3	4	5	6	7

16. I often pick certain music to motivate me.	1	2	3	4	5	6	7
17. I am not able to sing in harmony when somebody is singing a familiar tune.	1	2	3	4	5	6	7
18. I can tell when people sing or play out of time with the beat.	1	2	3	4	5	6	7
19. I am able to identify what is special about a given musical piece.	1	2	3	4	5	6	7
20. I am able to talk about the emotions that a piece of music evokes for me.	1	2	3	4	5	6	7
21. I don't spend much of my disposable income on music.	1	2	3	4	5	6	7
22. I can tell when people sing or play out of tune.	1	2	3	4	5	6	7
23. When I sing, I have no idea whether I am in tune or not.	1	2	3	4	5	6	7
24. Music is kind of an addiction for me - I couldn't live without it.	1	2	3	4	5	6	7
25. I don't like singing in public because I'm afraid that I would sing wrong notes.	1	2	3	4	5	6	7
26. When I hear a piece of music I can usually identify its genre.	1	2	3	4	5	6	7
27. I would not consider myself a musician.	1	2	3	4	5	6	7
28. I keep track of new music that I come across (e.g. new artists or recordings).	1	2	3	4	5	6	7
29. After hearing a new song two or three times, I can usually sing it by myself.	1	2	3	4	5	6	7
30. I only need to hear a new tune once and I can sing it back hours later.	1	2	3	4	5	6	7
31. Music can evoke my memories of past people and places.	1	2	3	4	5	6	7
32. The pandemic has increased my interest in listening to music.	1	2	3	4	5	6	7

33. The pandemic has increased my interest in performing music.	1	2	3	4	5	6	7
34. Listening to or performing music in quarantine has decreased my stress level.	1	2	3	4	5	6	7

35. I engaged in regular, daily practice of a musical instrument (including voice) for 0 / 1 / 2 / 3 / 4-5 / 6-9 / 10 or more years.

36. At the peak of my interest, I practiced 0 / 0.5 / 1 / 1.5 / 2 / 3-4 / 5 or more hours per day on my primary instrument.

37. I have attended 0 / 1 / 2 / 3 / 4-6 / 7-10 / 11 or more live music events as an audience member in the past twelve months.

38. I have had formal training in music theory for 0 / 0.5 / 1 / 2 / 3 / 4-6 / 7 or more years.

39. I have had 0 / 0.5 / 1 / 2 / 3-5 / 6-9 / 10 or more years of formal training on a musical instrument (including voice) during my lifetime.

40. I can play 0 / 1 / 2 / 3 / 4 / 5 / 6 or more musical instruments.

41. I listen attentively to music for 0-15 min / 15-30 min / 30-60 min / 60-90 min / 2 hrs / 2-3 hrs / 4 hrs or more per day.

42. The instrument I play best (including voice) is ____

Appendix E: Short Test of Musical Preference

For the following items, please indicate your basic preference level for the genres listed using the scale provided.

1-----------------2-----------------3-----------------4-----------------5-----------------6-----------------7
Strongly dislike Neither like nor dislike Strongly like

1. _____ Classical
2. _____ Blues
3. _____ Country
4. _____ Dance/Electronica
5. _____ Folk
6. _____ Rap/hip-hop
7. _____ Soul/funk
8. _____ Religious
9. _____ Alternative
10. _____ Jazz
11. _____ Rock
12. _____ Pop
13. _____ Heavy Metal
14. _____ Soundtracks/theme songs

Appendix F: Reduced Morningness-Eveningness Questionnaire

This scale is intended to record your own assessment of any sleep difficulty you might have experienced. Please check (by circling the appropriate number) the items below to indicate your estimate of any difficulty, provided that it occurred at least three times per week during the last month.

The following 5 questions will be about your daily sleep-wake habits and the times of day you prefer certain activities. For each question, please circle or clearly mark the number that corresponds to the answer choice that is most true for you. Please select only ONE answer per question. Base your judgments on how you have felt in recent weeks.

1.	*Approximately* what time would you get up if you were entirely free to plan your day?	1. 5:00-6:30 a.m. 2. 6:30-7:45 a.m. 3. 7:45-9:45 a.m. 4. 9:45-11:00 a.m. 5. 11:00 a.m.-12:00 noon 6. 12:00 noon-5:00 a.m.
2.	During the first half hour after you wake up in the morning, how do you feel?	1. Very tired 2. Fairly tired 3. Fairly refreshed 4. Very refreshed
3.	At *approximately* what time in the evening do you feel tired, and, as a result, in need of sleep?	1. 8-9 p.m. 2. 9-10:15 p.m. 3. 10:15 p.m.-12:45 a.m. 4. 12:45-2:00 a.m. 5. 2-3 a.m.
4.	At *approximately* what time of day do you usually feel your best?	1. 5-8 a.m. 2. 8-10 a.m. 3. 10 a.m-5 p.m. 4. 5-10 p.m. 5. 10 pm-5 a.m.

5.	One hears about "morning types" and "evening types." Which one of these types do you consider yourself to be?	1. Definitely a morning type 2. Rather more a morning type than an evening type 3. Rather more an evening type than a morning type 4. Definitely an evening type

Appendix G: Munich Chronotype Questionnaire

The next set of statements describe sleep habits during the week and during the weekend. For each question, please write in the number that corresponds to the answer choice or check the box that is most true for you. Work days are those which include scheduled events such as class or sports practice. Free days are days in which you are free to determine your activity schedule. Please select only ONE answer per question. Decide how well it applies to you at the present time (within the past few days).

WORK DAYS (please use am/pm)		
1	I go to bed at:	o'clock
Note that some people stay awake for some time when in bed		
2	I actually get ready to fall asleep at:	o'clock
3	I need this number of minutes to fall asleep sleep:	minutes
4	I wake up at:	o'clock
5	I need this number of minutes to get out of bed:	minutes
6	Do you use an alarm on work days?	Yes ☐ No ☐
7	If so, do you normally wake up before your alarm?	Yes ☐ No ☐

FREE DAYS (please use am/pm)		
8	I go to bed at:	o'clock
Note that some people stay awake for some time when in bed		
9	I actually get ready to fall asleep at:	o'clock
10	I need this number of minutes to fall asleep sleep:	minutes
11	I wake up at:	o'clock
12	I need this number of minutes to get out of bed:	minutes
13	Do you use an alarm on free days?	Yes ☐ No ☐
14	Is there a reason you cannot choose sleep time during free days?	Yes ☐ No ☐
If you selected yes above, please choose one of the below reasons (and specify if other)		

15	Roommates/pets ☐	Hobbies ☐	Other ☐ Such as: __________________
On average I spend the below amount of time outdoors in daylight (without a roof over my head):			
On work days:	________ hours ________ minutes		
On free days:	________ hours ________ minutes		

Appendix H: Pandemic Music Activities

1. Did you play any musical instruments (including voice) during the quarantine? (Yes/No)
    a. If **yes**:
        i. What instrument? _____________
        ii. How often did you play? (Very often/Fairly often/Once in a while/Only a few times/Once)
        iii. Did you have any technical training on this instrument before the quarantine? (Yes/No)
        iv. Had you ever played this instrument before the quarantine? (Yes/No)
            1. If **yes**:
                a. How long before the quarantine had it been since you played the instrument? ________________
2. Did you **attend** any virtual music events (virtual concerts or musicals, live streamed musical performances, online groups related to music, jam sessions with friends)? (Yes/No)
3. Did you **participate** in any virtual music events (virtual concerts or musicals, live streamed musical performances, online groups related to music, jam sessions with friends)? (Yes/No)

Appendix I: COVID-19 Stress Measure

Items

	1 Not at all	2	3	4 Very much
1. To what extent are you worried about how COVID-19 will impact your school year?				
2. To what extent are you worried about how COVID-19 will impact your own and your family's finances?				
3. To what extent are you worried about how COVID-19 will impact your ability to keep up your reputation?				
4. To what extent are you worried about how COVID-19 will impact you feeling connected to your friends?				
5. To what extent are you concerned about the COVID-19 crisis?				
6. How likely is it that you could become infected with the COVID-19 virus?				
7. How likely is it that someone you know could become infected with the COVID-19 virus?				
8. If you did become infected with COVID-19, to what extent are you concerned that you will be severely ill?				

Note. Items are rated on a 4-point scale, ranging from 1 (not at all) to 4 (very much). "A little" and "somewhat" were given as separate options, but combined here.

Appendix J: Lighting Conditions Questions

To be answered by checking yes or no:

- Since the COVID pandemic I have been social distancing by staying at least six feet from others
- Since the COVID pandemic I have spent less time socializing with my friends in person
- Since the COVID pandemic I spend less time outside or participating in outdoor activities
- Since the COVID pandemic I more frequently have items such as food or packages sent to my home or apartment
- Since the COVID pandemic I less frequently go shopping in person at retail stores or grocery stores
- Before the COVID pandemic, I would spend much of my day in natural daylight rather than artificial light
- Since the COVID pandemic, I spend much of my day in artificial lighting rather than natural daylight
- Since the COVID pandemic, I spend more hours after sundown in artificial light or using a screen device (smart phone, laptop, television, etc.) of some kind than I did before the pandemic
- The COVID pandemic has led me to alter my artificial light exposure from day to day (e.g., setting "lights off" times, reducing late night television, etc.)

Additional Q's:

- What types of artificial lights (e.g., fluorescents, LEDs, incandescent) are you typically exposed to?
    - Fluorescents
    - LEDs
    - Incandescent
    - Don't know
    - Other ______________
- When in artificial lighting, do you prefer warmer (e.g., more red or yellow) or cooler (e.g., more blue or violet) lighting, and does this change throughout the day?
    - Warmer (red, yellow, or orange)
    - Cooler (blue or violet)
    - No preference
    - Other ______________
- Have you begun using any lighting devices or apps since quarantine to help you wake up at more regular hours?

Appendix K: Continued Participation Briefing and Question

This survey was the first part of a study that is looking at how music affects the quality of sleep. The next part of the study is open to all interested participants who have completed this survey, which includes you!

The next part of this study will be to try out four samples of sound before sleep. Participants will listen to four different sound samples (no noise, white noise, rising melodies, and falling melodies) for four days and report their sleep quality on a short survey the following mornings.

For SONAS Students: **All PSYC 110/111 students who participate in this next part will earn three additional study participation credits!**
For external Emory College participants: **All participants in this next part will earn an additional $30!**

Are you interested in participating in this next part of this study? Yes No

Appendix L: Groningen Sleep Scale

1. I had a deep sleep last night
2. I feel that I slept poorly last night
3. It took me more than half an hour to fall asleep last night
4. I woke up several times last night
5. I felt tired after waking up this morning
6. I feel that I didn't get enough sleep last night
7. I got up in the middle of the night
8. I felt rested after waking up this morning
9. I feel that I only had a couple of hours' sleep last night
10. I feel that I slept well last night
11. I didn't sleep a wink last night
12. I didn't have trouble falling asleep last night
13. After I woke up last night, I had trouble falling asleep again
14. I tossed and turned all night last night
15. I didn't get more than 5 hours' sleep last night

All items are scored true / false

The first question does not count for the total score

One point if answer is 'true': questions 2, 3, 4, 5, 6, 7, 9, 11, 13, 14, 15

One point if answer is 'false': questions 8, 10, 12

Maximum score 14 points, indicating poor sleep the night before

Appendix M: National Sleep Foundation Sleep Log

Date: __/__/__

Day of week: M T W Th F Sat Sun

I went to bed last night at: _____ (PM/AM)

I got out of bed this morning at: _____ (AM/PM)

Last night I fell asleep:

Easily -------------------------☐

After some time -------------☐

With some difficulty --------☐

I woke up during the night:

# of times: ____________

# of minutes ___________

Last night I slept a total of: ___________ hours

My sleep was disturbed by:
List mental or physical factors including noise, lights, pets, allergies, temperature, discomfort, stress, etc.

When I woke up for the day, I felt (check all that apply):

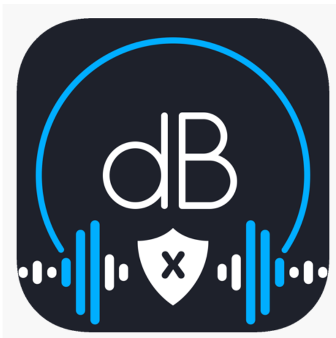
Refreshed --------------------------☐

Somewhat refreshed --------------☐

Fatigued ----------------------------☐

Appendix N: Participant Instructions for Volume Data

For each sound sample, choose a comfortable volume on your device to listen as you fall asleep. A single sample tone will be played at the start of each sound file. Follow the instructions below to set up your volume and record the level you choose.

1. If you have an iPhone, download the free app "Decibel X."
   a. 

2. If you have an Android, download the free app "Sound Meter."
   a. 

3. Play the sample tone at the start of the sound file.
4. Turn your computer's volume to a comfortable level that you can listen to while falling asleep.
5. Use the app (Decibel X or Sound Meter) to measure the decibels of the volume you choose and record that number here. _________________

Appendix O: Consent and Study Information Form for Initial Survey

Emory University
Written Consent
For a Research Study

Study Title: Music as a sleep aid: effects of types of music and prior musical experience on perceived sleep quality (Experiment 1)
Principal Investigators: [Anna Ree, Psychology], [Aliyah Auerbach, Neuroscience], [Paul Moon, Psychology], [Dr. Hillary Rodman, Psychology]
Funding Source: Undergraduate Research Programs Independent Grant

Introduction and Study Overview

Thank you for your interest in our music and sleep research study. We would like to tell you everything you need to think about before you decide whether or not to join the study. It is entirely your choice. If you decide to take part, you can change your mind later on and withdraw from the research study.

The purpose of this study is to investigate how typical music habits, level of musicianship, lighting environment, and specific technical elements of music correlate to quality of sleep. The study is funded by an independent grant from the Emory Undergraduate Research Programs. This study will take about 45 minutes to complete.

If you join, you will be asked to answer questions about demographic information, typical sleeping habits and quality, mood-related disorders, sleep disorders, level of musical involvement, pandemic functionality and activities, chronotype, and access to smartwatch technology so that we can accurately describe our sample. It should take about 45 minutes to answer all of the questions on the survey form. When you are finished, please submit the form.

There are no known risks with this type of survey. We are interested in your perceptions and opinions but you are free not to answer any questions on the survey. You also can end your participation in the study at any time.

This research study was not designed to provide direct benefit to you from participating in this project. We hope that you will find the survey interesting and that the study findings will contribute to scientific knowledge about how music intersects with quality of sleep.

Study records can be opened by court order. They also may be provided in response to a subpoena or a request for the production of documents. Certain offices and people other than the researchers may look at study records. Government agencies and Emory employees overseeing proper study conduct may look at your study records. These offices include the Office for Human Research Protections, the funder(s), the Emory Institutional Review Board, or the Emory Office of Research Compliance. Study funders may also look at your study records.

Emory will keep any research records we create private to the extent we are required to do so by law. A study number rather than your name will be used on study records wherever possible. Your name and other facts that might point to you will not appear when we present this study or publish its results.

We will disclose your information when required to do so by law in the case of reporting child abuse or elder abuse, in addition to subpoenas or court orders.

Your data [and specimens] from this study will not be shared with anyone outside this study, even if we take out all the information that can identify you.

Once the study has been completed, we will send you a summary of all of the results of the study and what they mean. We will not send you your individual results from this study.

Contact Information

If you have questions about this study, your part in it, your rights as a research participant, or if you have questions, concerns or complaints about the research you may contact the following:
Anna Ree, Principal Investigator: 770-365-3004
Emory Institutional Review Board: 404-712-0720 or toll-free at 877-503-9797 or by email at irb@emory.edu

Consent

If you are willing to volunteer for this research, please type your name below. You do not give up any rights by signing this form. If you need a copy for your records, you may request one below.

I would like to receive a summary of study findings (write your email address here if yes):

____

I would like a copy of this form for my records (choose Yes or No). Yes No

Appendix P: Consent and Study Information Form for Sleep Sound Conditions

Emory University
Written Consent
For a Research Study

Study Title: Music as a sleep aid: effects of types of music and prior musical experience on perceived sleep quality (Experiment 2)
Principal Investigators: [Anna Ree, Psychology], [Aliyah Auerbach, Neuroscience], [Paul Moon, Psychology], [Dr. Hillary Rodman, Psychology]
Funding Source: Undergraduate Research Programs Independent Grant

Introduction and Study Overview

Thank you for your interest in our music and sleep research study. We would like to tell you everything you need to think about before you decide whether or not to join the study. It is entirely your choice. If you decide to take part, you can change your mind later on and withdraw from the research study.

The purpose of this study is to investigate how typical music habits, level of musicianship, lighting environment, and specific technical elements of music correlate to quality of sleep. The study is funded by an independent grant from the Emory Undergraduate Research Programs. This study will take about one week to complete.

If you join, you will be asked to listen to a 15-minute sound file before sleep each night for four consecutive nights (Monday through Thursday) of one week. There are four different sound files, and you will listen to one per night. The order in which you listen to them will be random and will be assigned to you as soon as your confirm your consent to participate in this study. If you have access to smartwatch technology, you will be asked to use it to gather additional data on your sleep. The morning following each night of sound before sleep, you will be asked to complete a survey asking about your quality of sleep for the last sleep episode (the previous night). The survey should take about 15 minutes to complete. If you used a smartwatch to gather sleep data, you will submit that data to this survey form as well. When you are finished, please submit the form.

This research study could potentially negatively impact the quality of your sleep for a few nights of sleep. We are interested in your perceptions and opinions but you are free not to complete the conditions or answer any questions on the survey. You also can end your participation in the study at any time.

This research study could potentially benefit the quality of your sleep for a few nights of sleep. We hope that you will find the conditions interesting and that the study findings will contribute to scientific knowledge about how music intersects with quality of sleep.

Study records can be opened by court order. They also may be provided in response to a subpoena or a request for the production of documents. Certain offices and people other than the researchers may look at study records. Government agencies and Emory employees overseeing proper study conduct may look at your study records. These offices include the Office for Human Research Protections, the funder(s), the Emory Institutional Review Board, or the Emory Office of Research Compliance. Study funders may also look at your study records.

Emory will keep any research records we create private to the extent we are required to do so by law. A study number rather than your name will be used on study records wherever possible. Your name and other facts that might point to you will not appear when we present this study or publish its results.

We will disclose your information when required to do so by law in the case of reporting child abuse or elder abuse, in addition to subpoenas or court orders.

Your data [and specimens] from this study will not be shared with anyone outside this study, even if we take out all the information that can identify you.

Once the study has been completed, we will send you a summary of all of the results of the study and what they mean. We will not send you your individual results from this study.

Contact Information

If you have questions about this study, your part in it, your rights as a research participant, or if you have questions, concerns or complaints about the research you may contact the following:
Anna Ree, Principal Investigator: 770-365-3004
Emory Institutional Review Board: 404-712-0720 or toll-free at 877-503-9797 or by email at irb@emory.edu

Consent

If you are willing to volunteer for this research, please sign below. You do not give up any rights by signing this form.

____ __________ ______
Participant's Name / Signature Date Time

____ __________ ______
Person Obtaining Consent Date Time

I would like to receive a summary of study findings (write your email address here if yes):

____

I would like a copy of this form for my records (choose Yes or No). Yes No