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The use of music for Solace, its connection to Openness and its moderating effects on music listening and stress

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Contents

Abstract

English Version

Background: Stress can impose detrimental impacts on physiological and mental health, therefore the implementation of tools to mitigate stress responses is crucial. Music listening has been seen as beneficial in positively affecting parameters like heart rate variability (HRV) and self-reported stress levels. The utilization of music to regulate emotions through Solace following a distressing event presents a popular strategy. Therefore, people who tend to use music more for Solace were expected to show greater stress reductions in self-reported and physiological stress responses after listening to music. Furthermore, it was hypothesized that individuals higher in the personality trait Openness tend to utilize music more frequently as a means to regulate their emotions through Solace.

Methodology: *N* = 40 female participants were subjected to the Trier Social Stress Test (TSST) before being randomly assigned to music listening or sitting in silence and compared regarding their stress reductions. Changes in HRV, as well as subjectively reported stress through the Visual Analogue Scale (VAS) were collected. The Solace scale of the Brief Music in Mood Regulation (B_MMR) was employed to obtain the scores of that emotion regulation strategy and levels of Openness were assessed with the consecutive items from the Neo_FFI.

Conclusions: No significant results were found concerning a greater stress reduction through music listening in subjective stress responses. However, individuals in the silence condition showed a significantly greater stress reduction regarding HRV compared to the music condition. No moderating effect of Solace impacting the connection of music and stress reduction could be observed. Furthermore, no correlative association between Solace and Openness was found.

Key words: subjective stress report, heart rate variability, root mean square of successive differences, emotion regulation through solace, emotion regulation through music, Openness to Experience, Autonomic nervous system, HPA axis, Sympathetic nervous system, Parasympathetic nervous system

Deutschsprachige Version

Hintergrund: Stressreaktionen können die körperliche und psychische Gesundheit mitunter langfristig beeinträchtigen. Diese Umstände erfordern die Implementierung von Interventionen, wie das Hören von Musik, das mit einem Rückgang an Stressreaktionen assoziiert ist. Musikhören wurde unter anderem mit einem positiven Einfluss auf die Herzratenvariabilität (HRV), sowie auf subjektiv berichtete Stresslevel assoziiert. Eine populäre Strategie, um Emotionen nach einem aufwühlenden Erlebnis durch Musik zu regulieren, stellt das Suchen nach Trost im Musikhören dar. In der vorliegenden Arbeit wurde erwartet, dass Personen, welche Musik vermehrt nutzen, um Trost darin zu finden, auch eine stärkere subjektive und objektive Stressreduktion nach dem Musikhören erleben. Darüber hinaus wurde ein positiver Zusammenhang zwischen der Persönlichkeitsdimension Offenheit und der Trostfindung im Musikhören vermutet.

Methodik: *N* = 40 weibliche Teilnehmerinnen wurden nach einer Stressinduktion durch den Trier Social Stress Test (TSST) randomisiert auf zwei Bedingungen (Musik hören / Stille) aufgeteilt und in Bezug auf ihre Stressreduktion verglichen. Objektive Stressmaße wurden durch die HRV und subjektiv berichtete Stresslevel durch eine Visuelle Analogskala (VAS) abgebildet. Die Skala zur Trostfindung durch Musikhören wurde mit dem Fragebogen Brief Music in Mood Regulation (B_MMR) und Offenheitswerte durch die zugehörigen Items des Neo_FFI erhoben.

Schlussfolgerungen: Es wurden keine signifikanten Ergebnisse in Bezug auf eine größere Reduktion subjektiv berichteter Stresslevel durch das Hören von Musik gefunden. Das Sitzen in Stille schien hingegeben mit einer höheren Stresserholung in HRV-Maßen im Vergleich zum Musik hören assoziiert zu sein. Das Trostfinden im Musikhören hatte keinen moderierenden Einfluss auf die Hörbedingung und die Stressreduktion, außerdem konnte kein korrelativer Zusammenhang zwischen dem Trostfinden und der Offenheit von Personen nachgewiesen werden.

Introduction

Stress

The experience of stress is an unavoidable aspect of human life that, when excessive or sustained over a long period, can present serious problems for both mental and physical health. Stress responses can be defined as multifaceted psychophysiological reactions to inner or external challenges that threaten an individual`s effort to keep the internal milieu constant when facing an external environment (Bernard, 1957). Cannon (1915) labeled that process of keeping inner balance “homeostasis”. Stressors represent any kind of stimuli or situation that evoke a stress response and are presenting a complex physiological and psychological interplay that affects an individual`s capacity for adapting and wellbeing (Schneiderman et al., 2005).

The Transactional Model of Stress and Coping

According to Lazarus and Folkman’s transactional model of stress and coping (1984), stress is conceptualized as a dynamic process that involves an encounter between an individual and their environment. It is viewed as a transaction in which an individual appraises the demands placed upon them rather than just responding to a stimulus or environment. If these demands are perceived to exceed the individual`s adaptive resources and coping mechanisms, stress is likely to occur. The transactional model emphasizes the importance of appraisal to determine the extent to which situations are perceived and experienced as stressful.

The model differentiates between three types of appraisals. The primary appraisal describes the initial step in the stress appraisal process, where an individual evaluates whether a situation or stimuli is irrelevant, benign-positive, or stressful. If the event is considered stressful, it is further assessed for its potential harm, threat, or challenge. The secondary appraisal involves an individual`s evaluation of the available resources to cope with an event that was perceived as stressful. The secondary appraisal`s outcome influences the individual`s emotional response and the selection of coping strategies. The third type of appraisal within the model is termed reappraisal, which entails a reevaluation of the situation that occurs when new information becomes available or the situation itself changes and can alter the individual`s perception of the stressor. The entire stress appraisal process constitutes a continuous and dynamic interaction between individuals and their environment, reflecting the dynamic nature of the process.

Stress coping mechanisms, which are essential components of the transactional stress model, can be classified as either adaptive or maladaptive. Adaptive coping strategies are those that effectively mitigate stressors and contribute to functionality and well-being. In contrast, maladaptive coping strategies may offer a temporary relief, but by failing to address the root cause of stress can lead to exacerbating stress responses over time. The adaptiveness of a stress response is neither inherently adaptive or maladaptive, it is determined by the outcome of the coping process.

Short term stress responses can be considered part of a vital response to environmental demands, promoting necessary physiological and psychological adjustments. However, when stress is prolonged, it can lead to a state of chronic arousal which is associated with adverse health outcomes such as cardiovascular disease, immune system suppression, and mental health disorders (Mariotti, 2015; McEwen, 2007; Schneiderman et al., 2005).

Recent research has shown that chronic stress can involve changes in brain structures and functions, particularly in regions like the hippocampus and the prefrontal cortex, which are crucial for memory and executive function (McEwen et al., 2016). Cognitive skills like learning, remembering, and decision-making tend to be limited (Marin et al., 2011), whereas levels of anxiety and aggression are more likely to be increased. These circumstances are partly due to an over activation of the amygdala, a brain structure in the limbic system, that is crucial for the regulation of emotional processes and that readies the body for fight-and- flight responses (Roozendaal et al., 2009).

Allostasis, allostatic load and allostatic overload

Allostasis is a dynamic process by which the body achieves stability through physiological adjustments in response to stressors with the aim to maintain optimal functioning in the face of changing demands (Sterling & Eyer, 1988). This adaptive mechanism involves the activation of various regulatory systems, including the nervous, endocrine, and immune systems. Allostasis allows the body to respond to stress and restore balance, ensuring survival in challenging environments. However, chronic exposure to stressors can lead to an accumulation of physiological strains, known as allostatic load or allostatic overload (McEwen & Stellar, 1993).

Allostatic load represents the wear and tear on the body as it continuously adapts to stressors. It is a measure that considers the impact of prolonged stress on multiple physiological systems, including the cardiovascular, metabolic, and immune system. As the body continually strives to maintain stability, dysregulation can occur when allostatic systems are overtaxed or inefficient. This state of over taxation is referred to as allostatic overload (McEwen & Wingfield, 2003).

Physiological stress responses

The response to a stressful event always proceeds through a cascade of cardiovascular, endocrine, nervous, and immune system changes (Schneiderman et al., 2005). At least in the short term, these stress responses are generally adaptive as they prepare the body to cope with the demands posed by an internal or external stressor, such as trauma or invasive surgery. For instance, the body's physiological responses to these situations help to reduce additional harm to tissues (Lovallo, 2005).

Stress responses are regulated by an activation of the sympathetic-adrenomedullar (SAM) axis, the hypothalamic-pituitary-adrenal (HPA) axis, and the immune system. Initially, stress hormones are secreted in order to mobilize energy reserves for immediate utilization by the organism. Furthermore, a novel energy distribution pattern arises. During periods of stress, energy is allocated to the tissues that experience heightened activity, namely the skeletal muscles and the brain. At the same time, the activation and migration of immune system cells to combat affected sites takes place (Dhabhar & McEwen, 1997). Non-essential bodily functions, including digestion and the synthesis of growth and reproductive hormones, are paused. In periods of extreme crisis, engaging in activities such as eating, growth, and sexual activity potentially poses risks to physical well-being and even jeopardizes survival (Chu et al., 2023).

A main characteristic of stress responses is the activation of the autonomic nervous system (ANS) and the HPA axis.

Activation of the ANS

The ANS is composed of two main components, the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS) and is integral to the body`s rapid, initial stress response. The SNS gets activated by encountering a stressor, which initiates the fight-or-flight response. Adrenalin and noradrenaline are being released into the bloodstream through the adrenal medulla, the core of the adrenal gland which is located above the kidney. It can trigger physiological changes like an increase in HR and blood pressure (La Rovere et al., 2022), dilated airways, the redirection of blood flow to essential organs, and a temporary boost in energy due to the release of glucose and fats (Chu et al., 2023).

The system that counterbalances the effects of the SNS is the PNS, which gets activated once the stressor is no longer perceived as a threat. It regulates involuntary resting functions, such as slowing down the HR, decreases in blood pressure, the stimulation of the digestion, and other metabolic processes. Its essential task is to return the body to a state of rest (Won & Kim, 2016).

The response of the ANS to stress is designed to be a short-term survival mechanism. However, in modern life, where stressors regularly tend to be constant and varied, the prolonged activation of stress responses can affect various health problems, like hypertension and chronic inflammation and potentially develops to become chronic (Mariotti, 2015). Chronic stress can additionally impair the functioning of the PNS, hindering the body’s ability to fully relax and recover (Won & Kim, 2016). In addition to physical responses, the ANS also influences psychological stress responses, such as the perpetuation of feelings of anxiety (Daviu et al., 2019). Understanding and managing stress effectively is therefore important for maintaining both physical and mental health (McEwen, 2007).

One effective way to measure the adaptability of the ANS to stressful situations is by assessing the dynamic interplay between the sympathetic and parasympathetic branches through obtaining an individual`s heart rate variability (HRV).

Activation of the HPA axis

The HPA axis is a central part of the body's response system to stress. In the face of perceiving a stressor, the hypothalamus plays a critical role in the initiation of a stress response through the release of corticotropin-releasing hormone (CRH) into the bloodstream. The CRH continues to stimulate the pituitary gland for the secretion of adrenocorticotropic hormone (ACTH). The ACTH subsequently moves through the bloodstream to the adrenal glands, which get triggered to produce and release cortisol. Cortisol affects physiological changes by preparing the body for a fight-or-flight response by increasing the availability of glucose while suppressing non-essential functions like digestion, reproduction and by modulating immune responses (Schneiderman et al., 2005).

The HPA axis in a healthy brain and individual prevents excessive responses to stressors by being regulated through negative feedback loops. These work through the signal of high cortisol levels in the brain to reduce the production of CRH and ACTH which thereby decrease the production of cortisol. After the stressor is removed, the homeostatic state is usually restored through the reduction of cortisol levels and the return of the body`s systems to their baseline states (Lovallo, 2005).

Inversely, prolonged exposure to stressors can involve a dysregulation of the HPA axis. The risk is continuously elevated cortisol levels, which contribute to a variety of health problems such as depression, anxiety, immune dysfunction, metabolic issues, and cardiovascular diseases (McEwen, 2008).

Understanding the HPA axis’s response to stress is crucial for comprehending how the body responds to and copes with stressful situations. It also highlights the importance of effective stress management to maintain balance and prevent long-term adverse effects on health (Stephens & Wand, 2012)

Heart Rate Variability (HRV)

A healthy human heart encompasses roughly the size of a close fist and beats approximately 100.000 times per day (Shaffer et al., 2014). Its primary functions are to get blood from the body's tissues and to transport it to the lungs, as well as to collect blood from the lungs and distribute it to all tissues of the body (Weinhaus & Roberts, 2005). A normal human heart is structured into two upper and two lower chambers. The upper chambers, the right and left atria which are responsible for returning venous blood, and the lower chambers, the more muscular and spacious right and left ventricles which pump blood from the heart into the arteries and the lungs. This process creates a network of blood vessels for the purpose of circulating blood throughout the body (Birbaumer & Schmidt, 2003). The primary structures which are responsible for the initiation of a heartbeat are two pacemakers: the sinoatrial node and the atrioventricular node (see Figure 1).

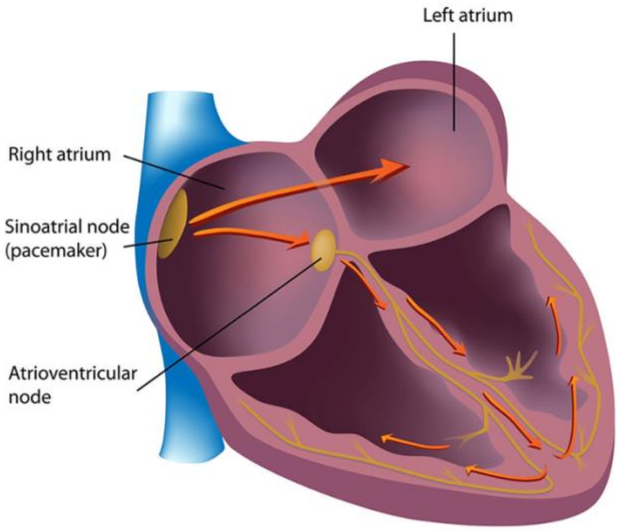

Figure 1: Electrical conduction system in the human heart, responsible for initiating heartbeats (Shaffer et al., 2014).

Heart rate (HR) refers to the frequency of the contractions of a heart per minute and is measured in ms. It is regulated through the activity of the SNS and the PNS through the sinoatrial and atrioventricular nodes, which serve as the core pacemaker of the heart. The average resting HR in people often falls between the range of 60 to 80 beats per minute (Shaffer & Ginsberg, 2017). Through applying an Electrocardiogram (ECG), the measurement of the heart's electrical conduction and contraction enables a potential visual representation of the HR.

HRV quantifies the fluctuation in time durations between consecutive heartbeats, known as Interbeat Intervals (IBIs) and is determined by measuring the interval between successive R peaks in an individual's HR (see Figure 2). The hearts adaptability is evaluated by examining the changes in time peaks, which enable the calculation of the overall variability of the heart within a specific predetermined time period (Shaffer et al., 2014). It reflects the dynamic interplay between the sympathetic and parasympathetic branches of the ANS, which control the activity of the heart (Vanneste & De Ridder, 2013). Sympathetic activity leads to an increase in HR, while parasympathetic activity leads to a drop in HR. Therefore, when sympathetic activity increases, the IBIs get shorter, but when parasympathetic activity increases, the IBIs become longer. A healthy heart in consequence doesn`t act as metronome, it rather works by showing complex and constant changes in oscillations in order to flexibly cope with sudden physiological or psychological threats to homeostasis.

HRV is regarded as an indicator of neurocardiac functioning by demonstrating the interactions between the heart and the brain, as well as the dynamics of the ANS (Shaffer et al., 2014). High HRV indicates a more elastic and adaptive cardiovascular system, while reduced HRV suggests a more rigid and less adaptable system (Shaffer & Ginsberg, 2017). Excessive instability negatively affects the body's capacity to function properly and to use energy efficiently, whereas insufficient variations suggest an increased risk of mortality, depletion or a medical condition. Obtaining HRV may provide an easily measurable output, which can offer significant insights into an organism's ability to function efficiently in a complex environment (Thayer et al., 2012; Thayer & Lane, 2007).

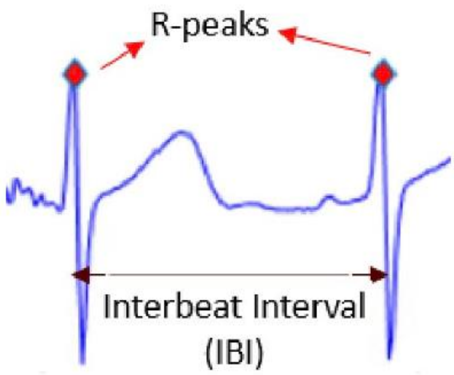

Figure 2: R- peaks encompassing Interbeat Intervals used for assessing HRV (Aygun & Jafari, 2019)

Stress responses are associated with a decrease in HRV, indicating a shift towards sympathetic dominance and a reduced parasympathetic influence of the ANS. Therefore, when stress responses develop to become chronic, they may contribute to a less variable and less adaptive HRV pattern (McCraty & Shaffer, 2015).

Due to its possible implications on health problems and the associated financial strains for the society by chronic or excessive stress without adequate recovery, extensive research underscores the importance of integrating strategies to build resilience and manage stress effectively (Nater, Gaab, et al., 2006). Consequently, the pursuit of cost-effective strategies for stress avoidance or stress management has emerged as a significant focus in contemporary research efforts. One domain that has shown promising as well as mixed scientific results in tackling stress is presented by the use of music as a therapeutical and cost-effective tool (de la Torre-Luque et al., 2017).

Music and stress

Since the early years of humanity, music has been playing an essential part of human life and developed into displaying a universal language (Yehuda, 2011). The role of music in human culture is multifaceted and extends from being a great source of entertainment to potentially impacting psychological well-being and overall health (Dingle et al., 2021). In general, research results on the effects of music on stress show mixed results, those variations often being generated due to individual differences, methodological issues, and contextual factors (Chanda & Levitin, 2013; Thoma et al., 2013).

Research has demonstrated that music can positively impact physiological responses, as well as cognitive functioning and emotional processes associated with stress (Khalfa et al., 2003; Nater, Abbruzzese, et al., 2006; Thoma et al., 2013). Furthermore listening to music in order to reduce stress responses is being used across all age spans to a similar degree (Ter Bogt et al., 2017). The therapeutic potential of music listening by it being a non-pharmaceutical, non-invasive, and cost-effective tool for stress reduction has therefore gathered great interest by various researchers over the past decades (Chafin et al., 2004, Davis & Thaut, 1989). Understanding the effects of music listening on acute stress and the underlying mechanisms through which music exerts its effects on stress reduction work holds great interest in contemporary research efforts.

A meta-analysis by de Witte and colleagues (2020) depicted tendencies of music listening in connection to a reduction in subjective stress and anxiety levels across various populations and stressors. Furthermore, a range of studies presented a link between music and the regulation of physiological parameters associated with stress, such as HR (Knight & Rickard PhD, 2001), blood pressure (Bernardi et al., 2006) and salivary cortisol (Khalfa et al., 2003; Linnemann et al., 2015). Listening to music has been additionally associated with changes in HRV, especially calming music or slow-tempo music tends to increase HRV, indicating enhanced PNS activation (Iwanaga et al., 2005; Roque et al., 2013). The greatest effect in physiological as well as subjectively reported stress reduction therefore seems to be connected to music with a slow tempo of 60-80 bpm (Linnemann et al., 2015). Sandstrom and colleagues (2010) provided evidence that music with high valence and low-arousal tends to be more effective at recovering after being exposed to an acute stressor than high-arousal and low valence music. Low valence music in a physiological sense particularly affected the restoration of HR positively. On a psychological level, evidence showed that the exposure to relaxing music after an acute stressful event could lower levels of self-reported perceived stress, states of anxiety, depression and negative affect as well as induce greater levels of positive affect (de la Torre-Luque et al., 2017).

Habitual music listening

A study by Linnemann and colleagues (2015) indicated that individuals who frequently engage in music listening may experience a more effective stress recovery. Specifically, regular music listening with the intention of relaxation was associated with lower subjectively reported stress levels and decreased stress markers, such as cortisol concentrations. In a study by Särkämo (2008), repeated music listening resulted in a significant reduction of depressive symptoms and mood enhancement in patients after a stroke (Liu et al., 2015) and decreases in cortisol concentration in healthy adults (McKinney et al., 1997).

Music is associated with possessing the ability to elicit strong emotional responses, hence relieving tension and negative emotions resulting from distressing life events (Blood & Zatorre, 2001). Repeated everyday listening to music may therefore have beneficial long-term health effects by applying the regulation of emotions through music on a regular basis (Henry et al., 2021).

HRV and music

The effects of music on the ANS, which are demonstrated by a range of studies, are particularly intriguing (Trappe & Breker, 2014). Since HRV serves as a valuable physiological marker which reflects the activity of the ANS during stress responses, research suggests that listening to relaxing music may influence this marker, not by directly causing stress reductions but by being part of the broader relaxation process that HRV measures (Pérez Lloret et al., 2014). In a systematic review by Mojtabavi and colleagues (2020), particularly classical and calm music were determined to elicit effects on the cardiovascular system. Listening to relaxing music has been associated with increased HRV, suggesting a shift towards parasympathetic dominance.

The calming effects of music on HRV may additionally be mediated by its impact on emotions in reducing perceived stress. The emotional and psychological engagement with relaxing music could therefore contribute to the modulation of autonomic responses (Kulinski et al., 2022). Negative emotions tend to decrease HRV, thereby exerting a negative impact on the ANS. In contrast, positive emotions tend to induce a greater coherence in heart rhythms and enhance the balance between the PNS and the SNS (McCraty & Shaffer, 2015).

Differentiation music therapy and music medicine

Within the realm of music related stress interventions, there are two separate approaches: music therapy and music medicine. Although they both use music as a therapeutical tool, the approaches and goals of each modality are different. Music therapy involves the guided and intentional use of musical elements, such as rhythm, melody, and harmony by a trained therapist to achieve therapeutical goals and to address the individual needs of clients. It therefore usually encompasses a social component as well as that clients frequently take an active role in music making. In order to improve the participants' physical, emotional, cognitive, and social well-being, the therapist involves them in a variety of music activities, such as singing, playing an instrument, or improvisation (Hillecke et al., 2005; Kern & Tague, 2017).

On the other hand, music medicine emphasizes the passive reception of music for its potential health advantages, especially by solely listening to it. In order to affect a person's physiological or psychological moods, this method frequently entails prescribing particular genres of music or playlists (Wheeler et al., 2019). Studies reveal that listening to music can trigger several neurobiological responses, including elevated noradrenergic activity, dopamine release, and endorphin release (Altenmüller & Bernatzky, 2015).

Summarized, a distinction is usually drawn between the engagement in music listening in music medicine versus an active involvement in music making and the presence of a trained therapist in music therapy (Adiasto et al., 2022)

Emotion regulation through music

The ability to regulate emotions is generally considered to be crucial for sustaining a healthy psychological and physiological life (Goethem & Sloboda, 2011). Applying emotion regulation strategies offers flexibility to react to situations of distress while a lack can have detrimental life-long impacts (Bhatnagar et al., 2011). The definition of emotion regulation states that it is '… a process by which individuals influence which emotions they have, when they have them, and how they experience and express these emotions' (Gross, 1998, p. 275). Therefore, emotion regulation aims at reaching or maintaining a comfortable level of arousal, which involves the adjustment of one or more emotional components (Moore, 2013).

Music has the propensity to elicit a diverse array of emotions, from excitement to relaxation, happiness to sadness, fear to solace, and even a combination of a wide array of these (Chanda & Levitin, 2013). This emphasizes the inherent potency of music. Engaging in music to regulate and influence emotions at all ages is widely recognized for being one of the most important motives in connection to music listening (North et al., 2000).

Gross (2002) proposed a process model of emotion regulation, which categorizes strategies to regulate emotions into two types: antecedent focused and response focused. The cognitive reappraisal of a situation, which allows for a modification of its emotional impact, holds the main function in antecedent regulatory techniques. On the other hand, response focused strategies are mainly associated with the act of suppression (Chin & Rickard, 2014). Strategies which involve reappraisal are generally associated with improved physiological and psychological well-being, whereas strategies of suppression are typically linked to less favorable well-being outcomes (Gross & John, 2003; Nyklíček et al., 2002).

In a study by Thayer and Newman (1994), listening to music was ranked as the second most important tool in terms of its effectiveness in improving mood, increasing energy, and reducing stress, as collected through self-reports. Listening to music is commonly found at social events and gatherings where it fulfills emotional roles, such as at funerals, weddings, religious ceremonies, and political gatherings (Yehuda, 2011). Music can be used in various emotionally engaging ways to diminish stress, namely by releasing and changing emotional states, altering attentional focus, engaging in music activities for emotional expression, as well as by matching the current emotional state people are in (Hallam et al., 2011; Lonsdale & North, 2011; Saarikallio, 2012). The individual emotional responses to music stimuli appear to be stable and tend to not be influenced by the individual`s level of musical expertise (Thoma et al., 2006). In contrast to coping behaviors, emotion regulation through music involves the changes in emotional states themselves rather than the stressors and strategies for managing them (Larsen, 2000).

Through the potential power of music to induce strong emotions, music listening is associated with the activation of different sub-cortical regions of the central nervous system. The limbic system encompasses structures such as the amygdala and interfaces with the prefrontal cortex, both of which play a central role in the regulation of stress and emotions (Wang & Saudino, 2011). Additionally, music listening triggers the activation of the ANS, resulting in observable physiological responses (Ellis & Thayer, 2010).

An underlying physiological mechanism for the association between music listening and the regulation of emotions and stress is considered to be through its impact on the activity of the HPA axis (Stansbury & Gunnar, 1994).

The capacity of music to elicit emotions makes it a potentially influential method for regulating emotions, a crucial component of mental well-being, and its utilization may therefore have clinical implications (Carlson et al., 2015). Furthermore, by providing a sense of companionship or empathy, especially to listeners experiencing loneliness or emotional distress, music can play a beneficial role in effectively managing emotional states (Saarikallio, 2011).

Two main goals in the use of music were identified by Saarikallio and Erkkilä (2007): mood improvement and mood control through listening to music. In order to realize these goals, the team of researchers identified seven distinct regulatory mechanisms concerning emotion regulation through music: Entertainment, Revival, Strong sensation, Diversion, Discharge, Mental work and Solace (Greasley & Lamont, 2011; Saarikallio & Erkkilä, 2007).

It is particularly assumed that one of these strategies, namely seeking Solace in music, can positively influence stress responses by providing individuals with comfort and emotional support.

Solace and music

The concept of finding Solace has long been recognized throughout history as a means of alleviating emotional distress after a disappointment or loss (Norberg et al., 2001). Finding Solace through listening to music is defined by an initial negative mood that shifts into a state of comfort when listening to music. Therefore, it doesn`t serve as a means to eliminate the stressor itself, but rather to counteract negative emotions connected to it (Hanser et al., 2016).

Especially during stressful times or difficult life occurrences, people tend to use music for Solace more frequently (Saarikallio, 2010), where it may provide them with a sense of acceptance and understanding (Ter Bogt et al., 2017). Using Solace as a strategy after stressful encounters seems to be more adaptive than others to deal with negative emotions and can even be seen as a protective factor against mental health risks (Carlson et al., 2015).

Using Solace to regulate emotions became particularly meaningful during the COVID-19 pandemics, where individuals were frequently and for prolonged periods of time alone while under a variety of acute stressors. The general amount of self-selected music listening during that period was increased and individuals who used music for Solace seemed to experience a beneficial impact on their well-being (Hanser et al., 2016; Hennessy et al., 2021).

Saarikallio (2012; 2013) identified a positive association between the frequency of music listening as well as the importance placed on music in individual's lifes with an increased propensity for regulating emotions through music. Further research discovered that individuals who were highly attuned to the emotional aspects of music were additionally more likely to seek Solace in it (Ter Bogt et al., 2017)

Finding Solace shares similarities with the emotion regulation strategy discharge, which is also associated with starting off in a negative mood. However, finding Solace primarily seeks to provide comfort to music listeners, in contrast to discharge which strives to release unpleasant, particularly angry feelings (Hanser et al., 2016; Saarikallio, 2010).

The process of regulating emotions through Solace may operate partly through cognitive reappraisals, which suggest a deliberate reinterpretation of emotional experiences (Saarikallio, 2012). But the comfort provided by music can for instance also, similar to the Solace a child finds in a caregiver`s soothing, emerge from less conscious mechanisms of emotion regulation that precede or run parallel to cognitive processes (Compas et al., 2014)

Situations which are mainly associated with the utilization of music for Solace are overall stress, personal losses, grief, health issues and episodes of sadness. These factors emphasize the notion that Solace is mainly sought for in music after daily setbacks (Hanser et al., 2016; Tol & Edwards, 2013).

Although the use of music to regulate emotions seems to be a dominant factor in most individuals to engage in music behaviors, its extent may be influenced by individual personality traits (Chamorro-Premuzic & Furnham, 2007).

Openness and Solace

Personality factors are associated with having a substantial impact on the efficacy of music in stress reduction (Haslam et al., 2022). Thoma and colleagues (2013) highlighted the significance of individual variations in predicting the stress-reducing effects of music. The way in which individuals habitually engage in music listening may differ based on their personality traits. For instance in regarding the trait Openness for Experience, which is characterized by a sensitivity for art and emotions (McCrae & Sutin, 2009), a greater tendency to aesthetic chills when listening to music (Nusbaum & Silvia, 2011), as well as a greater focus on inner feelings (Costa & Mccrae, 1992). Openness is furthermore associated with intense emotional responses to tender music, mostly evoked through a greater cognitive attentiveness to music (Colver & El-Alayli, 2016; Vuoskoski & Eerola, 2011). Openness has also been linked to broader and more eclectic music preferences (Dunn et al., 2012). According to a study by Greenberg and colleagues (2016), individuals with higher levels of Openness are more inclined to connect with music on both emotional and intellectual levels.

Therefore, research suggests a dynamic interaction between an individual's level of Openness, their music listening habits, and their ability to regulate stress. Linnemann and colleagues (2016) indicated that music listening can be particularly effective for stress reduction for people high in Openness, as they may be more attuned to and affected by music.

These studies reinforce the concept that music tends to be a powerful tool for emotion regulation in the context of stress with individual personality traits playing a significant role in this process. The personality trait Openness and its associated appreciation for art and emotion (McCrae & Sutin, 2009) is thought to potentially increase the soothing effects of music and thereby facilitate emotion regulation through Solace. Its association with the experience of aesthetic chills (Nusbaum & Silvia, 2011) and a profound inner emotional life (Costa & Mccrae, 1992) may predispose individuals to turn to music as a habitual coping mechanism. Therefore, it is assumed that when music has a higher effectiveness in providing emotional comfort it could lead to its more frequent use as a deliberate strategy to manage stress, the latter tendency will specifically be invested in this present thesis.

These assumptions highlight the importance of individual differences in music preferences and their role in stress management and emotional well-being. Further research in this area could provide deeper insights into personalized approaches for using music as a therapeutic tool in stress and emotion regulation.

Research gap

Since listening to music is associated with having positive impacts on stress reduction, a broad array of studies has focused on this connection over several decades. In that regard, the impact of music therapy (S. B. Hanser, 2014; Mao, 2022) and music making (Bittman et al., 2013; Scheve, 2004) on stress related outcomes has been widely studied through experimental studies. In comparison, the impacts of mere music listening received limited research attention. This misalignment creates a particular lack, especially since music is present in everyday life, where the vast majority of people owns devices with apps that can stream most of the existing music anywhere at any time(Linnemann et al., 2015).

Furthermore, based on prior research, music possesses the capability to induce strong emotions (Chanda & Levitin, 2013), which therefore facilitates the implementation of emotion regulation strategies. These emotion regulation strategies in combination with music listening are linked to the promotion of health and to the ability to buffer stress responses, which thereby elicit their importance for well-being (Lonsdale & North, 2011).

Finding Solace through music listening presents one of these strategies and is defined by finding comfort and understanding through music after a distressing event

(Saarikallio, 2012). The emotion regulation strategy Solace has been associated with the promotion of positive emotional states and the facilitation of recovery after troublesome circumstances (Ter Bogt et al., 2017). It has been shown to promote positive emotional states and to help facilitate the recovery after troublesome circumstances (Saarikallio, 2010). While prior studies have investigated in the stress-reducing effects of relaxed music listening (Thoma et al., 2013) and the utilization of music for emotion regulation (Henry et al., 2021), there is a lack of research specifically examining whether individuals who use music to a greater extent for Solace exhibit enhanced stress reductions when engaging in music listening. Understanding the impact of the utilization of music for Solace on stress reduction can provide valuable insights into the therapeutic applications of music and inform targeted interventions for stress management. Additionally, the act of seeking Solace in music may itself constitute a regulatory process which can potentially significantly mitigate stress responses. Insights from such research could improve the development of targeted music-based interventions for effective stress management.

Furthermore, since emotion regulation strategies tend to present valuable aid in reducing stress responses (Wang & Saudino, 2011), it is crucial to further investigate which characteristics in individuals make them more inclined to be using music for Solace. The personality trait Openness for Experience, which is associated to involve a sensitivity for art and emotions (McCrae & Sutin, 2009) may consequently predispose individuals to a greater tendency to use music for Solace. Individuals with higher levels of Openness tend to exhibit increased introspection and more emotional nuances (Abu Raya et al., 2023), factors that might lean them towards a greater reliance on music as a source for comfort and way to regulate their emotions. The tendencies can facilitate a more profound engagement with music, which can act as a reflective surface for their own emotional states and therefore provide the individual with a sense of comfort and understanding which is key to regulating emotions through Solace (Saarikallio, 2012). Additionally, individuals high in Openness may seek to explore and understand their emotions more, therefore might gravitate towards music as a stress reducing tool and find Solace in it due to its ability to aid with echoing and processing complex feelings.

By examining stress reductions through subjective reports and additionally with a cardiovascular measure obtaining HRV, this thesis tries to investigate stress responses to music listening by using a multidimensional approach.

Proposed model

This study posits that the association between listening to relaxing music and stress reduction can be observed in both self-reported stress levels and a cardiovascular physiological measurement, namely in HRV values. Given the available evidence, there seems to be an association between using music to regulate emotions through Solace and finding comfort when dealing with a distressing event (Saarikallio, 2010). Individuals who habitually use music for Solace may therefore experience a faster recovery in stress levels compared to those who use music less frequently for Solace based on theoretical considerations.

Furthermore, based on the conceptual framework of the trait Openness for Experience which encompasses a greater tendency towards the exploration of art and emotions in individuals with higher scores, these individuals might utilize music as a tool to regulate their emotions to a greater extend. This tendency could potentially result in an elevated reliance on music for Solace compared to individuals with lower Openness scores.

The objective of this thesis was to examine the impact of listening to music, as opposed to sitting in silence, on both subjective reported and cardiovascular stress responses. Furthermore, it aimed to explore how these effects are influenced by the emotion regulation strategy Solace, which is characterized by finding comfort through music listening following a distressing event. To further explore the characteristics of Solace, a potential connection to the personality trait Openness to Experience was additionally assessed.

Research questions and Hypotheses

The following research questions and hypotheses are of central interest in the present thesis and are presented as follows:

Q1: Does listening to relaxing music after an acute stressful event have a positive effect on subjective and objective stress reductions compared to sitting in silence?
H1: Individuals who listen to relaxing music after experiencing experimentally induced acute stress will report a greater reduction in subjective stress levels compared to individuals who sit in silence.

H2: Individuals who listen to relaxing music after experiencing experimentally induced acute stress will exhibit a greater improvement in HRV compared to people who sit in silence.

Q2: Does the extent to which people use music for Solace moderate the relationship between the Audio Intervention (music listening / sitting in silence) and the speed of stress reduction following an acute stressor?
H3: The effect of the Audio Intervention (music listening / sitting in silence) on the speed of stress reduction will be moderated by the extent to which individuals use music for Solace.
H4: The effect of the Audio Intervention on HRV improvement will be moderated by the extent to which individuals use music for Solace.

Q3: Do individuals who score higher in the personality trait Openness to Experience tend to use music more frequently for Solace compared to individuals who are lower in Openness scores?
H5: Individuals with higher scores on the personality trait Openness to Experience will report utilizing music for Solace to a greater extend in contrast to individuals who score lower on that personality trait.

The findings of this master thesis possibly highlight the relevance for the development of evidence-based interventions and may contribute to our understanding of the complex interactions between music, stress, emotion regulation, and individual differences in personality traits. Further research in this area could provide deeper insights into personalized approaches for using music listening as a therapeutic tool in stress management and emotion regulation.

Methods

Study Design

This master thesis consists of data collected at the department of Clinical and Health Psychology at the University of Vienna within the project “Effects of music on stress and skin barrier recovery” by Dr. Jasminka Majdandžić and Univ.-Prof. Dr. Urs Markus Nater.

After the recruitment process, female only participants were provided with a link to a survey via the platform Unipark, which consisted of different questionnaires to complete at home prior to the study day. One of the questionnaires included in there was the Brief Music in Mood Regulation Scale (B_MMR), which contains the scale Solace that represents a strategy to regulate emotions through music and is presenting one of the core variables for this thesis. Additionally relevant for this thesis was the scale Openness for Experience from the Neo_FFI. The assessment of Openness for Experience was important to test the relationship between the personality trait and the scale Solace from the B_MMR scale. The laboratory study was conducted at the Music and Health lab in the Psychological Department of the University of Vienna. To induce a stressful environment, the Trier Social Stress Test (TSST) was applied, which consists of a mock job interview and an arithmetical task that is held in front of a committee composed of two students from the research project. Subjective stress reports assessed through a Visual Analogue Scale (VAS) and cardiovascular responses, namely HRV collected through ECG, in relation to a stressful experience were assessed. The participants were randomized to an Audio Intervention with two conditions: either the experimental condition which involved listening to relaxing music for 30 minutes, or the control condition which involved sitting in silence for the same amount of time.

Participants

Participants were recruited from the general population through various social media platforms, online portals, posters and flyers that were distributed in a variety of buildings connected to the University, as well as in coffee shops and other spots that seemed eligible to hold participants for the study aim.

The required sample size was calculated through G*Power (Faul et al., 2007) with an effect size F^2 = 0.1, alpha error probability = 0.05, estimated power = 0.8 and number of tested predictors = 1. The required sample size resulted in N = 81. Due to this thesis being embedded in a broader study with a different research aim, the required sample size for this thesis cannot be guaranteed to be achieved and therefore results will be interpreted with care and in regards to the acquired statistical power.

Given the research emphasis in the broader study including measurements for salivary cortisol and alpha amylase, the sample selection followed stringent exclusion criteria to mitigate potential confounding variables which could affect these markers. That lead to a compilation of the sample based on established guidelines for cortisol and alpha amylase measurements (Strahler et al., 2017). Therefore, solely at birth assigned female participants who didn`t define their identity otherwise were recruited (full overview inclusion criteria see appendix). Additional factors relevant for the inclusion of participants on top of their biological sex were that they had to be between 18 and 35 years old with a Body Mass index (BMI) between 18 and 25. Participants were required to have a regular menstrual cycle, and anything that affected hormone balance, like pregnancy, hormonal contraceptives, or breastfeeding, led to exclusion.

The testing date was required to be within a certain time window of the menstrual cycle, namely the follicular phase. This decision was motivated by the understanding that sex steroids undergo significant fluctuations during the menstrual cycle, potentially influencing both the HPA axis, thereby affecting the cortisol response, and the ANS activity (Sato & Miyake, 2004).

Participants had to be non-smokers as well as non-excessive alcohol drinkers nor taking drugs. They were required to be non-allergic, without current physical health or mental health disorders, nor being currently in therapeutical treatment. Another exclusion criterion concerned psychology students since they typically possess familiarity with stress tests such as the TSST. Consequently, their awareness of the goal and the artificial nature of the committee could compromise the intended impact of stress inducement. Participants needed to be fluent in the German language and were not included if they were professional musicians or had absolute hearing. They were equally divided into two groups for an audio intervention and randomly assigned to either an experimental condition listening to music or a control condition sitting in silence. The incentive for full participation in the study was 45 Euros.

Materials and Measures

Visual Analogue Scale Stress (VAS)

The scale measures subjectively reported stress levels on a visual analogue scale (Cline et al., 1992). Participants had to set a mark on a line answering the question “Wie sehr fühlen Sie sich gestresst?”, which translates to “How stressed are you feeling?”. The scale has a value of 0 representing the minimum amount and 100 the maximum amount of subjectively perceived stress. The VAS was used 8 times throughout the course of the study. For this thesis, only the fourth- and fifth time measurement point were relevant, right before the Audio Intervention (music listening / sitting in silence) and after the Audio Intervention (music listening / sitting in silence).

Brief Music in Mood Regulation (B_MMR): Scale Solace

The German version of the B_MMR scale is a 21 item self-report questionnaire to assess emotion regulation associated with music. The scale primarily emphasizes the regulation of emotions through musical activity, while also exhibiting similarities with general emotion regulation theories (Saarikallio & Erkkilä, 2007). It is comprised of 7 subscales assessing different forms of emotion regulation through music: Entertainment, Revival, Strong Sensation, Diversion, Discharge, Mental Work and Solace. From the 7 scales the B_MMR is composed of, solely the 3 items of the Solace scale were used for this thesis. The Solace scale specifically looks at the utilization of music as a means to seek comfort, often in times of sadness or emotional distress. Therefore, it assesses the means of music to deal with stressful events and negative emotions (Saarikallio, 2010). The questions are answered on a 5- point likert scale that ranges from “Stimme überhaupt nicht zu” to “Stimme voll und ganz zu”, which translates to ranging from “Strongly disagree” to “Strongly agree” (Saarikallio, 2012).

Example items of the Solace scale are: “Wenn ich traurig bin, tröstet mich das Hören von Musik” or “Wenn mich meine Sorgen überwältigen, höre ich Musik um mich aufzumuntern“. These items translate to: „When I`m sad, music listening comforts me” and “When my worries overwhelm me, I listen to music to lift me up”. The psychometrics for the B_MMR scale Solace show good internal consistency reliability depicted through Cronbachs alpha = .85.

NEO-Fünf-Faktoren-Inventar (Neo_FFI): Scale Openness

The German Version of the Neo_FFI (Kanning, 2009) is a concise personality assessment based on the five-factor model of personality (Costa & Mccrae, 1992), measuring five fundamental personality traits: Openness, Conscientiousness, Extraversion, Agreeableness, and Neuroticism. In this study only the items for the scales of Openness, Extraversion and Neuroticism were obtained. Subsequently, only the scale Openness from the Neo_FFI was of interest for this thesis. The scale

Openness is composed of 5 items and is measured through a 5- point likert-scale. The Neo_FFI is widely used in research, clinical settings, and personality assessments due to its robust measurement of core personality traits (Körner et al., 2003). Example items of the Openness scale of the Neo_FFI are: “Mich begeistern die Motive, die ich in der Kunst und in der Natur finde.” and “Wenn ich Literatur lese oder ein Kunstwerk betrachte, empfinde ich manchmal ein Frösteln oder eine Welle der Begeisterung.“ These items translate to: „I am fascinated by motives that I find in art and nature” and “When I read literature or look at a work of art, I sometimes feel shivers or a wave of enthusiasm.”

The Neo_FFI has been extensively studied regarding its psychometric properties with convergent validity correlations ranging from .56 to .62, whereas no correlation for divergent validity was greater than .20. An obtained Cronbach`s alpha of .89 was indicative for a good internal consistency (Berth et al., 2006).

The Trier Social Stress Test (TSST)

The TSST was designed to induce moderate psychological stress in a laboratory setting and was developed by Kirschbaum and colleagues (1993). The stress-inducing capacities of the intervention have consistently demonstrated significant effects on both HR and subjective stress reports across multiple studies (Allen et al., 2014; Kudielka et al., 2007; Wearne et al., 2019). It presents a combination of social and evaluative stressors, which are among the most potent stimuli to evoke a stress responses in humans.

The TSST consists of two segments, a free speech, and a mental arithmetical task, both in which participants are required to stand in front of a panel, which is composed of two psychology students from the study team. The male student was ascribed the role of the so-called active stressor while the female student of the panel was acting as the passive stressor. The active stressor was responsible for giving verbal instructions to the participant which were aimed to enhance their stress levels. The passive stressor was advised to be silent and enhance the participants’ stress levels by having a neutral expression without giving social feedback, and was additionally responsible for timing the tasks. The panel was introduced to the participants as two psychologists who specialize in behavioral observation.

Behind the panel, a camera and a microphone were set up, which the participants were informed were taping them, although neither of them was actively recording throughout the tasks. These factors were expected to exacerbate the stress response.

At the beginning, the participants were given 3 minutes preparation time to prepare for a hypothetical job interview for a job of their choice with pen and paper, which they then were not allowed to use further on. The following segment contained a 5- minute mock job interview where the participants were advised to talk freely about their personal strengths in accordance with the depicted job, while not receiving social feedback. The task was designed to create a situation of social-evaluative threat. When a person was silent for more than 30 seconds, the active stressor prompted them to either resume discussing their job-related traits or maintain direct eye contact with the camera.

Further on, a 5- minute cognitive task in which participants were required to perform mental calculations by counting down from 1043 in increments of 17, without committing mistakes or getting assistance or social input, was implemented. If the participants made calculation mistakes, they had to restart from the beginning. Additionally, if they became excessively calm, the active stressor prompted them to compute faster or maintain direct eye contact with the camera to increase their level of stress (Kudielka et al., 2007).

HRV obtained through ECG sensor

HRV was operationalized through the analysis of Electrocardiogram (ECG) data using the data analyzer software and equipment developed by Movisens. The data was acquired through a sensor on a belt that was affixed under the participants chest in the beginning of the experimental session. Through double tapping the Electrodermal Activity (EDA) sensor, which was located on the non-dominant hand, participants set markers which helped with consecutive time windows which were visualized in the data for later analysis. The root mean square of successive differences (rMSSD) between successive R-R intervals was computed using four-minute segments, with an additional one-minute segment as the reference. rMSSD, a time domain measure, was chosen for its ability to assess parasympathetic influence on the ANS by serving as an index of vagal cardiac modulation. This method is considered particularly suitable for quantifying short-term HRV (DeGiorgio et al., 2010; Shaffer & Ginsberg, 2017).

Interpretation of rMSSD values involves understanding that low values signify higher physiological arousal, while high values indicate lower physiological arousal (Kothgassner et al., 2014). The HRV windows which were chosen for calculations in this thesis focused on two five- minute windows. The first one being right after the stress induction through the TSST and the second one being the last 5 minutes of the audio intervention (music listening / sitting in silence). To compute HRV for the entire 5-minute time intervals, the data analyzer software utilized the last minute of the five-minute intervals as a reference point.

Audio Intervention

The implemented Audio Intervention in the study consisted of two conditions people were randomly assigned to. The music listening condition represents the experimental condition of the study. In the beginning of the study, participants could choose between 6 different playlists which were put together in a pre-study. Therefore, the choice of music listened to presents a combination of experimenter-selected and self- selected music. The playlists included ambient, classical, guitar, jazz, lo-fi, and lounge music. The tempo did not exceed 80 bpm and the music was nonlyrical. The music was played through headphones which were placed on the participants heads by the experimenter with a comfortable volume, which was chosen by the participants beforehand. During the listening part of the study all participants sat on a lounge chair that was reclined and were advised to remain awake and calm during the 30 minutes listening part.

The silence condition encompassed the same study structure, with the exception that participants didn`t pick their preferred music playlist. During the audio intervention part of the study process, participants were also positioned in reclined lounge chairs for 30 minutes with headphones on, to keep both conditions comparable, but without music being played to them.

Procedure

Participants got in contact with the study team by responding to study adverts posted on various social media and online platforms as well as through flyers and posters. Following their stated interest, participants received a recruitment phone call where they were screened by a student from the research team for inclusion and exclusion criteria. If they were eligible to be included, participants got sent a link which included online questionnaires like the NEO_FFI and the B_MMR via the Unipark platform.

On the testing day, participants were required to arrive at 12:50 in the Music and Health lab at the department of Clinical and Health Psychology at the University of Vienna. After arrival they initially had to read through and fill out informed consent. Following that, the experimenter applied the ECG equipment, which got posited underneath their chest through a belt and the recording got started. Additionally, they also got a sensor admistered on their non-dominant hand, that measured their epidermal activity (EDA), with which they had to set markers by double tapping at certain time points which were relevant for HRV windows.

Subsequently, participants in the music listening condition had to choose a playlist of their preference out of six 30 seconds music examples. The chosen playlist was later on in the study process played to them for 30 minutes.

Following that, participants were led into an adjoining room where the stress induction was carried out using the TSST. Right after the stress test, participants reported their perceived stress on the VAS.

After returning to the previous room together with the experimenter, tape stripping was performed by another study team member on all subjects, along with the measurement of the trans epidermal water loss (TEWL) which lasted around 20 minutes.

Subsequently, the participants were instructed to sit on a lounge chair that was reclined, while the experimenter placed headphones on their head, instructed them to sit silent, to try not to fall asleep for the following 30 minutes and if needed offered them a blanket to stay warm. After starting the playlist, the experimenter and responsible TEWL person left the room and switched off the light, so the participants were left in the room by themselves with the window shades being closed from the beginning of the study on to reduce distraction. Women in the music listening condition subsequently engaged in a 30- minute session of listening to the playlist of their choice through headphones, whereas women in the silent condition were placed in the same environment but were sitting in silence for 30 minutes. Following that, subjective stress levels were assessed once again through the VAS right after music listening.

The designated time intervals for HRV measurements were 5 minutes following the stress test and the final 5 minutes of music listening. At the end of the study, participants were informed about the study´s objectives and the rationale behind the TSST and had to fill out information to obtain their 45 Euros incentive for full participation. Additionally, any further questions were addressed. The entire testing day for participants lasted about 4 hours, caused by a variety of additional measures (see Figure 3), that were assessed for the broader research project that this master thesis is embedded in.

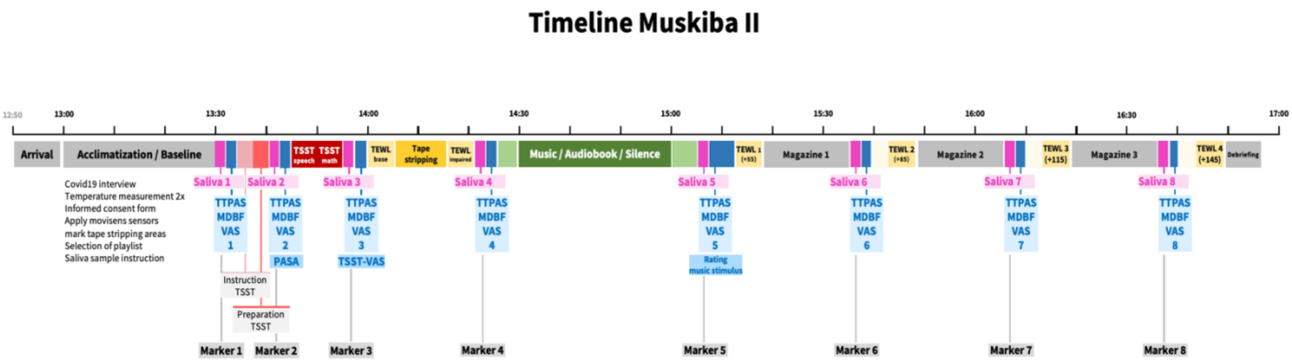

Figure 3: Timetable of the entire study course

Results

Statistical Analysis

The statistical analysis of the key variables was carried out through the statistics program IBM SPSS Statistics version 28. All tests were conducted with a significance level of $p < .05$. To control for outliers in every parameter, boxplot analyses were performed. Upon detection, two extreme outliers were observed, which significantly deviated from the rest of the data. To preserve the integrity of the statistical analysis, these outliers were expected to exert undue influence on the results. Consequently, the decision was made to exclude the corresponding data from further analysis. This approach is consistent with robust statistical practices and helps to avoid potential distortions in the findings (Kwak & Kim, 2017).

Sample Description

The final sample consisted of *N* = 40 female identifying healthy participants with a regular menstrual cycle. Their age ranged from eighteen to thirty-three, with a mean age of 24.15 (SD = 3.91). Among them, the majority of women were of Austrian nationality (70 %), followed by German nationality (17.5 %). The remaining portion of the sample comprised individuals with Colombian, Luxembourgian, Hong Kong SAR, Serbian, and Ukrainian nationalities (12.5 %). Reports concerning the education level showed results of 97.5 % reporting to have Matura (which translates to A-Levels) and one person having Realschule / mittlere Reife (which translates to secondary school). 80% of women indicated that they are currently studying or have obtained a University-level degree, whereas the remaining percentage claimed to have other or no professional education. Regarding occupation, 35% of women reported being in training / students and non-working, 30% worked less than half time, 22.5% reported working more than half time and 10% reported being unemployed. Only one person reported working full time. 52.5% of women indicated that they were currently single, whereas 47.5% reported being in a committed partnership. The participants' Body Mass Index (BMI) varied from 17.67 to 25.26, with an average of 21.01 (SD = 1.87) which indicated the required range for the study criteria. 2 participants from the music listening condition had to be excluded due to outliers, which led to a sample size of 18 in the music listening condition and 20 in the silence condition for Hypothesis 1, 3 and 5. Due to troubles with the ECG sensor which led to missing data for HRV measures, for Hypothesis 2 and 4 only 14 participants in the music and 13 participants in the silence condition left remaining. Effects of the subsequent power reduction on the generalizability and interpretation of the obtained results will be discussed.

Table 1

Descriptive Sample Statistics

Sociodemographic Characteristics	*Total amount (N)*	*Percentage*
Sex		
Female	40	100 %
Nationality		
Austria	28	70 %
Germany	7	17.5 %
Colombia	1	2.5 %
Hong Kong SAR	1	2.5 %
Serbia	1	2.5 %
Luxembourg	1	2.5 %
Ukraine	1	2.5 %
School Education		
Matura (A-Levels)	39	97.5 %
Realschule (Secondary School)	1	2.5 %
Vocational Education		
University	32	80 %
Other Vocational Training	1	2.5 %
No Vocational Training	5	12.5 %
Apprenticeship	1	2.5 %
Fachhochschule	1	2.5 %
Employment		
Fulltime	1	2.5 %
At least part time	9	22.5 %
Less than part time	12	30 %
In training	14	35 %
Unemployed	4	10 %

Description of Key Variables and Hypotheses testing

Subjective perceived stress reduction in relation to Audio Intervention

Participants' subjective stress scores obtained through the VAS after the stress inducement prior to the Audio Intervention showed a range from 0 – 47 with a mean stress level of 13.28 (SD = 16.68) and a Median of 5 for the music listening participants. The people in the silence condition showed stress scores ranging from 0 – 56 with a Median of 10.5 and a mean stress level of 17.4 (SD = 18.26). The obtained VAS scores after the Audio Intervention showed for people in the music listening condition a range of stress levels from 0 – 46 with a Median of 2 and a mean stress score of 6.89 (SD = 12.4). People who sat in silence reported a range of stress levels from 0 – 72 with a Median of 3 and a mean stress score of 10.53 (SD = 16.98). The difference score (DS) was obtained by subtracting the VAS measuring time point before music listening (T4) from the VAS measuring time point after music listening (T5) to measure the stress reduction between the two time points. It possessed a range between -38 and 35, with a mean score of -6.39 (SD = 15.61) for the music listening condition. People in the silent condition reported a DS (T5 - T4) between 27 and 16, with a mean of -7.05 (SD = 11.16). To assess normality distribution in the data, the Shapiro-Wilk-test as well as Kolmogorov-Smirnov test for normality were carried out. Both tests obtained significant results (Shapiro-Wilk: $p < .05$; Kolmogorov Smirnov: $p < .05$) indicating a lack of normality distribution in the data. This was additionally graphically visible supported by histograms depicting a right skewness distribution. Due to the violation of normality assumptions, it was inappropriate to proceed with parametric T-tests. Consequently, the non-parametric statistical method Mann- Whitney U test was chosen as an alternative to compare the stress reduction in the two groups. No significant effect was found for music listening or sitting in silence to reduce stress levels after an acute stressful event. The Mann Whitney U - Test revealed no significant effect for the Audio Intervention (U = 166.5, p = .346). Additionally, due to a small sample size and due to a non-normal distribution of the present data, Bootstrapping was additionally employed. No difference in the results was obtained when the resampling technique was implemented.

Table 2

Descriptive Statistics of Subjective Reported Stress Responses and Mann-Whitney U Test for Audio Intervention

		Music (*N* = 18)	**Silence (*N* = 20)**	***U* - test**
VAS before	*M* ± *SD*	13.28 ± 16.68	17.4 ± 18.26	z = -0.92
	Md	5	10.5	*p* = .355
	Min - Max	0 - 47	0 - 56	*U* = 148.5
VAS after	*M* ± *SD*	6.89 ± 12.4	10.53 ± 16.98	*z* = -1.38
	Md	2	3	*p* = .08
	Min - Max	0 - 46	0 - 72	*U* = 133.5
DS	*M* ± *SD*	-6.39 ± 15.61	-7.05 ± 11.16	*z* = -0.4
	Md	-1	-4.5	*p* = .346
	Min – Max	-38 – 35	-27 – 16	*U* = 166.5

Note. VAS = Visual Analogue Scale Stress; DS = Difference Score (T5 – T 4)

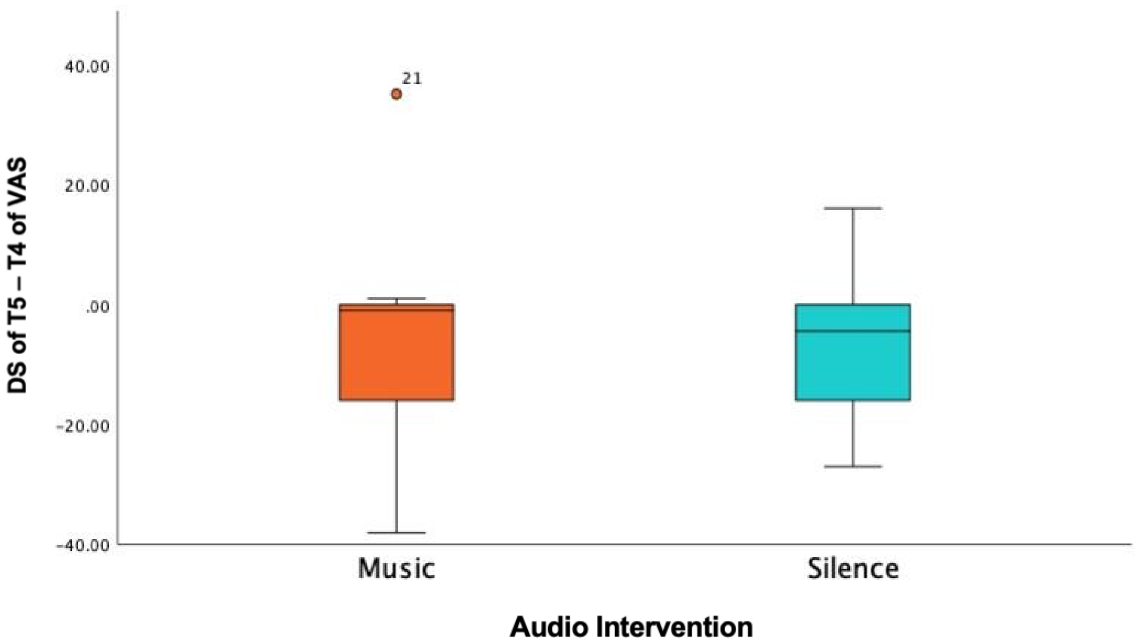

Figure 4: Boxplots of the Difference Scores (DS of T5 – T4) presenting the perceived stress reduction obtained through the Visual Analogue Scale (VAS) for the Audio Interventions.

Cardiovascular stress reduction (HRV) in relation to Audio Intervention

Participant`s cardiovascular stress response, obtained through rMSSD scores of HRV after the stress inducement prior to the Audio Intervention showed a range from 18.46 – 73.9 with a mean HRV of 42.13 (*SD* = 18.53) for participants in the music listening condition. Participants in the silence condition showed rMSSD scores ranging from 31.64 – 120.1, with a mean HRV of 61.2 (*SD* = 18.26). The obtained HRV of the last 5 minutes of the audio intervention showed for people in the music listening condition a range of rMSSD scores from 18.75 – 90.85 with a mean score of 42.37 (*SD* = 22.65). The assessed HRV of people who sat in silence displayed rMSSD scores with a range from 36.35 – 162.56, with mean scores of 76.04 (*SD* = 40.8). The DS was obtained by subtracting the obtained HRV of the 5 minutes after the stress exposure (T4) from the last 5 minutes of the audio intervention (T5) to measure the stress reduction between the two time points of the HRV windows. The DS possessed a range between -32.22 and 17.13, with a mean score of 0.25 (*SD* = 14.49) for the music listening condition. DS in HRV for people who sat in silence showed a HRV range between -14.14 – 59.53, with a mean of 14.84 (*SD* = 22.82).

The test for normality assessed through the Shapiro-Wilk-test as well as the Kolmogorov Smirnov test revealed no significant results for a lack of normality distribution (Shapiro – Wilk: $p > .05$; Kolmogorov Smirnov: $p > .05$). Independent T-tests of the DS for the Audio Interventions indicated a significant variation in HRV between the silence and the music listening conditions. Specifically, participants in the silence condition exhibited elevated rMSSD scores on HRV, compared to those in the music listening condition ($t(25) = -2$, $p = .028$) with Cohen`s d = -.077, suggesting a moderate sized effect.

Table 3

Descriptive Statistics of Stress Responses assessed through HRV and T-Tests for Audio Intervention

		Music (*N* = 14)	Silence (*N* = 13)	*t* - test
HRV before	*M* ± *SD*	42.13 ± 18.53	61.2 ± 18.26	*t* = - 2.23
	Md	32.21	55.36	*p* = .017
	Min - Max	18.46 – 73.97	31.64 – 120.1	*df* = 25
HRV after	*M* ± *SD*	42.37 ± 22.65	76.04 ± 40.8	t = -2.68
	Md	36.36	54.66	*p* = .01
	Min - Max	18.75 – 90.85	36.35 – 162.56	*df* = 25
				Cohen`s d = -1.03
DS	*M* ± *SD*	0.25 ± 14.49	14.84 ± 22.82	*t* = -2
	Md	1.45	9.8	*p* = .028
	Min – Max	-32.22 – 17.13	-14.14 – 59.53	df = 25
				Cohen`s d = -0.77

Note. HRV = Heart Rate Variability, measured in root Mean Square of Successive Differences before Audio Intervention and after Audio Intervention; DS = Difference Score (HRV after – HRV before)

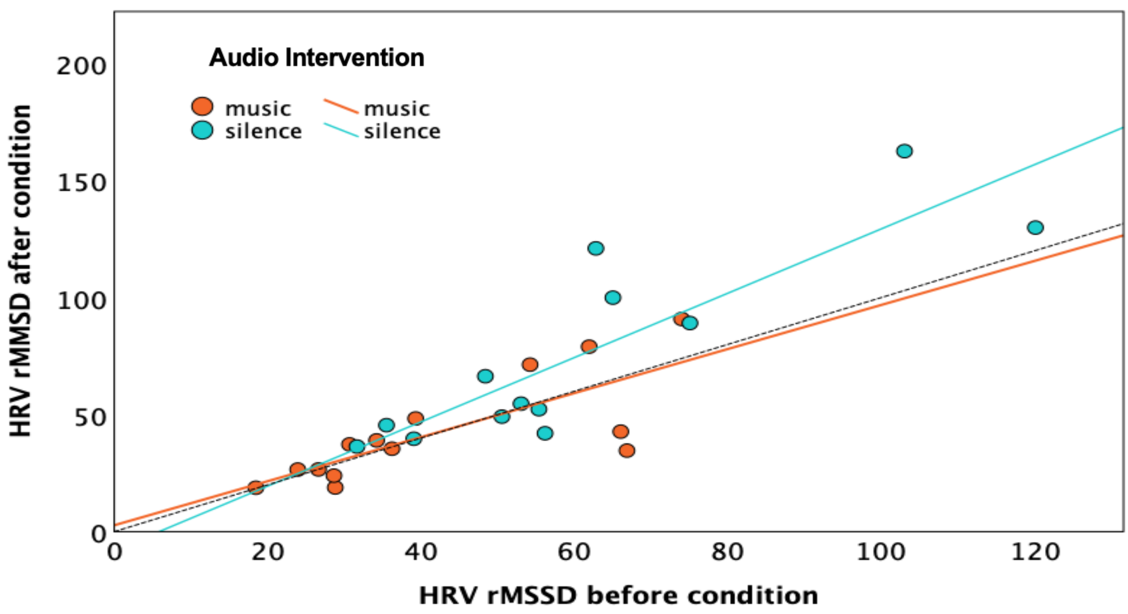

Figure 5: Scatterplot for Heart Rate Variability (HRV) in root Mean Square of Successive Differences scores (rMSSD) before and after the conditions (music / silence). The lines represent the change in HRV for each condition.

Moderation analysis: Interaction of Solace and Audio Intervention on stress reduction

The analysis of the third hypothesis utilized a moderated regression model with two predictors, namely the Audio intervention (music listening / silence) and Solace assessed through the Solace scale of the B_MMR and the dependent variable being the DS of T5 – T4 of the subjective reported stress reduction assessed through the VAS scale. The moderation analysis was aimed to investigate whether the extent to which individuals use music for Solace moderates the relationship between the audio intervention (music listening / silence) and the subjective stress reduction.

None of the predictors reached statistical significance. The coefficient for the audio intervention was b = 4.45 (se = 23.82, $t(34)$ = 0.19, p = .853), for Solace b = 0.35 (se = 3, $t(34)$ = 0.12, p = .909), and the coefficient for the interaction term was b = -0.47 (se = 2.07, $t(34)$ = -0.22, p = .824). These results suggest that there is no significant moderation effect of Solace on the relationship between the Audio Intervention and the subjective stress reduction. The interaction term between the Audio Intervention and Solace did not predict the self-reported stress reduction.

Table 4

Moderation Analysis: Main and Interaction Effects of Solace and Audio Intervention on Subjective Reported Stress Reduction

	b	***se***	***t***	***p***
Audio Intervention	*4.45*	23.82	0.19	.853
Solace	*0.35*	3	0.12	.909
Interaction	*-0.47*	2.07	-0.22	.824

Note. Audio Intervention = Random Assignment to Music listening versus Silence

Moderation analysis: Interaction of Solace and Audio Intervention on HRV

The analysis of the fourth hypothesis utilized a moderated regression model with two predictors, namely the Audio intervention (music listening / silence) and

Solace assessed through the Solace scale of the B_MMR and the dependent variable being the obtained DS of T5 – T4 of the HRV. The moderation analysis was aimed to investigate whether the extent to which individuals use music for Solace moderates the relationship between the Audio Intervention (music listening / silence) and the cardiovascular stress reduction.

None of the predictors achieved statistical significance. The coefficient for the audio intervention was $b = 13.8$ (se = 7.4, $t(23)$ = 1.87, p = .075), for Solace b = 1.62 (se = 4.59, $t(23)$ = 0.35, p = .727), and the coefficient for the interaction term was b = -2.27 (se =3.13, $t(23)$ = -0.73, p = .475). These findings indicate that Solace does not have a significant moderating impact on the relationship between the Audio Intervention and stress reduction depicted in HRV. The interaction term between the Audio Intervention and Solace did not predict the stress reduction in HRV.

Table 5

Moderation Analysis: Main and Interaction Effects of Solace and Audio Intervention on HRV

	b	***se***	***t***	***p***
Audio Intervention	*13.80*	7.4	1.87	.075
Solace	*1.62*	4.59	0.35	.727
Interaction	*-2.27*	3.13	-0.73	*.475*

Note. Audio Intervention = Random Assignment to Music listening versus Silence

Correlation analysis of Openness to Experience and Solace

The fifth hypothesis investigated a possible correlational connection between scores of the Solace scale of the B_MMMR and the Openness scale of the NEO_FFI. Spearman correlations found no significant correlation between Solace and Openness (r = .03, p = .85). Levels of Solace and Openness did not predict each other entirely. As for the low insignificant outcome, not even a trend can be reported.

Table 6

Correlation Analysis Solace scores of the B_MMR and Openness of the Neo_FFI

		Solace	Openness
Solace	Pearson Correlation	1	.03
	Sig. (2-tailed)		0.85
	N	38	38
Openness	Pearson Correlation	.03	1
	Sig. (2-tailed)	.854	
	N	38	38

Note. B_MMR = Brief Music in Mood Regulation; Neo_FFI = Neo Fünf Faktoren Inventar

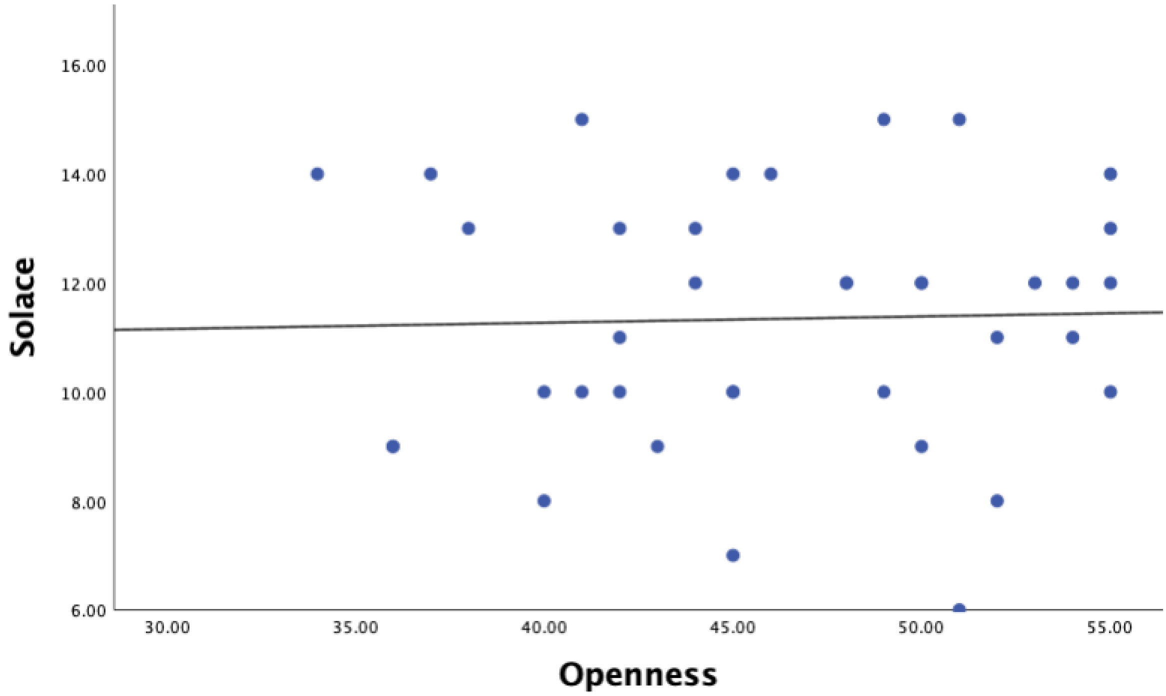

Figure 6: Scatterplot of the correlation between Openness to Experience and Solace.

Discussion

General Discussion

The objective of this thesis was to investigate the stress-reducing benefits of music listening and to determine whether individuals who utilize music for Solace to a greater extent would experience a greater reduction in stress levels when listening to music, compared to those who rely on music to regulate their emotions through Solace to a lesser extent. Furthermore, this thesis was aimed at exploring the connection between the personality trait Openness to Experience and the emotion regulation strategy Solace in connection to music.

In the examined sample, listening to music after a stressful event showed no significant mitigating effect on subjectively reported stress responses compared to sitting in silence. Therefore, listening to music or sitting in silence had no significantly greater effect on an individual`s stress response. Subsequently, the first hypothesis had to be rejected. Contrary to the stated second hypothesis, participants who sat in silence showed a greater stress reduction in the cardiovascular stress measure, depicted in a greater increase of HRV, compared to individuals listening to music. Consequently, silence seemed to have beneficial effects on physiological stress recovery compared to listening to music, whereas these results need to be regarded with caution due to the small sample size. Furthermore, the extent to which individuals utilize Solace did not significantly mitigate subjective stress reports and HRV stress measures whether through listening to music or sitting in silence. Additionally, no significant correlation between emotion regulation through Solace and Openness was found in the observed sample. Summarized, women with higher Openness scores in the acquired sample did not report a greater tendency to use music for Solace compared to less open participants.

Subjective stress reduction and music listening

Initially, it is essential to underscore caution when interpreting the null results due to the underpowered sample acquired in this thesis, through which we cannot definitively claim the absence of an effect in the general population.

Although a variety of studies have indicated the positive impact of music on stress reduction (Khalfa et al., 2003; Nater, Abbruzzese, et al., 2006), there exists a range of studies that have failed to observe these effects and are rather equivocal (Adiasto et al., 2022). Within these, music did not exhibit a higher potential for lowering stress compared to sitting in silence or listening to other auditory stimuli (Malakoutikhah et al., 2020; Radstaak et al., 2014; Sokhadze, 2007; Yamamoto et al., 2007).

In the context of stress reduction through music, it seems important to consider other moderating factors for this connection. Prior research has stated that there are individual differences in the response to music listening, which can have impacts on facilitating stress reduction through music. For example, the chosen music genre seems to have a great impact on an individual`s stress reduction. Although relaxing music with a slow tempo of 60 – 80 bpm seems to have positive impacts on HRV recovery and subjective reported stress responses, incorporating a variety of further genres could potentially enhance stress reducing effects. This diversity in music genres may offer a broader range of emotional experiences and resonate with individuals' unique preferences and emotional states. For instance, while classical music may evoke more feelings of relaxation (Labbé et al., 2007), upbeat genres like pop or jazz may stimulate positive emotions and may distract from stressors to a greater extend (Cook et al., 2017).

Additionally, music that is self-selected appears to have a greater stress reducing effect, potentially due to a greater familiarity with the musical material and eventually through giving participants' a greater feeling of the restoration of perceived control (Adiasto et al., 2022; Radstaak et al., 2014). Beyond that, participants' self-chosen music might prioritize music that is already known by the participants to have stress reducing effects on them (Baltazar et al., 2019; Thoma et al., 2011). In the present study, participants were allowed to choose one out of six set playlists which were put together in a pre-study, which offered them a combination of self- and experimenter selection. This might have still aggravated an advantage to the experimenter`s selected music and potentially diminished the stress reduction benefits of music.

Due to extensive research being conducted on the beneficial effects of music on stress reduction performed on participants in medical or therapeutic settings, a meta-analysis by Adiasto and colleagues (2022) highlighted the potentially advantageous impact of music in these settings as opposed to in healthy individuals. One possible contributing factor to a higher efficacy of music on stress reduction in a clinical context is theorized to be connected to the social component of having trained therapists in these environments. Furthermore, these music therapeutic interventions to reduce stress often last over longer time periods as opposed to short term music listening interventions under acute stress in experimental contexts.

Another factor that seems to be affecting the stress reducing potential of music listening is the specific time frame in which music listening is implemented following an acute stressful event (Adiasto et al., 2022). In the present study, participants went through a procedure where the trans epidermal water loss (TEWL) was measured in accordance with skin barrier recovery following the acute stressful event. The procedure was implemented between the stress inducement and the Audio Intervention of either silence or listening to music. Timing seems to be a crucial factor for implementing stress reduction interventions (Sano et al., 2017) and could have potentially significantly impacted the outcomes of the study. The procedure implemented between the stress inducement and audio intervention, might have prompted a significant decrease in participants' stress levels over time. This temporal factor potentially confounds our interpretation, suggesting that the observed stress reduction could be attributed, at least partially, to the passage of time rather than the specific intervention. Furthermore, individuals may have experienced a significant stress reduction simply due to the present social component in the TEWL procedure having an experimenter sitting with them. These factors potentially influenced the stress reducing capacities of the Audio Intervention. While music is used by people of all ages and genders for the reduction of stress and the regulation of emotions, evidence shows that stress responses in males and females, as well as through different age spans differ in accordance with music (Gupta & Gupta, 2016; Lee-Harris et al., 2018; Lonsdale & North, 2011). In the present study, a small sample of female only identifying young women (between 18 – 33) was assessed in their stress reduction tendencies through music and silence. This circumstance restricts the generalizability and constrains the comparison of the study results to a broad range of prior research investigating more diverse age and gender samples.

HRV and stress reduction

In the present thesis, contrary to prior research (Mojtabavi et al., 2020), music listening after an acute stressful event had a significantly smaller stress reducing effect compared to sitting in silence in the cardiovascular stress measure assessed through HRV. While these obtained results need to be approached and interpreted with care due to the small sample size, they stand in line with evidence suggesting silence to have a greater stress reducing effect on the ANS than music (Gabriel Piñeros et al., 2023) and an associated greater reduction of HR when sitting in silence for 2 minutes compared to listening to music (Bernardi et al., 2006). One possible explanation for the benefit of silence over music could be attributed to the stimulating nature of music itself, even when it is relaxing and with a slow tempo. Music as a stimulus may inadvertently activate the SNS to a greater extent than silence. This heightened SNS activation potentially influenced the stress reducing capacities of the music listening intervention.

Emotion regulation through Solace and stress reduction

The present study did not observe a significant interaction between participants' use of music for Solace and the audio intervention on stress reduction in subjective reported and the cardiovascular obtained stress parameter. Although prior research has stated that Solace is an effective emotion regulation strategy after a distressing event (Saarikallio, 2012), a study by Hanser and colleagues (2016) found that its core function seems to unfold when lyrics are present. Lyrics, preferably with which listeners can identify themselves after suffering through a negative life event, seem to have the widest range of emotional comfort found in music. The participants in this study were presented with solely instrumental music without lyrics to decrease stress levels and investigate the emotion regulation strategy Solace in relation to it. Therefore, the capacity for Solace might have been affected by the lack of lyrics in the music listened to.

Another aspect that has been suggested to significantly influence whether music is utilized for Solace is whether the music that is presented has emotionally relevant characteristics for the participants (Swaminathan & Schellenberg, 2015). Due to the available music playlists, that were put together in a pre-study, personally relevant associations were probably lacking, which diminished the application of emotion regulation strategies.

The definition of Solace to regulate emotions through music is that it is a strategy that is commonly used after experiences of sadness, loss and distressing life events (Saarikallio, 2012). In a study by Hanser and colleagues (2016), primary situations for Solace were situations of loss and sadness. Therefore, the inducement of stress through the social and evaluative threatening capacities of the TSST may have elicited distinct emotions than would`ve been relevant to evoke the emotion regulation strategy Solace.

The interpretation of the null findings also for this section are carefully made. Due to the small sample size for this thesis, the exclusion of an effect in the general population cannot be made.

Openness and Solace

Based on prior research associating people higher in Openness to Experience with having a greater tendency to possess a sensitivity for art and emotions (McCrae & Sutin, 2009), it was assumed that these individuals would also be more inclined to use music as a means of emotional regulation through Solace. No significant connection supporting that notion was found in the present sample.

A study by Chamorro-Premuzic & Furnham (2007) associated people who are more open with utilizing music to a greater extent in a rational and cognitive way than to regulate their emotions through it. Individuals with a more open personality tend to favor musical genres that are more intellectual and complex (Vella & Mills, 2017). Thus, those with higher Openness might benefit from listening to music more in an intellectually stimulating manner than to experience emotional relief through its utilization.

Individual differences in the way music is employed to regulate emotions seem to profoundly impact the utilization of music. Hence, factors other than an individual`s personality may play a more significant role in emotion regulation preferences through music.

It is worth noting that the small sample size of the present study prevents definitive conclusions regarding the absence of an effect in the population. Thus, caution must be exercised when interpreting these findings, and further research with larger and more diverse samples is needed to explore these relationships more comprehensively.

Limitations

Several limiting factors may have affected the testing of the hypotheses of interest in this thesis, thereby potentially influencing the outcomes. The primary constraint of the study regarding the interested variables for this thesis lies in the small sample size which constrained statistical power of the analysis and limited the ability to detect significant effects. Another limiting factor was the broad array of employed exclusion criteria, which was created to fit the research aim of the general study “Effects of music on skin barrier recovery”. Included participants had to be solely at birth assigned female and not identifying their identity otherwise within the age range of 18 and 35. This limitation upfront affects the generalizability of the findings to the total population. Furthermore, participants had to be without physical or mental health disorders, have a regular menstrual cycle, not use contraceptives nor be pregnant or breastfeeding. Participants who formerly had experience with stress tests or were psychology students, due to their high familiarity with the TSST, were additionally excluded from the study. Professional musicians and women with absolute hearing were further excluded to avoid confounding variables. All these variables narrowed the number and variability of participants down and affected the generalizability of results. Additional to the composition of the sample due to the set criteria by the superordinate study, the final sample was homogenous in educational and professional backgrounds, encompassing almost solely University students. A more diverse sample could portray the distribution in the broad population more validly and make research results more generalizable.

Due to difficulties with the ECG sensor, through which data for HRV was obtained, a great number of cases had to be excluded from the analysis due to missing data, which led to a profound reduction of power and might have obscured potential patterns or trends.

Between the stress inducement through the TTST and the Audio Intervention (music listening / silence), the TEWL procedure was implemented. It lasted approximately 20 minutes and potentially led to a significant reduction of stress levels, subsequently impacting the bandwidth of the Audio Intervention`s stress reducing effects. A smaller time window without additional procedures between stress induction and Audio Intervention would be preferrable for similar studies in the future.

Solely non-lyrical music was chosen for the playlists in the present study, which was due to standardization. Especially for emotion regulation strategies, self-chosen music with different genres and lyrics could have beneficial impacts and should be implemented in future similar studies.

While the terms mood and emotion hold conceptual differences between each other, they also share interconnected similarities and were used interchangeably in the present thesis.

This master thesis was carried out within the overarching research project "Muskiba: Effects of music listening on stress and skin barrier recovery" led by Jasminka Majdandžić. Therefore, the contents of this thesis may incidentally show overlap (in terms of e.g. appendices) with theses by other students co-supervised by Jasminka Majdandžić.

Future Directions

As the present thesis only yielded non-significant or underpowered results, potential future directions based on the collected data can only be hypothesized. Strategies to use music, which could potentially help to facilitate stress recovery after a stress response, so far seemed to present a useful tool when facing the great burden stress responses can carry onto human lives.

How music is used, by whom and in which way regarding the regulation of emotions after distressing events, will continue to represent a research field of interest. Due to the cheap and non-invasive nature of music especially in modern days, where music listening can easily be applied in all settings and age groups, the potential mechanisms behind it could be investigated in daily life through an increased implementation of Ecological Momentary Assessment (EMA) studies. Utilizing apps installed on participants' devices, researchers could monitor emotion regulation through music in response to daily setbacks, music genres, song preferences, lyrics, and trait differences.

Additionally, regarding the significant beneficial effect of silence over music in reducing stress in HRV measures in the present thesis, future studies should aim to replicate this finding and further on investigate possible mechanisms of why silence could elicit more calming effects on the ANS than music.

Conclusion

The present thesis was aimed to investigate the stress reducing impacts of music listening in a multidimensional approach. Self-reported stress levels showed no benefit of music listening compared to silence, whereas silence seemed to reduce physiological arousals to a greater extent which was depicted in a higher HRV. Additionally, this thesis aimed to give insights into whether music listening could have beneficial impacts on stress reduction in people who implement that strategy more habitually. No significant result for this connection could be obtained in the data.

Furthermore, a possible connection to the personality trait Openness to Experience and Solace was theorized, which was additionally not deducible from the present data. A small sample size as well as restricted inclusion criteria impacted the power of the study.

Since maladaptive stress responses carry a great burden for the individual and the society, the induction and regulation of emotions through music holds promising possibilities for well-being. Therefore, conducting more thorough research approaches in the future to explore tailored strategies in stress management using music and emotion regulation could provide significant health advantages.

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Appendix

Abstract English Version

Background: Stress can impose detrimental impacts on physiological and mental health, therefore the implementation of tools to mitigate stress responses is crucial. Music listening has been seen as beneficial in positively affecting parameters like heart rate variability (HRV) and self-reported stress levels. The utilization of music to regulate emotions through Solace following a distressing event presents a popular strategy. Therefore, people who tend to use music more for Solace were expected to show greater stress reductions in self-reported and physiological stress responses after listening to music. Furthermore, it was hypothesized that individuals higher in the personality trait Openness tend to utilize music more frequently as a means to regulate their emotions through Solace.

Methodology: *N* = 40 female participants were subjected to the Trier Social Stress Test (TSST) before being randomly assigned to music listening or sitting in silence and compared regarding their stress reductions. Changes in HRV, as well as subjectively reported stress through the Visual Analogue Scale (VAS) were collected. The Solace scale of the Brief Music in Mood Regulation (B_MMR) was employed to obtain the scores of that emotion regulation strategy and levels of Openness were assessed with the consecutive items from the Neo_FFI.

Conclusions: No significant results were found concerning a greater stress reduction through music listening in subjective stress responses. However, individuals in the silence condition showed a significantly greater stress reduction regarding HRV compared to the music condition. No moderating effect of Solace impacting the connection of music and stress reduction could be observed. Furthermore, no correlative association between Solace and Openness was found.

Key words: subjective stress report, heart rate variability, root mean square of successive differences, emotion regulation through solace, emotion regulation through music, Openness to Experience, Autonomic nervous system, HPA axis, Sympathetic nervous system, Parasympathetic nervous system

Deutschsprachige Version

Hintergrund: Stressreaktionen können die körperliche und psychische Gesundheit mitunter langfristig beeinträchtigen. Diese Umstände erfordern die Implementierung von Interventionen, wie das Hören von Musik, das mit einem Rückgang an Stressreaktionen assoziiert ist. Musikhören wurde unter anderem mit einem positiven Einfluss auf die Herzratenvariabilität (HRV), sowie auf subjektiv berichtete Stresslevel assoziiert. Eine populäre Strategie, um Emotionen nach einem aufwühlenden Erlebnis durch Musik zu regulieren, stellt das Suchen nach Trost im Musikhören dar. In der vorliegenden Arbeit wurde erwartet, dass Personen, welche Musik vermehrt nutzen, um Trost darin zu finden, auch eine stärkere subjektive und objektive Stressreduktion nach dem Musikhören erleben. Darüber hinaus wurde ein positiver Zusammenhang zwischen der Persönlichkeitsdimension Offenheit und der Trostfindung im Musikhören vermutet.

Methodik: *N* = 40 weibliche Teilnehmerinnen wurden nach einer Stressinduktion durch den Trier Social Stress Test (TSST) randomisiert auf zwei Bedingungen (Musik hören / Stille) aufgeteilt und in Bezug auf ihre Stressreduktion verglichen. Objektive Stressmaße wurden durch die HRV und subjektiv berichtete Stresslevel durch eine Visuelle Analogskala (VAS) abgebildet. Die Skala zur Trostfindung durch Musikhören wurde mit dem Fragebogen Brief Music in Mood Regulation (B_MMR) und Offenheitswerte durch die zugehörigen Items des Neo_FFI erhoben.

Schlussfolgerungen: Es wurden keine signifikanten Ergebnisse in Bezug auf eine größere Reduktion subjektiv berichteter Stresslevel durch das Hören von Musik gefunden. Das Sitzen in Stille schien hingegeben mit einer höheren Stresserholung in HRV-Maßen im Vergleich zum Musik hören assoziiert zu sein. Das Trostfinden im Musikhören hatte keinen moderierenden Einfluss auf die Hörbedingung und die Stressreduktion, außerdem konnte kein korrelativer Zusammenhang zwischen dem Trostfinden und der Offenheit von Personen nachgewiesen werden.

Figures

Tables