universität wien

MASTERARBEIT / MASTER'S THESIS

Titel der Masterarbeit / Title of the Master's Thesis

„Der Einfluss von Musikalität auf den Zusammenhang zwischen Musik, Stress und der Regeneration der Hautbarriere" / "The influence of musicality on the relationship between music, stress and skin barrier recovery"

verfasst von / submitted by

Katharina Knogler, BSc

angestrebter akademischer Grad / in partial fulfilment of the requirements for the degree of

Master of Science (MSc)

Wien, 2020 / Vienna 2020

Studienkennzahl lt. Studienblatt / degree programme code as it appears on the student record sheet:	UA 066 840
Studienrichtung lt. Studienblatt / degree programme as it appears on the student record sheet:	Masterstudium Psychologie UG2002
Betreut von / Supervisor:	Univ.-Prof. Dr. Urs Markus Nater
Mitbetreut von / Co-Supervisor:	Dr. Jasminka Majdandžić

Table of contents

List of figures

List of tables

List of appendices

List of abbreviations

SBR:	skin barrier recovery
TEWL*:*	transepidermal water loss
TSST:	Trier Social Stress Test
Gold-MSI:	Goldsmiths Musical Sophistication Index
GMS:	general musical sophistication
VAS:	visual Analogue Scale
rmANOVA:	repeated measures ANOVA
MTP:	measurement time point
M:	mean
SD:	standard deviation
SE:	standard error
p:	significance
ME:	music empathizing
MS:	music systemizing
MEMS:	Music Empathizing Music Systemizing

Abstract

Key words: stress, music, transepidermal water loss, skin barrier recovery, musicality, musical sophistication

Objectives

The negative effects of stress on various health outcomes are well known. One of these outcomes is the skin barrier recovery (SBR), a wound healing process. Music had stress-reducing effects in a multitude of studies. Hence, it was assumed that music has a positive effect on SBR via a stress-reducing pathway. However, the effects of music on stress can vary depending on, e.g., personality traits or musical experience. In this study, musicality was introduced as one of these possible influencing factors. The objective of this study was to investigate the relationship between music, stress and SBR, as well as the role of musicality in this context.

Method

Seven female participants were randomized into a music group or a silent control group. After a baseline phase of 30 minutes, participants completed the Trier Social Stress Test (TSST). After the TSST, participants went through a simple tape-stripping procedure. Then, the music group listened to music while the control group sat in silence for 30 minutes. Subjective stress was measured with a visual analogue scale. SBR was calculated using transepidermal water loss values. Musicality was measured with the German version of the Goldsmiths Musical Sophistication Index (Gold-MSI). Single case analyses were performed with three participants.

Results

No differences could be found between the music group and the silent control group regarding subjective stress and SBR. However, differences in SBR between one high and one low-scoring participant in the Gold-MSI were observed.

Conclusions

This study presents preliminary evidence for the influence of musicality on the relationship between music and SBR—investigating a novel pathway of the deleterious effects of stress on health with music as a potential buffering mechanism, at least for some populations.

Zusammenfassung

Schlüsselbegriffe: Stress, Musik, transepidermaler Wasserverlust, Regeneration der Hautbarriere, Musikalität, musical sophistication, musikalische Erfahrenheit

Ziele

Die negativen Effekte von Stress auf verschiedene Aspekte der Gesundheit sind wohl bekannt. Einer dieser Aspekte ist die Regeneration der Hautbarriere (RHB), ein Wundheilungsprozess. Musik zeigte stressreduzierende Effekte in einer Vielzahl an Studien. Daher wurde angenommen, dass Musik über einen stressreduzierenden Pfad positive Effekte auf die RHB haben würde. Die Effekte von Musik auf Stress können jedoch variieren, beispielsweise in Abhängigkeit von Persönlichkeitsfaktoren oder Erfahrenheit mit Musik. In dieser Studie wurde Musikalität als möglicher Einflussfaktor untersucht. Ziel dieser Studie war es, den Zusammenhang zwischen Musik, Stress und der RHB sowie der Rolle von Musikalität in diesem Kontext zu erforschen.

Methode

Sieben Teilnehmerinnen wurden einer Musikgruppe oder einer Stille-Kontrollgruppe randomisiert zugewiesen. Nach einer halbstündigen Baseline-Phase absolvierten die Teilnehmerinnen den Trier Social Stress Test (TSST). Anschließend wurde ein einfaches Klebestreifen-Abriss-Verfahren durchgeführt. Danach hörte die Musikgruppe 30 Minuten lang Musik, die Kontrollgruppe wartete für 30 Minuten in Stille. Subjektiver Stress wurde mit einer visuellen Analogskala gemessen. Die RHB wurde Anhand von Werten in transepidermalem Wasserverlust errechnet. Musikalität wurde mit der deutschen Version des Goldsmiths Musical Sophistication Index (Gold-MSI) erfasst. Einzelfallanalysen wurden an drei Teilnehmerinnen durchgeführt.

Ergebnisse

Es wurden keine Unterschiede in Bezug auf subjektiven Stress und RHB zwischen der Musik- und der Stille-Gruppe gefunden. Jedoch konnten Unterschiede in RHB zwischen einer Person, die hohe und einer Person, die niedrige Werte im Gold-MSI erreicht hatte, gefunden werden.

Konklusionen

Diese Studie liefert vorläufige Beweise für einen Einfluss von Musikalität auf den Zusammenhang zwischen Musik und RHB und untersuchte somit einen neuen Pfad, über den Stress schädliche Auswirkungen auf die Gesundheit ausübt, mit Musik als potenziellem Puffermechanismus – zumindest für manche Bevölkerungsgruppen.

Introduction

In the past decades, the research interest in stress and its relationship to various parameters like health and wellbeing has been growing. Stress is a major risk factor not only for mental disorders, but for several physical conditions as well. Depression and anxiety disorders often develop after stressful life events and cardiovascular disease can be caused by chronic stress (Schneiderman, Ironson, & Siegel, 2005). The impact of stress on health has been studied in various ways in the past decades and different health outcomes have been investigated. Amongst them, skin barrier recovery has gained more attention in scientific research because of growing understanding of the relationship between stress and skin conditions. Skin barrier recovery, which is the regeneration of the upper layer of the skin after impairment, has been used as a measure for the impact of stress on health in a full body of research and a negative relationship has been reported in several studies (e.g., Altemus, Rao, Dhabhar, Ding, & Granstein, 2001; Fukuda, Baba, & Akasaka, 2015; Garg et al., 2001; Muizzuddin, Matsui, Marenus, & Maes, 2003; Robles, 2007). Music, however, has been established as a therapy method for mental and physical conditions, as positive, i.e., calming effects of music on stress levels could be found. In a meta-analysis, Pelletier (2004) concludes that "music assisted relaxation techniques effectively decrease stress and arousal in medical, university, and occupational settings" (p.210). The present study aims to combine the calming effects of music on stress and the negative effects of stress on skin barrier recovery, assuming that music will show a positive effect on skin barrier recovery. However, Pelletier's meta-analysis (2004) revealed that the effects of music on stress depend on several factors, like age, gender or type of music. Another influential factor is musicality. Pelletier (2004) found that individuals with musical experience benefit more from music assisted relaxation techniques than non-musical individuals. Thus, it is expected that in this study highly musical individuals will profit more from a music listening session after skin disruption and show better subjective stress and skin barrier recovery than less musical individuals.

Theoretical Background

Stress and stress theories.

Despite its great impact, the term *stress* can be defined in various ways. In everyday language, we use it to describe an emotional or physical state as well as a situation. As the importance of stress not only grew in everyday life but in the scientific context as well, various definitions and theories of stress have been established which can be clustered in three groups (Knoll, Scholz, & Rieckmann, 2013). One group of theories defines stress as a specific

physiological response pattern. In this biologically and physiologically oriented group of theories, the type of stressor that causes the bodily reaction plays a minor role than the reaction itself. One famous representative of this group is Hans Selye, who defined stress as "the nonspecific response of the body to any demand made upon it" (Selye, 1976, p.137) and claimed that these responses are caused and driven by cortisol, a biological stress marker (Knoll et al., 2013). He was the first to describe the hypothalamic-pituitary-adrenal axis (HPA axis), one of the two major bodily systems responsible for the stress reaction, which will be described in more detail below.

Another famous researcher who examined bodily reactions to stressors was Walter Bradford Cannon. He formulated the concept of the fight-or-flight response. This concept describes the animal reactions to threat, which can either result in an attack of the source of the threat or in a flight from the source. These reactions are driven by the second major bodily stress system, the sympathetic nervous system, which causes the release of the hormones epinephrine and norepinephrine from the adrenal medulla. These two systems act together to provide the body with the necessary energy to deal with a stressor (Schneiderman et al., 2005). The fight-or-flight concept was later expanded by Barlow (2002) by a third reaction, the *freeze* reaction, which describes the abrupt inhibition of motor and vocal activity that may take place when both fight and flight are unlikely to be effective in a given situation (Schmidt, Richey, Zvolensky, & Maner, 2008). According to Schmidt et al. (2008), the freeze response, which can often be observed in animals (e.g., when movement may provoke attacks by an enemy) is not very likely to occur in humans, with important exceptions found in the PTSD (posttraumatic stress disorder)/ rape literature, where victims report inability to move during the assault.

In the second group of stress theories, stress is defined as the stimulus which leads to a certain reaction (Knoll et al., 2013). In contrast to the first group of theories, the focus is on the types of stressors rather than on the bodily response patterns. One famous theory of this group is called *critical life events* by Holmes and Rahe (1967). They claim that the extent of change caused by an event, be it positive or negative, is responsible for the amount of stressful emotional reactions caused by the event. Kanner, Coyne, Schaefer, and Lazarus (1981) focused less on life changing events rather than on everyday stressors and formulated their ideas in their theory of *daily hassles*, which they deemed responsible for perceived stress levels.

Theories of the third group claim that stress consists of the interaction between a situation and the person involved. One of the most influential theories in stress research that belongs to the last group is the *transactional stress model*, described by Richard S. Lazarus. Lazarus claims that stress results from the relationship between situations and individuals and is highly

dependent on their respective properties (Lazarus & Folkman, 1984). According to this cognitive theory, an individual's appraisal of a given situation is crucial for the definition of the situation as a stressor. This assessment process can be separated in primary and secondary appraisal, which—according to the authors—do not necessarily run successively, as the name would imply, but rather in parallel. Primary appraisal describes the process in which a person evaluates whether a situation is a threat or not. In more detail, the authors claim that there are three kinds of primary appraisal of a given encounter or stimulus, namely 1) irrelevant, when the encounter has no impact on a person's well-being, 2) benign-positive, when the situation or stimulus comes along with or promises positive consequences, or 3) stressful, if a situation or stimulus carries (or is expected to carry) harm/loss, threat, or challenge. These three aspects differ from each other concerning when they take place and the emotions they inhere. Harm/loss concerns happenings that have already taken place and that a person now has to cope with. Threat refers to harms or losses that are expected to take place. Challenges are future encounters as well, but they differ from threats insofar as that they not only bring negative but positive emotions, as well, like excitement or eagerness. Importantly, as threats and challenges refer to future situations, they permit anticipatory coping. Lazarus and Folkman (1984) define coping as the process of handling demanding situations or encounters. Anticipatory coping means that, to some extent, plans and arrangements can be made, and difficulties can be tackled beforehand.

Therefore, the individual needs to assess whether it possesses the necessary resources to cope with the situation, which is called secondary appraisal. In this evaluative process, individuals seek out possible coping options and their likelihood to help achieving the desired goal, as well as the likelihood that the individual is able to apply coping strategies effectively.

The interaction between primary appraisal of what is at stake and secondary appraisal of possible coping strategies constitutes the strength of the stress response. This interaction can get quite complex, but broken down into very simplified words it can be said that the higher the threat and the poorer the available coping resources, the higher the stress reaction, and vice versa.

These evaluation processes also depend on the individual's personality traits. In a very interesting paper on the relationship between personality and stress, Vollrath (2001) gives an overview of studies that examined the relationship between these two concepts on the basis of Lazarus' transactional stress theory, the Big Five personality factors (openness, conscientiousness, extraversion, agreeableness, neuroticism) and other personality traits. The author aims to demonstrate that the stress process is influenced by personality in every aspect, like selection and shaping of stress situations, primary and secondary appraisal, and coping. In her

explanations of the effect of personality on appraisal, Vollrath (2001) detects that in this context primary appraisal has been more studied than secondary appraisal. However, evidence for a significant influence of various traits can be found for both. Neuroticism, for example, influences primary as well as secondary appraisal negatively, whereas extraversion interacts positively with the evaluation of stressful situations or threats.

In addition to the presented theories there is one important concept which must not be left out in the discussion about stress theories: the concept of allostasis and allostatic load. Bruce McEwen (1998) describes allostasis, which was first introduced by Sterling and Eyer (1988), as "physiological responses of the autonomic nervous system, HPA axis, cardiovascular, metabolic and immune systems" in response to perceived or real threats and challenges to an organism's safety and homeostasis, which "lead to protection and adaptation of the organism to these challenges" (McEwen, 1998, p. 37). It should be mentioned, at this point, that it is not possible to fully distinguish the two terms homeostasis and allostasis. Allostasis, on the one hand, is "an essential component of maintaining homeostasis" (p. 37), which, on the other hand, comprises all processes undertaken by an individual to maintain its inner, physiological equilibrium. According to McEwen, those protective an adaptational processes referred to as allostasis have their price for the organism. To describe missing as well as excessive responses of the involved systems in their reaction to threat, McEwen introduced the term *allostatic load* and defines it as "the wear and tear on the body and brain resulting from chronic overactivity or inactivity of physiological systems that are normally involved in adaptation to environmental challenge" (p. 37).

This definition shows that McEwen's concept of allostatic load refers to long-term stressors rather than to acute stress responses. In stress research and the conceptualization of stress, a distinction between acute and chronic/ long-term responses to stress can be made. In the study presented in this master's thesis, the focus is on the acute stress response. The physiological and biological processes involved in this response will be described in the following section, with special attention to the hypothalamic-pituitary-adrenal axis.

The acute stress response: the hypothalamic-pituitary-adrenal axis.

When a human organism is faced with a stressor, it shows an adaptive complex pattern of reactions known as the *stress response*. It comprises endocrine, nervous and behavioral as well as immune systems (Joseph & Whirledge, 2017). From an evolutionary point of view, this response is crucial for the survival of an individual as it provides all the cognitive and metabolic resources necessary to respond to a threat. The primary mediator of the stress response is the

hypothalamic-pituitary-adrenal (HPA) axis. In a chain reaction, the hypothalamus, the pituitary gland and the adrenal glands act together to govern the cardiovascular and metabolic system, functions of the immune system, behavioral responses and reproduction. If the organism recognizes an event as stressor, the paraventricular nucleus (PVN), a set of neurons in the hypothalamus, is triggered to release corticotropin-releasing hormone (CRH) and arginine vasopressin (AVP). These neurotransmitters stimulate the anterior pituitary gland, located below the hypothalamus, to produce and secrete adrenocorticotropic hormone (ACTH). Via blood circulation, ACTH travels to the adrenal glands and stimulates the adrenal cortex to synthesize and release cortisol, amongst other products. Cortisol, a well-studied stress hormone that belongs to the group of glucocorticoids, is released into the blood circulation, starting a negative feedback loop: High levels of cortisol in the blood circulation inhibit further production of CRH and, consequently, ACTH, which regulates the HPA axis from acute activation back to its original physiological state.

Besides the activation of the HPA axis in response to a stressor, which usually takes 20 to 30 minutes after identification of the stressor (Rousset & Halioua, 2018), a second pathway gets activated already within seconds: the sympathomedullary pathway. It leads to the secretion of adrenaline and noradrenaline (also known as epinephrine and norepinephrine) in the adrenal medulla and is responsible for the fight-flight-freeze-reaction described above.

In this study, cortisol was measured because of various reasons and advantages. Cortisol, as an objective measure of the stress response, can be measured in saliva and blood to assess momentary reactions, or in hair to assess long-term stress responses. Salivary cortisol is easily measurable as it can be assessed non-invasively with the use of saliva samples. Despite clear instructions on how to get the samples and how to handle them properly, no medical training is necessary. Therefore, and because this study aims for insights in acute stress responses instead of long-term reactions, saliva cortisol was measured.

Moreover, cortisol is especially interesting in the context of this study because of its interference with the recovery of the skin barrier after impairment, which will be described in detail below, as skin barrier recovery is the main component of this research project.

The relationship between stress and health.

Based on the stress theories described above, a whole body of research has dealt with the relationship between stress and health. Although the stress response is, per se, useful and crucial for the survival of an organism, it can also impact health when it is inappropriate (i.e., inadequate, excessive and/ or prolonged). Research of the past decades has already tried to

unravel the complex interactions between stress, health and the immune system, a central mechanism involved in regulating our health. Although the underlying functioning is highly complex, more and more knowledge could be accumulated in the last decades about the impact of psychological stress on various health outcomes.

It can be concluded, for example, that under acute stress, the immune system increases its functions, whereas under chronic stress immune functions are supressed (Nater, Ditzen, & Ehlert, 2011). In a very extensive review on stress-induced immune dysfunctions, Glaser and Kiecolt-Glaser (2005) aggregated and summarized results from the field of psychoneuroimmunology. The authors report that a) psychological stressors can lead to a reactivation of latent herpesviruses, b) stress can trigger inflammatory responses which can increase the risk for cancer, c) psychological stress can compromise the efficacy of specific vaccinations, d) early stressors can have a long-term impact on the development of endocrine and immune systems, and e) wound healing can be impaired by stress and anxiety. Glaser and Kiecolt-Glaser (2005) summarize their findings as follows: "Together, these studies support the hypothesis that morbidity can be directly linked to stress-induced immune dysregulation" (p. 249).

Furthermore, individuals who show relatively high reactions to stressors are at higher risk for cardiovascular disease. According to Lovallo (2015), "[…] it is increasingly recognized that persons who have larger than normal responses to psychological stress are at increased risk of cardiovascular disease and premature death, and a similar picture is emerging in relation to immune system function" (Lovallo, 2015, p.250). In their review, Steptoe and Kivimäki (2012) support this view, concluding that stress might contribute to the risk of cardiovascular disease not only by triggering acute cardiac events but also in the long-term, for example by increasing the risk for the development of atherosclerosis.

In their review on the relationship between stress, depression, the immune system and cancer, Reiche, Nunes, and Morimoto (2004) report that stress and depression can lead to impairment of the immune system which consequently contributes to the initiation and progression of at least some types of cancer. In an older study by Kiecolt-Glaser, Marucha, Mercado, Malarkey, and Glaser (1995), the effects of stress on wound healing were studied. The sample consisted of caregivers of patients with Alzheimer's disease, as this group is assumed to experience psychological stress for a longer period of time. In fact, Kiecolt-Glaser et al. (1995) reported longer wound healing processes in caregivers than in the control group.

There is also evidence that stress is associated with several skin diseases. This relationship is well-studied for psoriasis. Rousset and Halioua (2018) published a review of the literature on this topic with a final sample of 133 articles and found that in 31–88 % of the reviewed

cases, psoriasis patients report that stress acts as a trigger of their disease. Concerning the incidence of the illness, the authors claim that stress may trigger psoriasis in predisposed individuals. In line with those findings, Stewart, Tong, and Whitfeld (2018) draw a similar deduction in their review on the associations between psychological stress and psoriasis. The authors included a much smaller amount of studies in their review (n = 12), nevertheless they found "a probable temporal association between different measures of psychological stress and onset, recurrence and severity of psoriasis" (p. 1281). In their conclusion, Rousset and Halioua (2018) describe that skin, endocrine, nervous, and immune systems act together in a large multidirectional complex and emphasize the importance of their interplay.

Taken together, the effects of stress on health can be tremendous and should be studied thoroughly to broaden our knowledge on how exactly stress damages health and how we can intervene and prevent negative health outcomes. The study presented in this master's thesis shall contribute to the understanding of this complex by studying the relationship between stress, endocrine processes, psychological aspects and an important immune function: the recovery of the skin barrier.

Human skin, skin barrier and skin barrier recovery.

The skin consists of two main layers, which are the dermis (inner layer) and the epidermis (outer layer). Beneath these two layers, the hypodermis or subcutaneous tissue is located. The epidermis is composed of four sublayers: the stratum basale (inner layer), stratum spinosum, stratum granulosum, and the stratum corneum (the outermost layer; Losquadro, 2017). The stratum corneum is the main (physical) component of the skin barrier which acts as a barrier between underlying tissue and the environment. It prevents dehydration or infection of the skin and protects skin tissue from chemicals or mechanical stress (Proksch, Brandner, & Jensen, 2008).

Consequently, damage of the skin influences the integrity of the protective functions of the skin barrier. In healthy skin, the immune system immediately works on the regeneration of the affected skin area. This process is called the skin barrier recovery (Alexander, Brown, Danby, & Flohr, 2018). Skin barrier recovery can be assessed using the measurement of transepidermal water loss (TEWL), which is "the most widely used objective measurement for assessing the barrier function of the skin" (p. 2296). As already mentioned above, the stratum corneum (SC), which is a central contributor to the properties and function of the skin barrier, protects the skin from dehydration, doing so by preventing the evaporation of too large amounts of water through the skin. Diffusion of water through the SC is normal and happens, to some

degree, in healthy skin. However, in some skin diseases or if healthy skin gets damaged, TEWL is increased, which means that unusually large amounts of water get lost through the skin. The exact amount of vaporizing water can be measured with a probe placed on a fixed area of the skin surface, and it is measured in units of grams of water per hour per square meter ($g/h/m^2$).

Measurement of TEWL has gained more attention in psychological research to assess relationships between health and various psychological parameters, like, for example, stress.

The relationship between stress and skin barrier recovery.

Several psychological stressors have been found to impair skin barrier recovery. In their study, Altemus et al. (2001) investigated the effects of three different stressors on various dermatologic measures. In detail, the impact of psychologic interview stress, sleep deprivation and physical exercise on transepidermal water loss, skin barrier recovery and skin conductance were measured in women in combination with measurements of stress hormones and immunological parameters. In the context of the relationship between skin barrier recovery, stress and stress hormones, the major findings of this study were that interview stress as well as sleep deprivation stress had a negative impact on the recovery of the skin barrier, whereas physical exercise did not. Changes in stress hormone levels have only been found for psychological interview stress.

In two different studies, one by Fukuda et al. (2015), the other by Garg et al. (2001), university stress was found to have negative effects on skin barrier recovery. Fukuda et al. (2015) compared 16 female students during three different time periods: two periods that were considered especially stressful (during final examinations and after returning from long vacations), and a third, less stressful period which served as control. The researchers found a deterioration in skin barrier recovery in both elevated-stress groups. In a very similar study with comparable results, Garg et al. (2001) reported that “the greatest deterioration in barrier function occurred in those subjects who demonstrated the largest increases in perceived psychological stress” (p. 54).

Stress caused by divorce had negative effects on skin barrier recovery in healthy women in a study by Muizzuddin et al. (2003). In this study, women suffering from psychological stress because of marital disruption were compared to a control group of women who perceived themselves as *happy*. Muizzuddin et al. (2003) found strong correlations between skin barrier recovery and perceived stress three hours ($r = 0.64$) and 24 hours ($r = 0.74$) after tape stripping. The skin barrier recovered faster in the *happy* control group.

Robles (2007) could replicate the findings that psychological stress acts negatively on skin barrier recovery for acute stress. In his study, he used the Trier Social Stress Test (TSST;

Kirschbaum, Pirke, & Hellhammer, 1993), a validated and commonly used laboratory stressor which will be discussed in more detail in the methods section of this thesis, to induce acute psychological stress and found that those participants who underwent this test displayed delayed recovery of the skin barrier.

These findings raise the question which mechanisms are responsible for the negative impact of stress on skin barrier recovery. Dermatological research already tackled this issue. Interestingly, it could be found that the effects can be explained by the negative impact of cortisol on the synthesis of lipids that are indispensable for stratum corneum regeneration (Choi et al., 2005; Orion & Wolf, 2012). In more detail, the negative effect of cortisol on lipid synthesis leads to decreased production of lamellar bodies and corneodesmosomes which are, in turn, crucial for skin barrier recovery.

In sum, it can be stated that psychological stress can impair several health outcomes, among them the recovery of the skin barrier after damage. This knowledge raises the question how those negative effects can be prevented, which interventions are effective in stress reduction and, moreover, if these interventions can be used to support health functions. Robinson et al. (2017), for example, already found a positive influence of social closeness on skin barrier recovery after tape stripping, which was moderated by the reduction of self-reported stress. Relaxation techniques have been shown to have beneficial effects on skin barrier recovery after impairment, as well, as reported by Robinson, Jarrett, and Broadbent (2015). To tackle this issue more thoroughly, literature on the relationship between stress and music, a potentially stress reducing factor, will be revised in the following section. Additionally, the concept of musicality will be discussed. Based on those insights, the research project conducted in the context of this master's thesis will be presented.

The relationship between stress and music.

A large body of work on the effects of music on stress has indicated that music can reduce subjective and physiological indices of stress, like blood pressure (Chafin, Roy, Gerin, & Christenfeld, 2004), heart rate (Knight & Rickard, 2001), salivary cortisol (Khalfa, Bella, Roy, Peretz, & Lupien, 2003), plasma cortisol (Ventura, Gomes, & Carreira, 2012), state anxiety (Knight & Rickard, 2001; Ventura et al., 2012), or subjective stress (Lai & Li, 2011; Chang, Yu, Chen, & Chen, 2015).

In their study, Knight and Rickard (2001) let their participants give an oral presentation about a difficult topic. In the experimental condition, participants listened to relaxing music nearly for the whole procedure (from after baseline measurement until debriefing). The control

condition did not listen to music. The dependent variables in this study were systolic and diastolic blood pressure, salivary cortisol and immunoglobulin A (IgA), subjective anxiety and heart rate. A significant increase due to the stressor was found for systolic blood pressure, subjective anxiety and heart rate. Remarkably, those effects did not occur in the music condition. Hence, music was able to prevent some negative physiological and subjective effects of stress.

In a similar study, Khalfa et al. (2003) had their participants perform the TSST. Salivary cortisol levels were measured at several time points before the TSST (baseline) and afterwards (recovery). In the experimental group music was played during the recovery phase while the control group sat in silence. Khalfa et al. (2003) found a quicker decrease in salivary cortisol in those individuals who listened to music after completion of the stress task than in those who did not listen to music. More precisely, cortisol levels were still increasing in the control group at the beginning of the recovery phase but decreasing immediately in the experimental group.

Ventura et al. (2012) examined plasma cortisol levels and state anxiety values in women undergoing amniocentesis. Participants were randomly assigned to one of three groups: listening to relaxing music, sitting and reading magazines or sitting in the waiting room, each for 30 minutes before examination. Cortisol and state anxiety were measured before and after amniocentesis. The results showed the greatest decrease in both plasma cortisol and state anxiety in the music condition.

Chang et al. (2015) investigated the effects of a music intervention on several stress outcomes in pregnant women and found significantly lower levels of psychosocial stress post-intervention in the experimental group that received routine prenatal care with music than in the control group that received routine prenatal care without music. Lai and Li (2011) were interested in the effects of self-selected soothing music versus silence on stress-related outcomes (self-perceived stress, heart rate, blood pressure, finger temperature and blood cortisol) in nurses. This population was selected by the authors as they assumed nursing a highly stressful profession. Self-perceived stress was measured using a 0–10 cm visual analogue scale (VAS) and was found to be significantly lower after music than after the control condition.

Mahdipour and Nemotollahi (2012) also found a significant decrease in stress as well as anxiety and depression scores in heart surgery patients who listened to thirty minutes of music with natural sound effects like bird chirping or sea sounds. In this study, similar results were found for the group who visited an intensive care unit programme, but not for those who only received usual treatment.

Labbé, Schmidt, Babin, and Pharr (2007) examined the effects of music on stress in more detail, taking into account different types of music. When comparing four different

conditions (classical music, self-selected relaxing music, heavy metal music and silence) with regard to the effects of music on participants' emotional state after a stressful task, the researchers found that classical and self-selected relaxing music significantly enhance feelings of relaxation and reduce state anxiety. Silence only had positive effects on feelings of relaxation but did not reduce state anxiety, and heavy metal did not enhance relaxation, but even increased state anxiety. These results suggest that music can enhance relaxation and decrease state anxiety, two constructs that are both closely related to stress. Moreover, the relevance of the type of the selected music could be shown, as only slow to moderate tempo music as well as self-selected music which participants found relaxing had significant effects on relaxation and state anxiety.

Some meta-analyses investigated results of a multitude of studies about the dampening effects of music on various stress parameters. Fancourt, Ockelford, and Belai (2014) put together the results of 63 studies in total and investigated their outcomes for several parameters, including psychological, physiological and endocrinological responses. Of 25 studies that used psychological tests, 22 "achieved statistical significance and found that psychological results aligned with results from biomarkers". Similarly promising results were found for physiological markers: 16 out of 20 studies reported decreases in blood pressure, heart rate and respiratory rate. The results for cortisol level changes are convincing as well. A majority of the studies that investigated changes in cortisol levels found a reduction in cortisol levels due to music. In two studies that reported opposite results, there was still a smaller increase of cortisol in the music group than in the control group.

It must be emphasized that the stress reducing effects in most cases only occurred when relaxing, low tempo music was used. Fancourt et al. (2014) also investigated research for stimulating music but only found mixed results.

An earlier meta-analytic review by Pelletier (2004) investigated research articles that used music to decrease arousal due to stress and found a significant decrease in arousal because of music as well as music assisted relaxation techniques. The author noted that "the amount of stress reduction was significantly different when considering age, type of stress, music assisted relaxation technique, musical preference, previous music experience, and type of intervention" (p.192).

De Witte, Spruit, van Hooren, Moonen, and Stams (2019) performed a systematic review and two meta-analyses with 104 randomized controlled trials on the effects of music interventions on stress-related outcomes. Based on their analysis the authors concluded that music

interventions have the potential to decrease psychological as well as physiological stress outcomes.

In another meta-analysis, Chanda and Levitin (2013) report studies that inspected possible links between personality traits and music induced changes to stress parameters and state that "underlying personality dimensions are factors that mediate physiological stress responses to music. This is consistent with an emerging literature which suggests that individual differences in personality and cognitive traits influence psychological and physiological responses to different types of music" (p.185).

According to the presented literature, it can be summarized that relaxing, low tempo music generally shows stress reducing effects with respect to several psychological and physiological stress outcomes, and that these effects depend on various variables like type of stress, personality traits, music preference or experience with music.

A construct which is strongly related to experience with music is the concept of musicality, which will play a major role in this study and will therefore be discussed in more detail in the following section.

Musicality.

Despite the broad use of the term in everyday language as well as in literature, over two centuries of research (Gembris, 1997) on that topic still have not brought about one precise definition of musicality. The reasons for that are diverse and can be located in historical and cultural circumstances and methodological considerations.

The approaches taken to measure musicality have changed in the last 200 years. Gembris (1997) distinguishes three different phases of the investigation of musicality: the *phenomenological approach* (1800–1910/1920), the *psychometric approach* (from the 1920s until the 1990s), and the *musical meaning approach* (emerging in the 1980s). The beginning of the first phase, which aimed to "develop a global description and phenomenology of musical abilities" (p.19) can be dated back to a treatise published already in 1805 by Christian Friedrich Michaelis (Michaelis, 1805). His work seems to be the first attempt to describe musical abilities that constitute musical talent. Notably, although he took into account various activities like musical memory, enjoyment of music, accuracy of reproducing melodies or musical expressiveness in singing and performance, the two abilities he considered most important were musical discrimination skills and taste. Seemingly, back then it was reasonable and possible to claim that some kinds of taste are better than others, and to connect taste with talent - a notion which is not found to be true anymore nowadays.

90 years later, in 1895, another work on musicality has been published, namely the book *Wer ist musikalisch?* (Who is musical?) by Theodor Billroth (Billroth, 1895). He based his definition of musicality on a statement of the Viennese music critic and theorist Eduard Hanslick, who defined music as *tonally moving forms* (Gembris, 1997). Accordingly, musicality was the ability to perceive those forms.

These examples show how the definition of musicality can change over time according to the "understanding of music and musical aesthetics" (Gembris, 1997, p.19). However, they had been published before systematic research tools to test for musicality have been established, which changed with the development of psychology and its empirical scientific methods. Those new possibilities set stage for the second phase which Gembris (1997) called *psychometric approaches*. The aim of research conducted in this phase was to find an objective definition of musicality which was supposed to be unrelated to aesthetic norms, and to develop adequate psychometric musicality tests. Despite the efforts, those tests often only measured a restricted set of musical abilities and therefore lacked validity. Another problem of those tests was that they often focused more on cognitive than on emotional aspects. In *Psychology of music*, for example, Seashore (1938) proposed that musicality be assessed measuring sensory capacities. This approach was criticized by the philosopher and composer Theodor W. Adorno, who claimed that the meaning of music is not addressed with this approach (Adorno, 1940). According to Gembris (1997), this claim accounts for all psychometric definitions of musicality of that time.

The third phase deals with exactly this lack of consideration of emotions and meaning and is therefore introduced as the *musical meaning approach* which takes into account cognitive as well as emotional aspects of music. Blacking (1990), for example, claimed that *musical intelligence* was the "cognitive and affective equipment of the brain with which people make musical sense of the world" (as cited in Gembris, 1997, p.72). Gembris (1997) concludes that this understanding of musical ability seems to be the most promising approach.

In addition to those historical developments in the past two centuries, the definition of musicality is highly dependent on current cultural and societal backgrounds (Müllensiefen, Gingras, Musil, & Stewart, 2014). For example, the distinction between individuals according to their perceived musicality is not culturally universal. While in Western societies clear distinctions are made between musical and unmusical individuals due to their musical talent and expertise, "all members of an African society are able to perform and listen intelligently to their own indigenous music" (Blacking, 1973, p.4, as cited in May, 1973). Blacking concludes that "tests of musical ability are clearly relevant only to the cultures whose musical systems are

similar to that of the tester" (p.6). This line of thought should be kept in mind with regard to the presented study and considerations about generalizability of the findings.

However, in cultures that distinguish between different degrees of musical talent, this distinction needs to be built upon behaviors in which musical talent or musicality can show. This is the case for various activities, ranging from singing, playing an instrument, having expert knowledge about musical genres, composers or musicians, composing pieces, having a good sense of rhythm, or being able to easily remember melodies. In the past decades, many attempts have been made to develop an adequate measuring instrument for musicality, all facing the same problem that this term can be defined in various ways. Most of them only assess single aspects of musicality, like the *Musical Ear Test* by Wallentin, Nielsen, Friis-Olivarius, Vuust, and Vuust (2010), the *Profile of Music Perception Skills* by Law and Zentner (2012), the *Music Experience Questionnaire* by Werner, Swope, and Heide (2006), the *Music Use Questionnaire* by Chin and Rickard (2012), or the *Music Engagement Questionnaire* by Vanstone, Wolf, Poon, and Cuddy (2016). A variety of musical achievements or skills are often overlooked (Murphy, 1999) —e.g., "the abilities to verbally communicate about music at a high level, to use music effectively to manipulate one's own emotional states and those of others, and to compare music stylistically" (Müllensiefen et al., 2014, p. 2). These skills, however, are crucial for occupational groups like music producers, journalists or DJs.

In order to unite all these facets of musicality, Müllensiefen et al. (2014) of the Goldsmiths University of London introduced a new measuring instrument, the *Goldsmiths Musical Sophistication Index* (Gold-MSI), which is based on the concept of *musical sophistication*. The authors argue that they use this term instead of musical talent, ability, musicality et cetera, because they assume that it is less loaded with preconceptions and biases as it has not been used that often in previous research. They define musical sophistication as "a psychometric construct that can refer to musical skills, expertise, achievements, and related behaviours across a range of facets that are measured on different subscales" (p.2). Following their definition, individuals with high levels of musical sophistication show "a) higher frequencies of exerting musical skills or behaviours, b) greater ease, accuracy or effect of musical behaviours when executed, and c) a greater and more varied repertoire of musical behaviour patterns." The authors stress that the questionnaire was not developed to distinguish between individuals with extremely high levels in Musical Sophistication but should be applicable for the general population, which is already evident in the title of their paper "The Musicality of Non-Musicians: An Index for Assessing Musical Sophistication in the General Population".

Another aspect that can be derived directly from the title of the article is the fact that musical sophistication is used to assess musicality. Because of its extensive conceptualization and the consideration of numerous facets of musicality, this questionnaire and the concept of musical sophistication were used to assess musicality in the study presented in this master's thesis. It is assumed that musical sophistication reflects what is generally meant when we speak of musicality, which is why the choice fell on this questionnaire. In the subsequent parts of this work, the term *musicality* is used when speaking of *musical sophistication*.

As a consequence of the assumptions that experience with music influences how music acts on stress (Pelletier, 2004) and that experience with music is one aspect of musicality (Müllensiefen et al., 2014), musicality is expected to play a role in the relationship between music, stress as well as skin barrier recovery. The research questions and hypotheses that were formulated based on these assumptions will be presented in the following paragraphs.

Research Questions and Hypotheses

Proposed model.

As music has been shown to have positive, i.e., calming effects on stress, whereas stress affects skin barrier recovery negatively, it can be assumed that music has positive effects on skin barrier recovery via the reduction of stress. However, in a meta-analysis, Pelletier (2004) found that several parameters influence how music acts on stress, such as age, music preferences, or musical experience. Musicality was introduced as another concept closely related to musical experience that might mediate the effects of music on stress. In detail, it is possible that highly musical individuals respond more intensely—regarding feelings of, e.g., joy, being carried away, chills, liking, or appreciation for the compositions, the beauty of the pieces and the instruments used—to music and therefore show better stress outcomes than less musical individuals after listening to music. It must be emphasized that this assumption is speculative and solely based on theoretical considerations. The study presented in this thesis has the potential to shed light on this relationship.

If we expect that after listening to music, individuals high in musicality show better stress outcomes than less musical individuals, and taking into account that stress impacts skin barrier recovery negatively, whereas the reduction of stress has positive effects on skin barrier recovery, we can expect that music will show positive effects on skin barrier recovery most of all in highly musical individuals. Until now, research has not dealt with this issue. Thus, the proposed study will test these assumptions directly.

Research questions and hypotheses.

The aim of this master's thesis is to fill some still existing research gaps. In general, as Yehuda (2011) stated in his paper on music and stress, more research on the relationship between music and stress is necessary, especially when it comes to the effects of music on subjectively experienced stress and stress emotions. Testing for the relationship between music and subjectively experienced stress, this study aims to contribute to the generation of knowledge in this research area. Moreover, existing literature lacks studies on the relationship between music, stress and a third variable, namely skin barrier recovery. To the best of my knowledge, this research project is the first to relate these three components to each other and study their interconnection. Consequently, the concept of musicality has not been considered in the context of music, stress and skin barrier recovery, either.

The research questions arising because of lack of evidence in the cited literature are:
1.) Do individuals who listen to music after experiencing experimentally induced acute stress show a quicker recovery in subjective stress, their salivary cortisol level and a quicker skin barrier recovery than individuals who listen to an audiobook or sit in silence?
2.) Do highly musical individuals differ from less musical individuals in response to a music listening session after being experimentally stressed regarding the recovery in subjective stress, their salivary cortisol level and their skin barrier recovery?

Finding an answer to these questions is of relevance because knowledge about the relationship between music and health could be implemented in clinical settings to alleviate stress and foster wound healing. Accordingly, music could have the potential to replace tranquilising medication which is often used in medical settings although associated with many contraindications and negative side-effects (de Witte et al., 2019). Studying the effects of musicality in this context can broaden our state of knowledge about the application area and limits of musical interventions. Therefore, the second research question aims to study whether music can be a useful tool for the general population or whether most of all musical individuals can profit from musical interventions.

Based on the evidence presented above, following hypotheses are proposed:
H_{1a}: Individuals who listen to music after experiencing experimentally induced acute stress will show a quicker recovery in subjective stress than individuals who listen to an audiobook or sit in silence.
H_{1b}: Individuals who listen to music after experiencing experimentally induced acute stress will show a quicker regeneration of their salivary cortisol level than individuals who listen to an audiobook or sit in silence.

H_{1c}: Individuals who listen to music after experiencing experimentally induced acute stress will show a quicker skin barrier recovery than individuals who listen to an audiobook or sit in silence.

H_{2a}: Highly musical individuals show a quicker recovery in subjective stress in response to a musical intervention after being experimentally stressed than less musical individuals.

H_{2b}: Highly musical individuals show a quicker regeneration of their cortisol response in response to a musical intervention after being experimentally stressed than less musical individuals.

H_{2c}: Highly musical individuals show a quicker skin barrier recovery in response to a musical intervention after being experimentally stressed than less musical individuals.

In the following paragraphs, the study conducted to tackle those hypotheses will be presented.

Method

Study Design

For this master's thesis, the data collected in the pilot-testing of the research project *Stress und Musik- oder Hörbuchhören* by Univ.-Prof. Dr. Urs Markus Nater and Dr. Jasminka Majdandžić, conducted at the University of Vienna, were used. Participants of the study, which were all female, were recruited in the circle of acquaintances of the research team and screened for inclusion and exclusion criteria in a telephone interview (see appendix pp. 71–79). They were asked to fill out several questionnaires online via Unipark, amongst them the Gold-MSI which is the questionnaire that was used in this study to measure musicality. Those questionnaires had to be completed before the laboratory study, which took place at the Department of Psychology of the University of Vienna. In this experiment, a between subjects design was used for the comparison of different acoustic stimuli on subjective stress, TEWL and salivary cortisol. Participants were randomly assigned to the experimental group (music listening) or one of the control groups (audiobook listening or silence). After a baseline phase, they were experimentally stressed using the Trier Social Stress Test (TSST; Kirschbaum, Pirke, & Hellhammer, 1993). Directly afterwards, the skin barrier was damaged at a small area of the forearm of the non-dominant hand. Then, the experimental group listened to one out of five playlists for half an hour. They could choose which playlist to listen to. The control group did not listen to music but either listened to a neutral audiobook or sat in silence. Measurements of subjective stress, TEWL and cortisol were taken at several time points before and after the TSST and tape stripping (see figure 1). Between the last four measurement time points (MTP), i.e., MTP 5, 6, 7

and 8, participants could read magazines in order to avoid boredom or frustration. Due to the small sample size available by the time of analysis, single case analyses were performed with three participants to test for the hypotheses presented above.

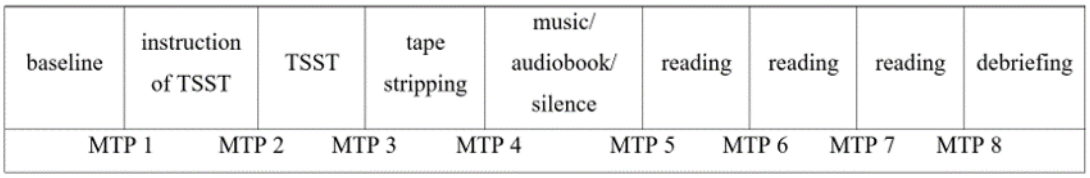

Figure 1. Course of study

Note. At measurement time point (MTP) 1–8, saliva samples were taken and subjective stress was assessed. At MTP 3–8, TEWL was measured. MTP 3 served as TEWL baseline, MTP 4 provided the TEWL value directly after skin disruption via tape stripping.

Participants

In this study, only women aged between 18 and 35 were recruited in order to control for possible gender and age-related effects. Because of a possible interplay between estrogen levels (which vary depending on the phases of the menstrual cycle) and salivary cortisol levels (Kirschbaum, Kudielka, Gaab, Schommer, & Hellhammer, 1999), participants were all tested in their follicular phase to ensure standardization. As the presented data were collected in the pilot-testing phase of the research project *Stress und Musik- oder Hörbuchhören* by Univ.-Prof. Dr. Urs Markus Nater and Dr. Jasminka Majdandžić, conducted at the University of Vienna in February and March 2020, participants were recruited only in the circle of acquaintances of the research team. It was always ensured that the participant and the testing team did not know each other in order to prevent possible social support effects, as such effects have already been shown by Heinrichs, Baumgartner, Kirschbaum, and Ehlert (2003).

All participants fulfilled the following inclusion and exclusion criteria: They were healthy, did not smoke, did not use hormonal contraception, were not over- or underweight (BMI <17 or >25), did not drink excessively, take drugs or psychoactive substances, have chronic physical or mental health problems or any kind of allergy, take medication that influences the hormonal balance, have experience with stress tests, and they had proper German language skills. Furthermore, professional musicians or those of occupational groups related to music—like music shop assistants, sound engineers or music teachers—were not included in the study.

On arrival, participants were given all the relevant information about the study and their right to stop participation at any time without giving reasons. The participant information and informed consent form can be found in the appendix on pp. 80–85. They were informed that the researcher will answer questions and give more information at the end of the study.

Participants were granted 45€ for full study participation. The research project was approved by the Ethics Committee of the University of Vienna (operation number: 00494).

Materials and Measures

Subjective stress.

As apparent from the theoretical background of this study, psychological stress has often been operationalized with measurements of state anxiety in previous stress literature. This is reasonable as state anxiety can be defined as part of the emotional response to a stressful experience (de Witte et al., 2019). Still, this study tried to tackle the feeling of subjectively felt stress more directly. Therefore, subjective stress levels were assessed using a visual analogue scale (VAS; see appendix, p. 91) for the question "Wie sehr fühlen Sie sich gestresst?" ("How stressed do you feel?"). Participants could indicate their subjective stress level on a line with the negative pole "gar nicht" ("not at all") and the positive pole "sehr stark" ("very strongly"). The VAS was exactly 100 mm long; 0 mm indicated that the participant was not feeling stressed at all, 100 mm indicated that the participant felt very stressed.

Cortisol response.

Cortisol levels were measured with saliva samples. Despite the many possibilities to assess cortisol levels, salivary cortisol was used because it displays the current physiological stress response objectively, directly and with only a small time delay. Moreover, saliva samples can be taken very easily and non-invasively.

Skin barrier recovery.

The skin barrier recovery (SBR) was operationalized with the transepidermal water loss (TEWL) after skin impairment. In this paradigm, the upper layer of the epidermis is removed using a simple tape stripping method. This procedure is painless and harmless for the participant but is still effective in impairing the skin barrier just enough to lead to a measurable increase in evaporation of water through the skin. The extent of water loss can be measured with a Tewameter (Tewameter® TM 300). Skin barrier recovery at each assessed time point x can be calculated

using the following formula:

$$\frac{\text{TEWL (after impairment) - TEWL (time point x)}}{\text{TEWL (after impairment) - TEWL (baseline)}}\ x\ 100 = \text{percentage of SBR at time point x.}$$

Tape stripping procedure and TEWL measures.

The tape stripping paradigm was conducted in order to remove the stratum corneum, which is the upper layer of the skin. The procedure followed the approach described by Robinson et al. (2017) in their paper about the influence of social closeness on skin barrier recovery after tape stripping. Four measurement sites (one control and three testing sites) of about 1 cm^2 each were used. They were located at the inner side of the forearm of the non-dominant arm in a distance of 1 cm from the arm bend and marked with a stamp. The testing sites were dry shaved with a disposable razor to ensure optimal measurement conditions. During the whole experiment, the measurement sites had to stay uncovered. Room temperature was kept constant between 22.5°C and 23.5°C, room humidity was controlled every time a measurement was conducted and never crossed the recommended range of 40–60%.

Before tape stripping started, the researchers prepared 40 strips of tape (Scotch Classic Packaging Tape), and the probe of the Tewameter was put in a probe heater set to 34°C. The TEWL-baseline measurement, taken directly after the TSST and before tape stripping, served as reference point for the subsequent procedure. Skin impairment with tape stripping should lead to a minimum change of 15 $g/h/m^2$. To achieve this change, the strips were used the following way: Tape was attached to the testing sites with light pressure and removed at a moderate tempo. The sides from which the tape was pulled off the skin were alternated with every tape strip. After the first 20 strips, TEWL was measured at the testing sites. If TEWL had already increased by 15 $g/h/m^2$, TEWL was measured at all three testing sites and used for the analysis. If TEWL had not increased sufficiently, another 10 strips were applied and the procedure was repeated. The maximum of tape strips used to remove the stratum corneum was 40. If not enough change had occurred then, the testing was continued unless TEWL had not increased by more than 5 $g/h/m^2$. In those cases, participants or individual testing sites should have been excluded. This happened twice in the presented sample.

Musicality.

In order to differentiate between highly musical and less musical individuals, the German version of the Gold-MSI was used (see appendix, pp. 86–89). The original questionnaire by Müllensiefen et al. (2014) was translated and validated by Schaal, Bauer, and Müllensiefen (2014) and consists of 39 music-related items. It also contains additional sociodemographic and

economic questions which were not used in this study because they were neither relevant for the research question nor did they provide new information, as sociodemographic data was assessed elsewhere.

In the Gold-MSI, participants are presented with 31 statements which they can respond to on a 7-point-Likert-scale, ranging from “Stimme ganz und gar nicht zu” (“do not agree at all”) to “Stimme voll und ganz zu” (“fully agree”). The other 8 items refer to active music making and listening and can be answered by choosing one numerical value (e.g., having played an instrument or singing regularly for “0 / 1 / 2 / 3 / 4-5 / 6-9 / 10 or more years”). The items can be clustered into five subscales (active engagement, perceptual abilities, musical training, singing abilities, emotions) and an additional global scale (general musical sophistication, GMS). 18 of those items load on the factor GMS. One item was not included in this study as it asked for the instrument one can play best, which did not provide information relevant for the investigated research questions. Thus, the final questionnaire used in this study consisted of 38 items in total. Sample items and reliability values for each subscale and the global scale of the German version of the Gold-MSI can be found in table 1. The correlations relevant for convergent and discriminant validity can be looked up in Müllensiefen et al. (2014), tables 3–6.

As intended by the authors of the questionnaire, only the global GMS scale was used to rate the musicality of the participants. Data norms for the global scale and each subscale—derived from the German sample—are given in the appendix on p. 90.

Participants completed the questionnaire at home via Unipark before participating in the laboratory study. Completion of the questionnaire took about 6 minutes for the 38 items.

Table 1

Sample items and reliability values for each subscale and the global scale of the German version of the Gold-MSI

Scale	Cronbach's α	sample item
Aktiver Umgang mit Musik (active engagement)	.800	Ich beschäftige mich in meiner Freizeit viel mit musikbezogenen Aktivitäten. (I spend a lot of my free time doing music related activities.)*
Wahrnehmungsfähigkeiten (perceptual abilities)	.834	Ich finde es schwierig, Fehler festzustellen, die ein Sänger macht, selbst wenn ich das Lied kenne. (I find it difficult to spot mistakes in a performance of a song even if I know the tune.)*
Musikalische Ausbildung (musical training)	.880	Ich habe regelmäßig und täglich ein Instrument (einschließlich Gesang) für __ Jahre geübt. (I engaged in regular, daily practice of a musical instrument (including voice) for ___ years.)*
Gesangsfähigkeiten (singing abilities)	.842	Ich bin in der Lage, die richtigen Töne zu treffen, wenn ich zu einer Aufnahme mitsinge. (I am able to hit the right notes when I sing along with a recording.)*
Emotionen (emotions)	.719	Ich suche häufig eine bestimmte Musik aus, um mich zu motivieren oder zu begeistern. (I often pick certain music to motivate or excite me.)*
Allgemeine musikalische Erfahrenheit (general musical sophistication)	.908	Ich würde mich selbst nicht als Musiker/-in bezeichnen. (I would not consider myself a musician.)*

Note. * = Translations are taken from the original English version of the Gold-MSI.

The TSST.

The TSST is a stress test developed by Kirschbaum, Pirke, and Hellhammer (1993) "as a standardized protocol for the induction of moderate psychosocial stress in laboratory settings" (Kudielka, Hellhammer, & Kirschbaum, 2007, p.56) with the aim of being able to conduct research about psychobiological stress responses in a controlled setting. During its development, the TSST has been found to elevate cortisol concentrations (serum and saliva), ACTH (adrenocorticotropic hormone), growth hormone and heart rate (Kirschbaum et al., 1993). Since its publication in 1993, "the TSST has proven a useful tool in the fields of basic, applied and clinical psychobiological research with a wide range of psychobiological outcome variables" (p.74).

The standard procedure of the TSST is as follows: After an initial baseline phase, participants are brought to the testing room where the committee, dressed in white coats, is already awaiting them sitting at a table. The committee consists of a male so-called active and a female so-called passive stressor. Additionally, a camera and a microphone are set up. In the testing room the investigator introduces the participants to the TSST. They are informed that they will have to participate in a mock job interview in the first part and solve a mathematical task in the second part of the test. In the instructions for the job interview, participants are informed that they will have to apply for a job of their choice. They should imagine that the committee already has all the necessary information about their curriculum vitae and school reports, so they shall only talk about their personality traits.

After a preparation phase of three minutes, the job interview takes place for five minutes. First, participants hold the speech they prepared. When they have finished, the committee is instructed to wait up to 20 seconds before they ask further questions in order to generate an awkward silence which should make the participant feel uncomfortable and nervous. In the second part, participants are instructed to count backwards in steps of 17, starting with the number 2043. When they make a mistake, they have to start again with 2043.

During the whole procedure, the committee is instructed to maintain a neutral facial expression, not to be too friendly and not to give the participant any positive encouragement. Only the active stressor (who was always male in the presented study) may talk to the participant, and both the active and the passive stressor (who was always female) should take notes on a fake-protocol sheet. During the mental arithmetic test, they should remind the participant to calculate faster, speak up, and look into the camera.

Music playlists.

After the tape stripping procedure, participants listened to 30 minutes of music or an audiobook or sat in silence. In the following section, the choice for the approach used in the study will be discussed and music and audiobook selection procedures will be described in detail.

Researchers that use music interventions in their studies basically have three main possibilities for music selection: The pieces or melodies can either be researcher-selected, self-selected, or a compromise between these two options, where participants have the choice between various researcher-selected pieces or playlists. Researcher-selected music has the advantage of controllability of, e.g., style or tempo of the pieces, whereas self-selected music matches the participant's taste and preferences better. While some studies found better stress reducing effects for self-selected music (e.g., Jiang, Rickson, & Jiang, 2016; Jiang, Zhou, Rickson, & Jiang, 2013; Juslin, Liljeström, Västfjäll, Barradas, & Silva, 2008), a recently published meta-analysis (de Witte et al, 2019) could not confirm these findings, but reports that "the way the music was selected did not influence the effect of music interventions on stress-related outcomes" (p.15).

In this study, the third option was chosen: The researchers created six playlists with music pieces of different styles which they found relaxing. Additionally, the pieces had to be nonlyrical and the tempo should not exceed 80 beats per minute (de Witte et al., 2019). This procedure allowed the researchers to prepare playlists that could be tested for their calming and mood-regulating effects in a pre-study and thus provided controllability, while at the same time giving the participant freedom of choice for their favourite genre. Music preference has already been found to be an important moderator for the effectiveness of stress reduction in previous studies. Tan, Yowler, Super, and Fratianne (2012), for example, found a strong correlation between music preference and the perception of relaxation in music. In an older study, Stratton and Zalanowski (1984) also found that "the most important factor in relaxation was the degree of liking for the music" (p.1). Therefore, it seemed necessary to give participants the opportunity to choose their favourite music style in order to enable relaxation.

Based on these arguments, the research team decided to create six playlists of various genres between which participants could choose. The six genres included in the pre-study where: Guitar, Classical, Lo-Fi, Ambient, Jazz and Lounge. Criteria for the audiobooks were a length of 30 minutes and a non-arousing topic. The audiobooks which were chosen and used as one of two control conditions treated certain topics from the fields of biology, history, cosmology, philosophy and physics. Each playlist as well as the audiobooks lasted 30 minutes.

In order to investigate the effects of the playlists and the audiobook, a pre-study was conducted. 70 female participants were randomly assigned to one of the seven conditions (six playlists, one audiobook on history) and asked to fill out one questionnaire before and one after the listening session. The questionnaires contained 30 (pre-questionnaire) and 56 items (post-questionnaire). The 30 items of the pre-questionnaire were asked repeatedly (before and after the listening session), the additional 26 items directly referred to the music or audiobook.

The results indicated that all music playlists lead to a significant increase in relaxed positive affect, which was measured with *The Types of Positive Affect Scale* (TTPAS) and is strongly negatively correlated with subjective stress (Gilbert et al., 2008). The audiobook did not lead to a significant increase in relaxed positive affect. However, further analysis of the data revealed mixed, ambiguous results for the classical playlist. Therefore, this playlist was excluded from the main study.

Previous research on the effects of music on stress has used different approaches concerning the time point of application of the music intervention. Participants in the respective studies either listened to music nearly during the whole procedure (e.g., Knight & Rickard, 2001), after the stressor (e.g., Khalfa et al., 2003), or before the stressful event (e.g., Ventura et al., 2012). A study which used a very similar approach to that used in the research project presented in this master's thesis is the one conducted by Thoma et al. (2013). In this study, participants also went through the TSST protocol, but in contrast to our study, they listened to either music, rippling water or sat in silence prior to the stressor. Several stress outcomes were measured repeatedly, among them salivary cortisol and subjective stress (measured with a VAS). Unexpectedly, cortisol values were highest in the music group and lowest in the group that listened to rippling water. Subjective stress measures did not differ significantly between the three conditions. Perhaps the time point for application of the music intervention is a crucial factor, and listening to music *after* the TSST, as was done in our study, yields different results than listening to music before the stressor.

Procedure

The study took place at the Faculty of Psychology at the University of Vienna in February and March 2020. Due to the diurnal cycle of cortisol with a peak in the morning, appointments were always made in the afternoon, starting at 1 PM and ending at about 5 PM. On enrolment, participants were randomly assigned to the experimental group (music) or one of the control groups (audiobook or silence). Upon arrival, information was given and the informed consent (see appendix on pp. 80–85) was signed. After that, the skin areas that were

used for tape stripping and TEWL measurement, located on the volar forearm of the non-dominant arm, were marked with a stamp. Then, music playlist or audiobook selections were made. Participants of the music and audiobook group could choose which playlist or audiobook to listen to, respectively. The music group could choose between playlists of five different genres (Guitar, Lo-Fi, Ambient, Jazz and Lounge) that were selected by the researchers and found to be relaxing in a pre-study, as already described above. In detail, participants could listen to a few seconds of each playlist but did not receive explicit information about the genre. They based their preference solely on what they had heard. The control group that listened to a non-arousing audiobook had the choice between five different topics (biology, history, cosmology, philosophy or physics).

After a baseline phase of 30 minutes in which participants could read magazines, the first saliva sample was taken and TEWL and subjective stress levels were assessed for the first time. Afterwards, acute psychological stress was experimentally induced using the TSST. In this paradigm, participants must complete a mock job interview and a mental arithmetic test in front of a panel consisting of two researchers who are instructed to maintain neutral facial expressions.

After the TSST, the tape stripping procedure was conducted, followed by a session of 30 minutes of music listening in the experimental group and listening to an audiobook or sitting in silence in the control group. Music and audiobook were applied using wireless Sennheiser headphones (Sennheiser HDR 160). Participants of the silence condition wore the same headphones while sitting in silence for reasons of standardization and to eliminate possible interfering noise as good as possible. After the listening/ silence session, participants stayed in the lab for another 90 minutes for further measurements. During this time, participants in both groups were allowed to read magazines in order to avoid boredom or frustration. The dependent variables subjective stress, cortisol concentration and TEWL were measured at several time points before and after the TSST, after tape stripping, and during the music/ audiobook/ silence and reading phases (figure 1). In total, participants were present in the lab for up to four hours.

Analysis

The VAS for subjective stress was evaluated measuring the distance from zero to the mark set by the participant with a ruler. Unfortunately, the analysis of salivary cortisol was still pending at the time of analysis of the study results, which is why salivary cortisol measurements could not be included in the analysis. This represents a big limitation of this study which will be discussed in the limitations section of this master's thesis. TEWL measures were calculated

as follows: The TEWL value for one measurement time point was calculated using the average of the values of the three testing sites. Following the recommendations described in the manual of the Tewameter (Tewameter® TM 300), individual measurement sites were excluded if they were not within a range of 10 g/h/m². In detail, the two measurement sites closest to each other were included in the analysis. Skin barrier recovery was calculated with the formula presented above.

For the descriptive analysis of the key variables, the statistics programme IBM SPSS Statistics, version 24, was used. For musicality, the Shapiro-Wilk test was performed to test for a normal distribution in the studied sample. The Levene test for equality of variances was calculated for the two conditions that were finally used in the analysis (silence and music) to check the requirements for the t-test for differences in mean values which was performed for the two conditions. A repeated measures ANOVA (rmANOVA) was performed with the eight measurement time points (MTP) of subjective stress (VAS) as within-subjects factor *time* to assess the effectiveness of the TSST in the induction of subjectively felt stress. The Shapiro-Wilk test was used to check the requirement of a normal distribution at each level of the within-subjects factor for the rmANOVA. TEWL and SBR were analysed descriptively.

To test the proposed hypotheses, single case analyses were performed. This approach was chosen as only a very limited number of participants had already taken part in the study at the time of analysis, which rendered powerful statistical analyses impossible. The participants for the single case analyses were selected based on study condition (one participant of the music condition and one participant of the silence condition) for the hypotheses 1a and 1c. Additionally, these participants should have a similar, moderate score in the GMS scale of the Gold-MSI. For hypotheses 2a and 2c, two cases of the music condition were selected, one scoring high in the Gold-MSI and one scoring low.

Results

Recruitment

Figure 2 shows the course of recruitment. As this study used the pilot-testing data of participants who were recruited in the circle of acquaintances of the research team, the full number of private contacts is unknown. In the process of private contact, the research team already excluded those of the possible participants who did not fulfil the main inclusion criteria. Only those were invited to participate in the study who were female, between 18 and 35 years old and did not take hormonal contraception. Those who fulfilled the criteria and were interested to participate in the study where invited to complete the telephone screening. Participants

could choose whether they wanted to complete the screening with their acquaintance or with another team member who they did not know. In total, 22 people took part in the telephone screening. Ten had to be excluded, most of the time because of allergies or psychological or health problems which often included long-term medication.

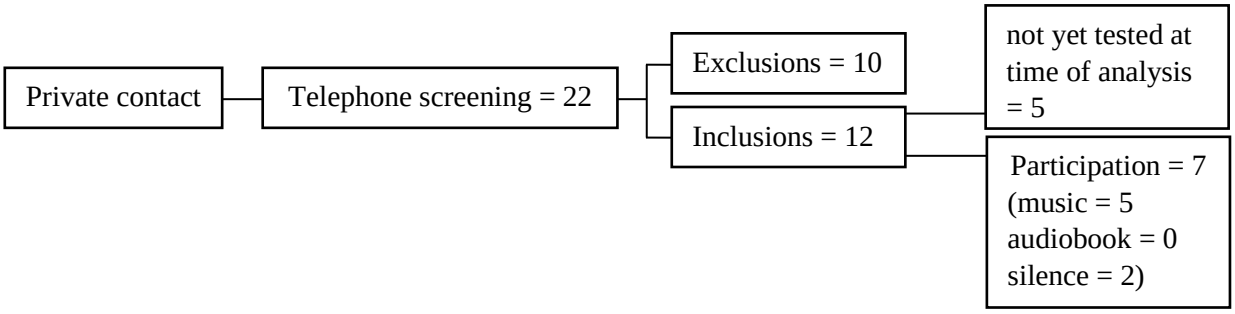

Figure 2. Course of recruitment

Of the 12 inclusions, seven had already completed the study at the time of analysis. Five were tested at a later date and therefore not included in this master's thesis. Data of two participants had to be excluded from the analysis because the TEWL values did not fulfil the criteria—i.e., either the values of the three measurement sites were not within a range of 10 g/h/m², or tape stripping did not lead to a sufficient increase of 5 g/h/m².

Sample Description

The final sample consisted of $N = 5$ women. Mean age was 28.2 ($SD = 4.55$). All participants were of high educational levels, with all of them indicating to have the *Abitur/Matura*. All of them attended University or had in the past. Three participants were employed, one full-time, two at least half a day. Two participants indicated not to have a job as they were still in training.

Description of Key Variables

Musicality.

In the global scale (general musical sophistication, GMS) of the Gold-MSI, the sample scored medium to high in musicality ($M = 79.80$, $SD = 12.19$, $Min = 66$, $Max = 97$). For data norms of the Gold-MSI, see appendix p. 90. There was no participant who scored very low (i.e., $\leq 25^{th}$ percentile) in the Gold-MSI. Two participants scored very high ($\geq 75^{th}$ percentile). As

there are no recommendations in the publications on the Gold-MSI regarding cutoff scores for high and low musicality and after correspondence with one of the authors of the German version of the Gold-MSI (N. K. Schaal, personal communication, March 4, 2020), the 25th and 75th percentile were set as cutoff scores for low and high musicality in this sample.

Skewness was positive and relatively low (|skewness| = 0.581, *SE* = 0.913), which indicates a slightly right-skewed distribution. Kurtosis in this sample was negative and low as well (|kurtosis| = -0.756, *SE* = 2.0), which indicates that the scores of the sample were concentrated near the mean and not many extreme values appeared. The Shapiro-Wilk test for normality points to a normal distribution in the studied sample (*W* = .720).

The Levene test for equality of variances between the two conditions (silence and music) was not significant. The t-test for differences in mean values revealed no significant differences in musicality between the two conditions silence and music (*p* = .150). However, it must be emphasized that due to the very small sample size, these results must be interpreted carefully and rather descriptively.

Subjective stress.

Figure 3 shows the course of subjective stress, measured with a VAS, averaged over the five participants.

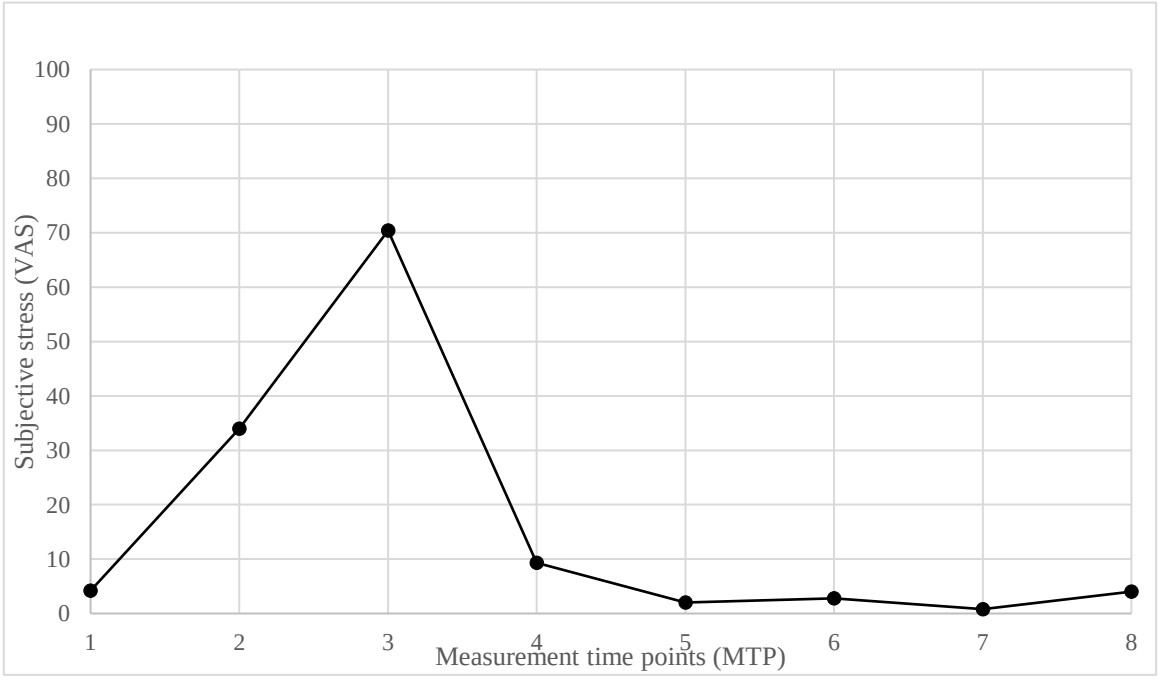

Figure 3. Course of subjective stress levels (VAS), averaged over the study sample

To calculate whether the TSST was effective in inducing stress, an rmANOVA was performed, with *time* as within-subjects factor. Again, it has to be emphasized that the small sample size only permits restricted interpretation of these results.

The assumption of a normal distribution of each level of the within-subjects factor *time* was tested with the Shapiro-Wilk test and given only at MTP 2 and 3 (MTP 1: $p = .001$, MTP 2: $p = .064$, MTP 3: $p = .648$, MTP 4: $p = .001$, MTP 5: $p = .005$, MTP 6: $p = .010$, MTP 7: $p = .021$, MTP 8: $p = .010$), which represent the measurements after instruction of the TSST (MTP 2) and after performance of the TSST (MTP 3).

In the rmANOVA, the within-subjects factor *time* was highly significant ($F(21063.694, 2.011) = 19.154$, $p = .001$).

Transepidermal water loss and skin barrier recovery.

Figure 4 shows the course of TEWL and corresponding SBR, averaged over the five participants.

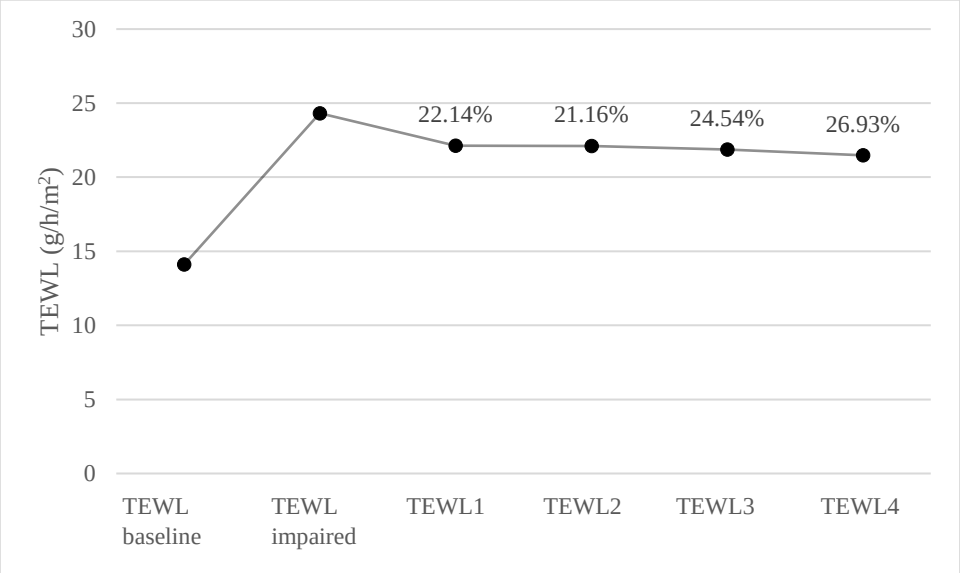

Figure 4. Course of TEWL and SBR, averaged over the sample

In the cases of two participants, one measurement site had to be excluded because the three testing sites were not within a range of 10 g/h/m². Thus, the two sites closest to each other were averaged and used for the analysis.

In nearly all cases, a sufficient increase in TEWL of at least 5 g/h/m² was reached. Only in one case, one of the three measurement sites had to be excluded from the analysis because at this site, the increase in TEWL was only 3.5 g/h/m². The other two sites of this case had an increase of 8.2 g/h/m² and 5.6 g/h/m² and were thus averaged and used in the analysis.

In four cases, the maximum of 40 tape strips was used to achieve this change. Only in one case, 30 tape strips were enough. There was no case in which the desired TEWL-increase of 15 g/h/m² was achieved; only one case came close to this value, with 14.7 g/h/m² difference between MTP 3 and 4. The mean difference between MTP 3 (baseline TEWL) and MTP 4 (TEWL after tape stripping) was 10.21 g/h/m². After skin impairment, one person showed no decrease in TEWL but even an increase at MTP 6, 7 and 8 compared to TEWL after tape stripping (MTP 4).

Table 2 gives an overview over subjective stress levels (VAS), TEWL and SBR, averaged over the five participants.

Table 2

Subjective stress (VAS), TEWL and SBR, averaged over the five participants

Measurement time point (MTP)	VAS	TEWL ($g/h/m^2$)	SBR
MTP 1	4,2		
MTP 2	34		
MTP 3 (TEWL baseline)	70.4	14.11	
MTP 4 (TEWL impaired)	9.3	24.32	
MTP 5	2	22.12	22.14%
MTP 6	2.8	22.11	21.16%
MTP 7	0.8	21.87	24.54%
MTP 8	4	21.47	26.93%

Note. Subjective stress was measured with a VAS at all 8 MTP. TEWL was measured at MTP 3–8. MTP 3 displays the baseline TEWL value. MTP 4 displays TEWL directly after tape stripping. MTP 5–8 display subsequent TEWL values. Percentages of skin barrier recovery (SBR) are given for MTP 5–8.

Hypothesis Testing: Hypotheses 1a and 1c

Choice of single cases.

To test H_{1a}, H_{1b} and H_{1c}, two single cases where studied in detail. The selection criteria were study condition, full completion of the study, and comparable sum scores in musical sophistication, measured with the Gold-MSI. Hence, one participant who listened to music after the TSST and one participant who sat in silence were chosen. The choice fell on the silence

condition as control in order to be able to rule out the possibility that listening to an acoustic stimulus per se impacts subsequent stress and TEWL values. Because the saliva samples taken in the study have not yet been analysed at time of data analysis for this master's thesis, neither H_{1b} nor H_{2b} could be addressed. Therefore, only H_{1a}, H_{1c}, H_{2a} and H_{2c} will be discussed in the following sections. The names of all participants have been changed in order to ensure anonymization.

Case A: Laura.

Laura is a 32-year-old healthy University student. She indicated not to work as she was still in training. In the Gold-MSI she reached 75 out of 18–126 possible points. Table 8 shows the values per subscale and in the global scale of the Gold-MSI. The corresponding data norms are given in parenthesis. Laura was randomly assigned to the silence condition. Hence, between MTP 4 and 5, Laura was sitting in silence for half an hour.

Figure 5 depicts the course of her subjective stress level. Figure 6 depicts the observed course of TEWL. Table 3 shows the corresponding values for each MTP. Forty tape strips were used to reach the necessary increase in TEWL. One TEWL measurement site had to be excluded because TEWL was not within a range of 10 g/h/m² after tape stripping. Her baseline TEWL value was 10.80 g/h/m², which—according to the manual of the Tewameter (Tewameter® TM 300)—indicates a healthy skin condition.

Table 3

VAS and TEWL values of case A (Laura) at each MTP

Measurement time point (MTP)	VAS	TEWL ($g/h/m^2$)	SBR
MTP 1	1		
MTP 2	21		
MTP 3 (TEWL baseline)	39	10.80	
MTP 4 (TEWL impaired)	2	25.50	
MTP 5	1	21.70	25.85%
MTP 6	1	21.15	29.59%
MTP 7	1	21.60	26.53%
MTP 8	1	20.80	31.97%

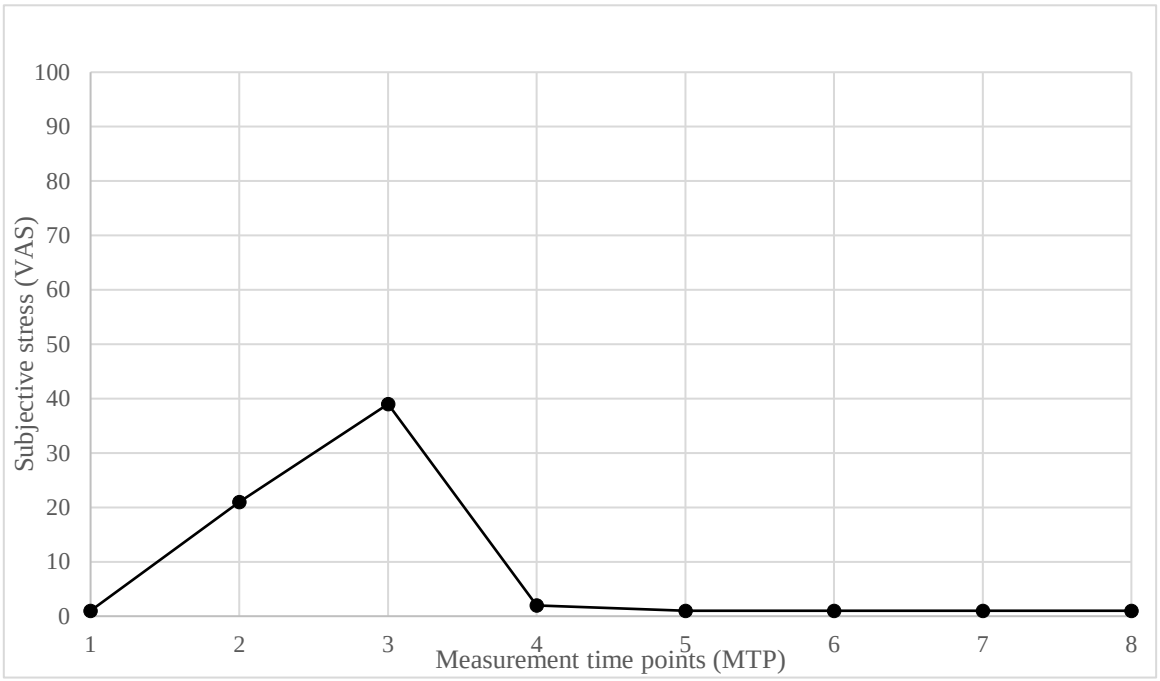

Figure 5. Course of the subjective stress level (VAS) of Case A (Laura)

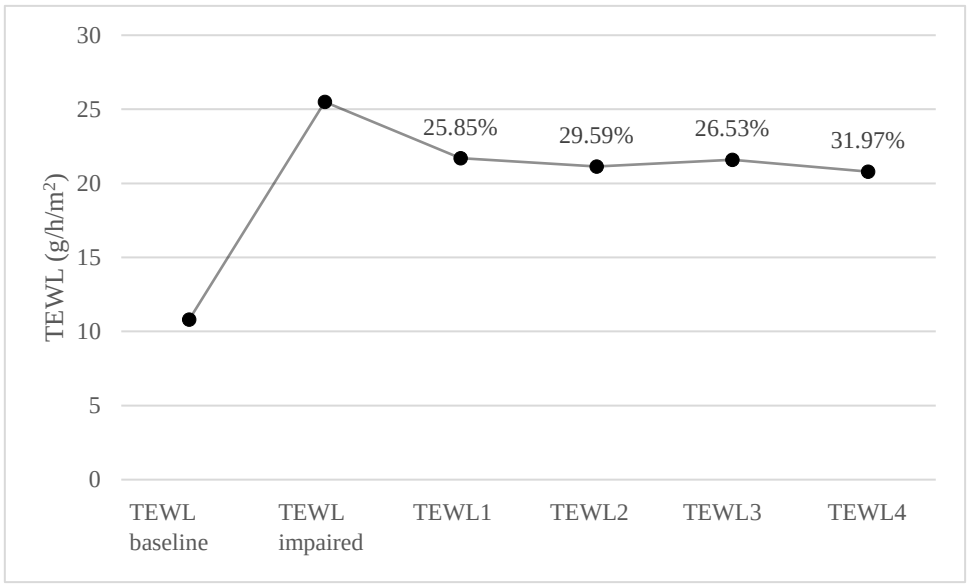

Figure 6. Course of TEWL and percentages of SBR of Case A (Laura)

Case B: Elisa.

Elisa, a 29-year-old healthy woman, indicated that her highest educational level was University education and that she works full-time. She scored 74 points in the Gold-MSI (see table 8 for detailed scores and data norms). Elisa was randomly assigned to the music condition. She decided to listen to the Jazz playlist in the music listening phase (between MTP 4 and 5). The courses of subjective stress and TEWL, including percentage rates for SBR, can be seen in figure 7 and 8. VAS, TEWL and SBR values of case B are displayed in table 4. The maximum of 40 tape strips was used to increase TEWL sufficiently. Elisa's baseline TEWL value was 16.33 g/h/m², which indicates a normal skin condition.

Table 4

VAS and TEWL values of case B (Elisa) at each MTP

Measurement time point (MTP)	VAS	TEWL ($g/h/m^2$)	SBR
MTP 1	1		
MTP 2	22		
MTP 3 (TEWL baseline)	50	16.33	
MTP 4 (TEWL impaired)	0	25.03	
MTP 5	0	23.83	13.79%
MTP 6	0	23.17	21.46%
MTP 7	0	22.37	30.65%
MTP 8	15	22.80	25.67%

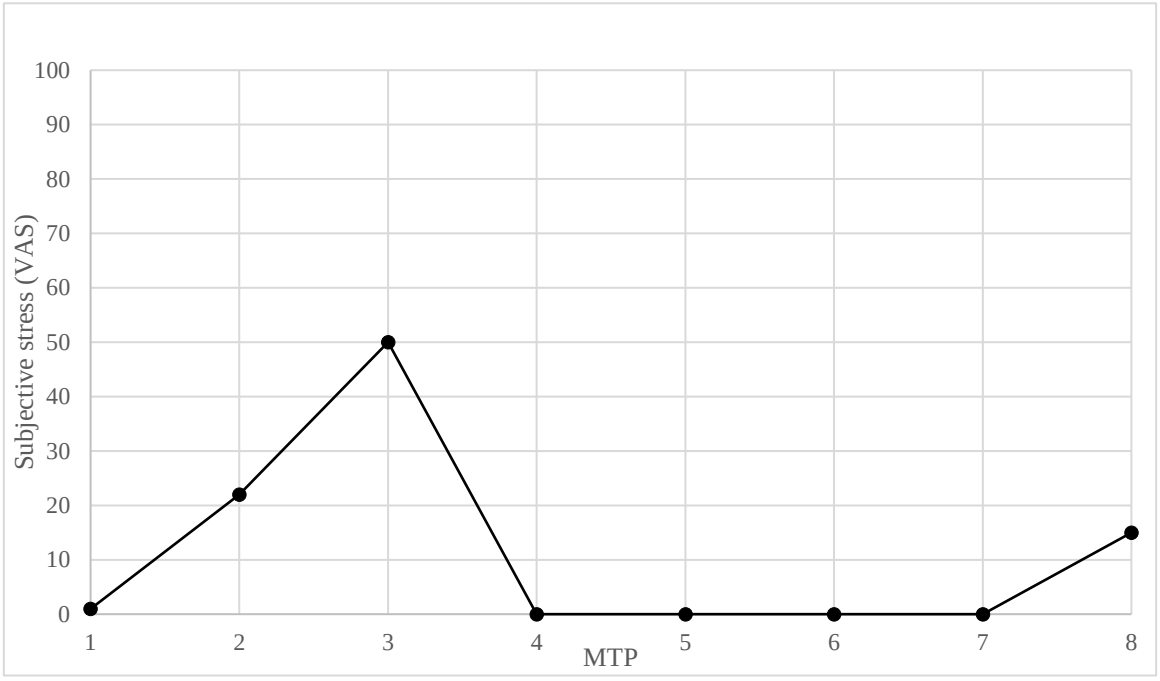

Figure 7. Course of the subjective stress level (VAS) of Case B (Elisa)

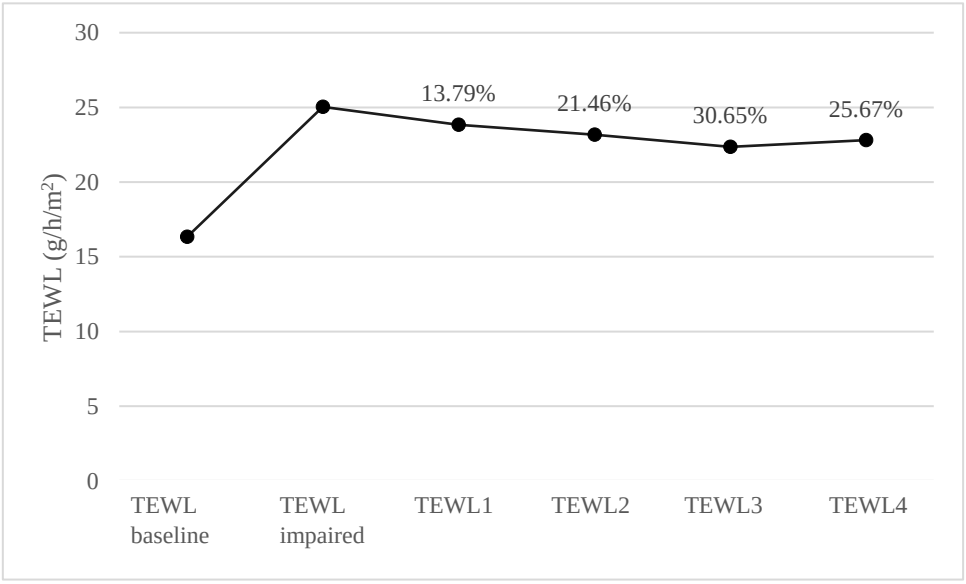

Figure 8. Course of TEWL and percentages of SBR of Case B (Elisa)

Comparison of Case A (silence) and Case B (music).

To tackle the research question whether individuals who listen to music after experiencing experimentally induced acute stress show a quicker recovery in subjective stress and a quicker skin barrier recovery than individuals who sit in silence, these two cases—Case A, Laura, who sat in silence, and Case B, Elisa, who listened to music—must be compared.

Figure 9 and 10 display the courses of subjective stress and SBR of Case A (Laura; silence) and B (Elisa; music). In table 5, TEWL values and SBR are summarized.

Table 5

TEWL values and percentage of SBR of Case A (Laura; silence) and B (Elisa; music)

	Case A (Laura)		Case B (Elisa)	
MTP	TEWL ($g/h/m^2$)	SBR	TEWL ($g/h/m^2$)	SBR
MTP 3 (TEWL baseline)	10.80		16.33	
MTP 4 (TEWL impaired)	25.50		25.03	
MTP 5	21.70	25.85%	23.83	13.79%
MTP 6	21.15	29.59%	23.17	21.46%
MTP 7	21.60	26.53%	22.37	30.65%
MTP 8	20.80	31.97%	22.80	25.67%

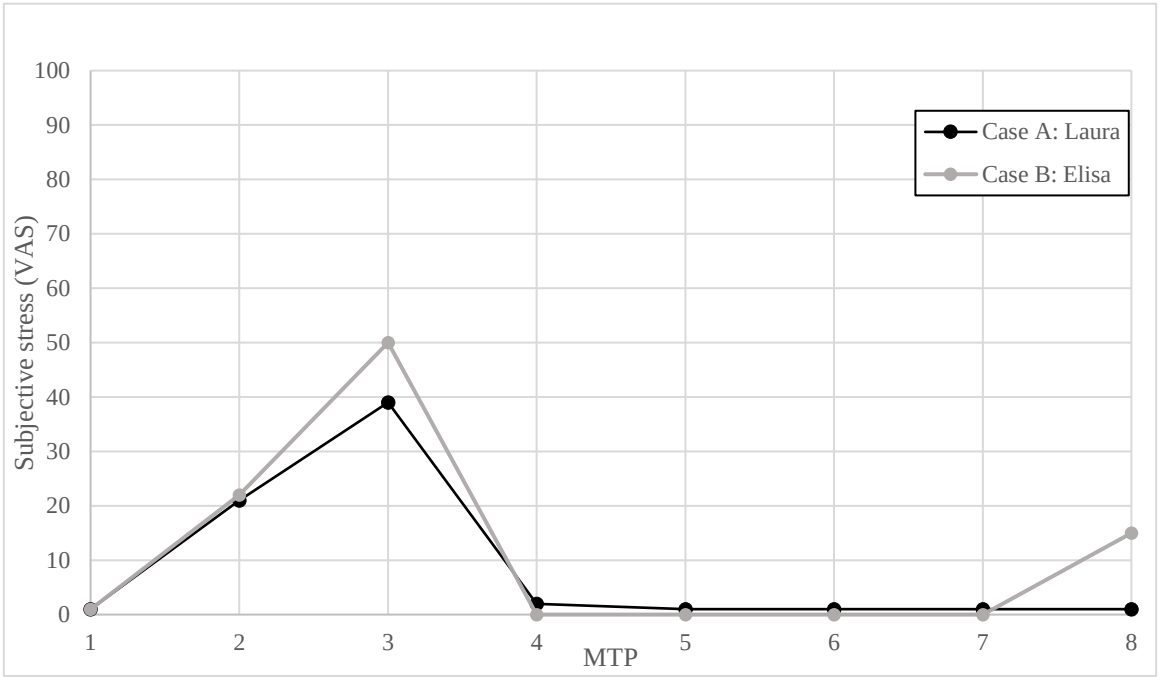

Figure 9. Courses of the subjective stress levels (VAS) of Cases A (silence) and B (music)

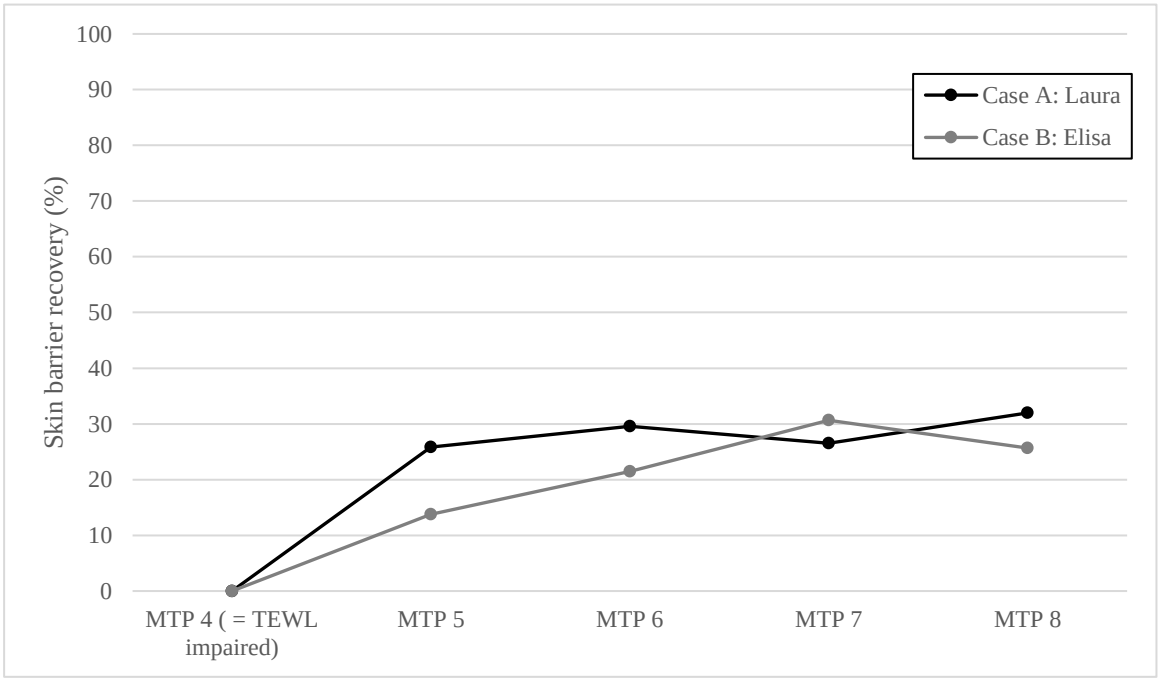

Figure 10. Courses of SBR of Cases A (silence) and B (music)

Hypothesis Testing: Hypotheses 2a and 2c

Choice of single cases.

To test the hypotheses 2a and 2c, a similar procedure was used as for the hypotheses 1a and 1c. Two cases that had completed the study entirely were chosen based on their study condition and their total score in the Gold-MSI. This time, both participants had to be in the music condition, and they had to differ regarding their Gold-MSI score. To test for H_{2a} and H_{2c}, one participant scoring very high and one participant scoring very low had to be analysed. Therefore, the originally planned procedure would have been to analyse those two participants of the studied sample who had scored highest and lowest in the Gold-MSI, respectively. Unfortunately, the person scoring lowest had to be excluded from the analysis because of faulty TEWL values, as described above. Therefore, the data of Case B (Elisa) were used for H_{2a} and H_{2c} as well, as she was the participant who scored second lowest of those in the music condition.

Case C: Anna.

Case C, Anna, was 21 years old and healthy at the time of testing. The student indicated to be unemployed at the moment. Anna was the participant who scored highest in the Gold-MSI, with 97 out of a possible total of 126 points. Detailed scores per subscale and data norms for the Gold-MSI are given in table 8. She was randomly assigned to the music condition and chose the Lo-Fi playlist. The course of subjective stress and TEWL are depicted in figures 11 and 12, respectively. Her VAS, TEWL and SBR values are given in table 6.

Forty tape strips were used to increase TEWL. In Anna's case, one TEWL measurement site had to be excluded from the analysis because no sufficient change in TEWL was reached. The difference between MTP 3 (TEWL baseline) and 4 (after tape stripping) was only 3.5 g/h/m². The other two sites of this case could be used as an increase of 8.2 g/h/m² and 5.6 g/h/m² was observed. Anna's baseline TEWL value was 12.95 g/h/m², which indicates a healthy skin condition.

Table 6

VAS and TEWL values of case C (Anna) at each MTP

Measurement time point (MTP)	VAS	TEWL ($g/h/m^2$)	SBR
MTP 1	0		
MTP 2	44		
MTP 3 (TEWL baseline)	74	12.95	
MTP 4 (TEWL impaired)	0	20.05	
MTP 5	0	16.60	48.59%
MTP 6	0	17.55	35.21%
MTP 7	0	16.95	43.66%
MTP 8	0	17.45	36.62%

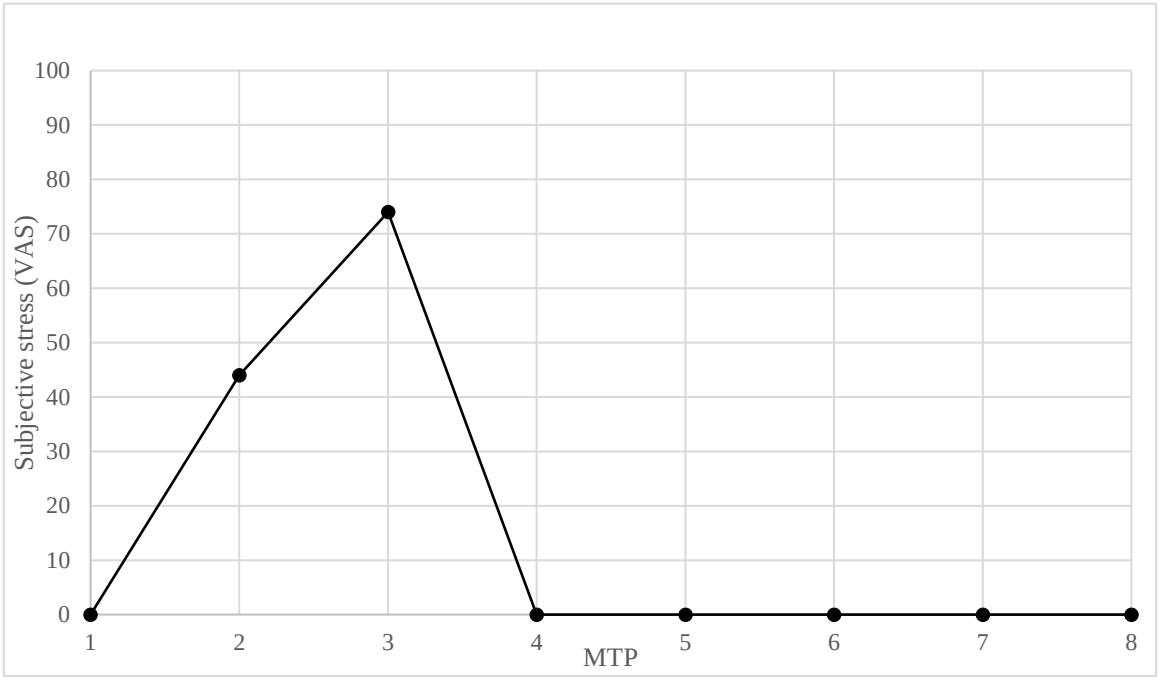

Figure 11. Course of the subjective stress level (VAS) of Case C (Anna)

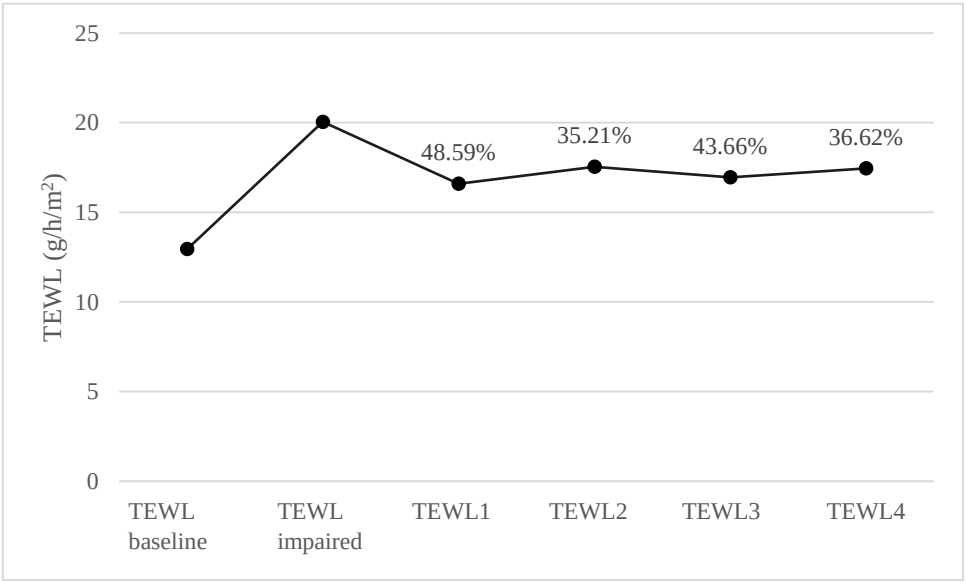

Figure 12. Course of TEWL and percentages of SBR of Case C (Anna)

Comparison of Case B (moderate in GMS) and Case C (high in GMS).

Figure 13 and 14 display the courses of subjective stress levels and SBR of Case B (Elisa; moderate in GMS) and Case C (Anna; high in GMS). In table 7, TEWL values and SBR are summarized.

Table 7

TEWL values and percentage of SBR of Case B (Elisa; moderate in GMS) and C (Anna; high in GMS)

	Case B (Elisa)		Case C (Anna)	
MTP	TEWL ($g/h/m^2$)	SBR	TEWL ($g/h/m^2$)	SBR
MTP 3 (TEWL baseline)	16.33		12.95	
MTP 4 (TEWL impaired)	25.03		20.05	
MTP 5	23.83	13.79%	16.60	48.59%
MTP 6	23.17	21.46%	17.55	35.21%
MTP 7	22.37	30.65%	16.95	43.66%
MTP 8	22.80	25.67%	17.45	36.62%

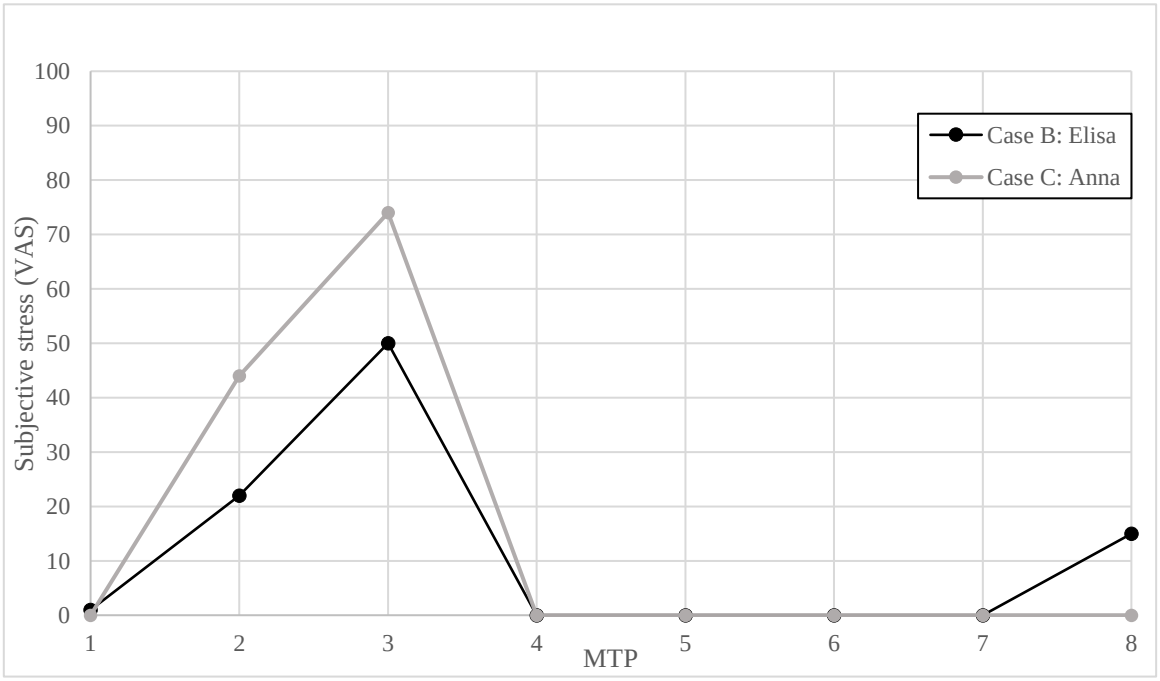

Figure 13. Courses of the subjective stress levels (VAS) of Cases B (moderate in GMS) and C (high in GMS)

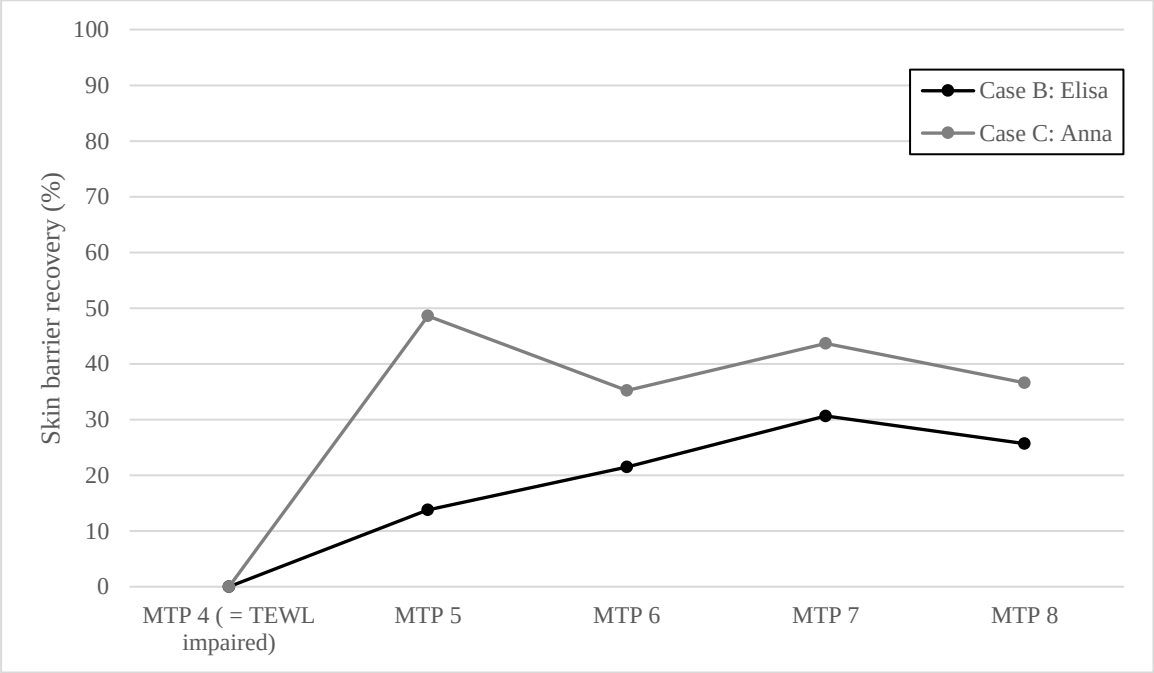

Figure 14. Courses of SBR of Cases B (moderate in GMS) and C (high in GMS)

Table 8

Scores and data norms for each subscale and the global scale of the Gold-MSI

	Subscales of the Gold-MSI					
Case	AE	PA	MT	SA	EM	GMS
A (Laura)	31 (40–45%)	51 (70–75%)	16 (30–35%)	33 (70%)	37 (90%)	75 (55–60%)
B (Elisa)	23 (15–20%)	44 (40%)	28 (65%)	31 (65%)	30 (40%)	74 (55%)
C (Anna)	42 (80–85%)	56 (85–90%)	28 (65%)	45 (95–100%)	37 (90%)	97 (90%)

Note. AE = Active Engagement, PA = Perceptual Abilities, MT = Musical Training, SA = Singing Abilities, EM = Emotions, GMS = General Musical Sophistication. The values in parenthesis represent the data norms for the respective score reached by the participant.

Discussion

Discussion of the Key Variables of the Overall Sample.

As reported, the sample appeared to be medium to high in musicality (*M* = 79.80, *SD* = 12.19, *Min* = 66, *Max* = 97). Because there was no person who scored very low in musicality, analysis of the hypotheses 2a and 2c was only possible to a limited extent, which represents a big limitation of this study.

Graphical analysis of the course of subjective stress as well as the significant result for the factor *time* in the rmANOVA (F(21063.694, 2.011) = 19.154, *p* = .001) reveal that the TSST was effective in the induction of subjective stress. This was expected as the TSST has already proven an effective stress inducing tool in prior research (Kirschbaum et al., 1993). The Shapiro-Wilk test for normality was not significant at MTP 2 and 3, which means that at those MTP, the values of the VAS for subjective stress were normally distributed, while at MTP 1 and 4–8 they were not. This also supports the assumption that the TSST lead to changes in subjective stress. In detail, participants appeared equally stressed (with values below 5) at MTP 1 and 4–8, while at MTP 2 (after instruction of the TSST) and 3 (after the TSST), instruction and performance of the TSST had an impact on subjective stress and lead to normally distributed values. However, at MTP 2 and 3 the values differed strongly between the participants, with a range of 21–62 in the VAS at MTP 2 and 39–99 at MTP 3. Only speculations can be made about the reasons for this. One reason might be that the VAS is not an objective measure of stress, but participants indicate their subjectively felt stress level on their own. This implicates that each participant has their own reference point for what is extreme high and extreme low stress. This will also be discussed in the limitations section of this master' thesis. Another simple explanation could be that the participants really differed that extremely in their stress response to the TSST.

On average, the sample had healthy skin, as indicated by a mean TEWL baseline value of 14.11 g/h/m². In nearly all cases—with one exception in which one individual testing site had to be excluded—tape stripping lead to an increase in TEWL by at least 5 g/h/m² (*M* = 10.21 g/h/m²). However, the recommended increase of 15 g/h/m² was never reached, which might also restrict interpretability of the results. On average, TEWL decreased over time in the studied sample. The abnormalities observed regarding TEWL measurement will be discussed in the limitations section of this thesis.

The differences in individual SBR values between participants of different conditions or GMS scores will be discussed in the following sections.

Discussion of Hypotheses 1a and 1c: Case A and B

To answer the research question whether individuals who listen to music after experiencing experimentally induced acute stress show a quicker recovery in subjective stress, their salivary cortisol level and a quicker skin barrier recovery than individuals who listen to an audiobook or sit in silence, two cases where selected for evaluation in a single case analysis. One of these cases had to be a participant of the music condition. For the other case, a person of the silence (and not the audiobook) condition was chosen in order to rule out possible effects that originate from listening to an acoustic stimulus, which might have appeared in the audiobook condition. Additionally, those two cases had to be similarly musical, with comparable scores in the GMS scale of the Gold-MSI. The two cases chosen for this purpose were Laura (A, silence) and Elisa (B, music). As already mentioned, cortisol values could not be included in the analysis.

At MTP 1, both Laura and Elisa indicated a subjective stress level of 1, which can be interpreted as that both were not stressed after the 30-minutes baseline phase. After instruction of the TSST, subjective stress rose similarly in both participants, with a value of 21 in Case A (Laura; silence) and 22 in Case B (Elisa; music). After the TSST, stress differed slightly between the two participants. Elisa indicated more stress (50 in the VAS) than Laura (39). At MTP 4 (after tape stripping), Elisa, who had been more stressed at MTP 3, indicated a stress level of 0, while Laura indicated a stress level of 2 in the VAS. Although graphically and in absolute numbers the difference between MTP 3 and 4 was higher for Elisa than for Laura, this difference cannot be interpreted because of 1) the negligible difference between both participants at MTP 4 and 2) possible floor effects.

The same applies to subjective stress differences between the participants at MTP 4 and 5. These two MTP would be of great interest for the hypothesis 1a because the listening (or silence) session occurred between these two MTP. For Case A (Laura) who participated in the silence condition, subjective stress differed only by 1 unit between MTP 4 and 5. Participant B (Elisa) who participated in the music condition showed no difference in subjective stress, whereby floor effects come into play in this case, as well. Elisa already indicated a value of 0 at MTP 4, which implies that no more decrease was possible. In the further course, VAS values stayed stable in both participants, with one exception at MTP 8 in Elisa's case, whose stress level rose to a value of 15. The reason for this is unknown. One possible explanation might be that the participant might have come under time pressure because of the long study duration in which participants had no access to a clock and thus never knew how late it was. However, this is purely speculative and irrelevant for the answering of the investigated research question.

In sum, the available data of Case A and Case B do not support the hypothesis that individuals who listen to music after experiencing experimentally induced acute stress will show a quicker recovery in subjective stress than individuals who sit in silence. Hence, H_{1a} cannot be accepted.

To investigate hypothesis 1c, the course of TEWL and SBR rates of both participants must be analysed and compared. At baseline (MTP 3), Laura (Case A; silence) had a TEWL value of 10.80 g/h/m², which indicates a healthy skin condition. Elisa (Case B; music) had a TEWL value of 16.33 g/h/m², which indicates normal skin condition. After tape stripping (at MTP 4), the TEWL values of both cases nearly aligned with each other: Laura's TEWL rose to a value of 25.50 g/h/m², Elisa's TEWL rose to a value of 25.03 g/h/m². However, Laura, who had participated in the silence condition, displayed a quicker skin barrier recovery than Elisa, who had listened to music after the TSST (between MTP 4 and 5). At MTP 6 and 8, SBR was higher in Case A, as well. Only at one MTP (MTP 7), the percentage of SBR was higher in Case B. It must be assumed that this is either because of some kind of measurement error or because of influence of sweating on TEWL at MTP 7 in Case B, as SBR recovery decreased again between MTP 7 and MTP 8, which should not be possible.

The results of the analysis of the TEWL and SBR data do not support the assumed hypothesis H_{1c}. Thus, based on the available data, hypothesis 1c cannot be accepted.

Discussion of Hypotheses 2a and 2c: Case B and C

To address the second research question—Do highly musical individuals differ from less musical individuals in response to a music listening session after being experimentally stressed regarding the recovery in subjective stress, their salivary cortisol level and their skin barrier recovery?—two cases had to be selected for the single case analysis that differed strongly in their level of musicality, i.e., in their score in GMS. The choice for the person scoring highest fell on Case C (Anna), who scored 97 out of a possible total of 126 points (90^{th} percentile) in the Gold-MSI. Of the participants who had completed the study at the time of analysis, the one scoring lowest (64 points, 40^{th} percentile) had to be excluded because her TEWL data were not usable. Therefore, the participant who had scored second lowest in the global score of the Gold-MSI was chosen: Case B (Elisa), who had scored 74 points (55^{th} percentile).

At baseline, both participants indicated a very low subjective stress level, with 1 unit in Elisa's case and a value of 0 in Anna's case. As indicated by the VAS score at MTP 2, both reacted differently to the instruction of the TSST. While Elisa's score only rose to a value of

22, Anna's score rose to a value of 44 in the VAS. Nearly the same difference value (22 units at MTP 2, 24 units at MTP 3) was also given at MTP 3 (directly after the TSST), where Anna (high in GMS) stated a higher stress level (74 units) than Elisa (moderate in GMS; 50 units). Afterwards, subjective stress dropped to a value of 0 in both cases and stayed at that level until the end of the study—with one exception for Elisa at MTP 8, as already discussed above. Hence, hypothesis 2a—that highly musical individuals show a quicker recovery in their subjective stress level in response to a musical intervention after being experimentally stressed than less musical individuals—cannot be addressed based on the given data, as subjective stress was already at a level of 0 before the music listening session in both cases.

For the investigation of H_{2c} which says that highly musical individuals show a quicker skin barrier recovery in response to a musical intervention after being experimentally stressed than less musical individuals, TEWL values and SBR rates of the two participants must be analysed. Both participants started with different TEWL values at baseline. While Anna displayed a healthy skin condition at MTP 3 (baseline TEWL = 12.95 g/h/m²), Elisa displayed normal skin condition (baseline TEWL = 16.33 g/h/m²). Tape stripping lead to an increase in TEWL of 7.1 g/h/m² in Anna's (high in GMS) skin and 8.7 g/h/m² in Elisa's (moderate in GMS) skin at MTP 4. Between MTP 4 and 5, the participants listened to music (Elisa listened to the Jazz playlist, Anna listened to the Lo-Fi playlist). Interestingly, SBR rates differed to a great extent between Anna and Elisa after the music listening session (MTP 5). Elisa (moderate in GMS) had a percentage of SBR of 13.79%. Anna (high in GMS) had an SBR rate of 48.59% after music listening, which is the highest SBR rate observed in all participants not only at MTP 5 but at all MTP assessed in this study. In the subsequent course, SBR rates were always higher in Case C (Anna) than in Case B (Elisa). However, it can be viewed critically that in Case C, at two MTP SBR rates were lower than at the preceding MTP. In Case B this was also the case at MTP 7 and 8. While in Case C no reasons are known for this, in Case B an interesting observation has been made which could contribute to the explanation of the decrease in SBR. As already described above, Elisa indicated an increase in subjective stress between MTP 7 and 8, while at the same time displaying an increase in TEWL (i.e., a decrease in SBR). A connection between a rise in subjective stress and TEWL at MTP 7 and 8 is conceivable, although purely speculative, as no cortisol values are available to support this explanatory approach. Another possible explanation could simply be that the Tewameter used in this study uses a highly sensitive probe which always carries the risk for measurement errors. This issue will be discussed in the limitations section.

However, Anna (high in GMS) constantly showed higher SBR rates than Elisa (moderate in GMS), which supports the assumed hypothesis that highly musical individuals show a quicker skin barrier recovery after a music listening session after being experimentally stressed than less musical individuals. Hence, the available data seem to suggest that hypothesis H_{2c} may hold true.

General Discussion

In this study, two research questions were investigated. In simple words, the first question addressed whether music might have an influence on stress and skin barrier recovery. The second question asked whether these effects might be stronger in highly musical individuals than in less musical individuals. To find answers to these questions, single case analyses were performed. The choice fell on this approach because of the very small sample size ($N = 5$) available at the time of analysis. This must be kept in mind in the discussion of the results of this study, as high statistical power is not given in such a small sample. Therefore, the results only provide tentative answers to the presented research questions.

Analyses of the results revealed that the data did not show any patterns in support of three out of four hypotheses. In the first two hypotheses it was assumed that individuals who listen to music after being experimentally stressed recover faster from subjective stress as well as from impairment of an area of their skin than individuals of a silent control group. This was assumed because, as explained in detail in the introduction section of this thesis, music has been shown to decrease subjective stress (e.g., Lai & Li, 2011) and stress has been shown to impair skin barrier recovery (e.g., Altemus et al., 2001). Thus, music should have positive effects on skin barrier recovery. To investigate this assumption, subjective stress and skin barrier recovery were assessed and analysed. Unfortunately, the available data did not allow the investigation of a connection between stress and SBR. This can be explained because of the time shift between the peak of stress and SBR measurements. Stress was highest at MTP 2 (after instruction of the TSST) and 3 (directly after the TSST). TEWL was first measured at MTP 3. Then, skin impairment followed between MTP 3 and 4. By the time of MTP 4, stress levels had already dropped to the baseline level and stayed constant in the subsequent course in the three single cases studied in the analysis. This had two consequences. First, as SBR could be calculated for the first time at MTP 5, it follows logically that no relation can be established between subjective stress and SBR. Levels of cortisol, a stress hormone, could yield better insights into the relationship between stress and SBR, but were not available at the time of analysis, which represents a big limitation of this study. Second, hypothesis 1a and 2a could not be studied, because no

difference values could be calculated between MTP 4 and 5, which represent the MTP before and after music listening/ silence.

A possible explanation for the close-to-baseline values in subjective stress at MTP 4 was that tape stripping occurred right after the TSST, i.e., between MTP 3 and 4. This procedure took quite some time: First, TEWL was measured at all of the three testing sites (which could take up to 90 seconds per site). Then, in all of the three cases, 40 tape strips were applied to the skin, which is time consuming as well. Afterwards, TEWL was measured at all sites, again. In sum, this procedure could take up to 15 minutes. Not only was this a lot of time to recover from subjectively felt stress, but participants were also distracted from ruminating about the experienced stress test. As already shown in previous TSST studies (e.g., Capobianco, Morris, & Wells, 2018), worrying and rumination about the stress test can prolong stress recovery. It can be assumed that the tape stripping procedure—which was probably new to each participant—distracted participants from ruminating or worrying about their performance in the TSST. This might have led to the very low values in subjective stress at MTP 4.

However, the hypothesis that SBR recovery would be better in individuals who listened to music than in those who sat in silence after being experimentally stressed did not find any support in the available data. The compared participants did not differ greatly neither in their subjective stress response to the TSST nor in their subsequent VAS values. However, they differed regarding condition (music or silence). Against the expectations, SBR at MTP 5–8, which were the MTP after tape stripping, was constantly better in the participant of the silence condition than in the participant of the music condition. Thus, H_{1a} as well as H_{1c} cannot be accepted.

Hypotheses 2a and 2c addressed the influence of musicality on the effects of music on stress and skin barrier recovery. To the best of my knowledge, this study is the first to investigate this issue. Unfortunately, as was the case with hypothesis 1a, H_{2a} could not be addressed for the same reasons. The investigation of hypotheses 2c yielded interesting results though. The participant who had scored highest in the general musical sophistication scale of the Goldsmiths Musical Sophistication Index showed a better skin barrier recovery than the person with a low score in the Gold-MSI, which supports the assumed hypothesis 2c.

This result might explain the lack of evidence for hypothesis 1c. If we assume that most of all highly musical individuals profit from a music listening session and that less musical individuals profit less, it follows that less musical individuals who listen to music should show outcomes similar to those of individuals who sit in silence. However, this does not explain why the participant of the silence condition had a better SBR than the participant of the music condition.

The finding that the musical participant had better SBR than the less musical participant goes in line with the meta-analysis of Pelletier (2004) who found that individuals with musical experience benefit more from music assisted relaxation techniques than non-musical individuals. However, it cannot be disregarded that other factors that might contribute to the found effect have not been considered in the study design, like personality traits or performance in the TSST, which might influence the stress reactivity to the TSST. A concept other than musicality which has not been considered in this master's thesis but might contribute to how music acts on health are the constructs of music empathizing (ME) and music systemizing (MS). Introduced in 2008 by Kreutz, Schubert, and Mitchell (2008), it builds on Baron-Cohen's *Empathizer-Systemizer-Theory* (*E-S theory*; Baron-Cohen, Knickmeyer, & Belmonte, 2005), which postulates a distinction between two general cognitive styles: Empathizing refers to the tendency or ability to identify mental states of others and to respond to them accordingly with an adequate emotion, in order to be able to predict future behavior and respond to it; "Systemizing is the drive to analyze a system in terms of the rules that govern the system, in order to predict the behavior of the system" (Baron-Cohen et al., 2005, p.820). Kreutz et al. (2008) expanded this theory onto the music domain. The authors conducted a questionnaire study and developed the *Music-Empathizing-Music-Systemizing* (*MEMS*) inventory based on their findings. According to Kreutz et al. (2008), music systemizers focus more on structural features of a musical piece and appreciate a piece based on their analysis of those features, whereas for music empathizers the emotional content of music is of more relevance and elicits stronger experiences or responses. The cognitive style used may vary between individuals as well as between situations. Furthermore, differences between professional musicians, amateur musicians and non-musicians were observed: The more experienced an individual is, the higher the tendency for MS. Results for ME were not that clear but point towards an interaction with sex. No differences in ME between professionals, amateurs and non-musicians were found in male subjects, whereas female professionals scored higher in ME than amateurs and non-musicians in at least one of the two studies conducted by Kreutz et al. (2008).

Hence, there might be a connection between the concepts of musicality and MEMS in women. It is conceivable that the degree of musicality influences how music is perceived by the listener and on which aspects he or she focuses his or her attention. The results found by Kreutz et al. (2008) already point towards a connection between musicality and MEMS, although the interaction seems to be quite complex, as correlations between experience with music were found for ME as well as for MS. It might be possible that individuals high in ME—who focus on the emotional content of music—score especially high in the subscale *Emotions*

of the Gold-MSI, whereas individuals high in MS—who focus on the structural components of musical pieces—score especially high in, e.g., *Active Engagement* or *Musical Training*.

This, in turn, might contribute to the explanation of the results found in this study, which point towards a positive effect of music especially in highly musical individuals. If we assume that MS and ME both correlate with—at least certain aspects of—musicality, musical systemizers as well as musical empathizers might profit from listening to music with regards to subjective stress and skin barrier recovery. As already mentioned, distraction can help reducing subjective stress because it prevents the individual from ruminating about the stressor. Hence, it might be that musical systemizers focus on the analysis of the musical pieces they listen to and thus do not ruminate about, e.g., their performance in the TSST, which reduces subjective stress, which, in turn, increases skin barrier recovery. Musical emphasizers, on the other hand, might profit from music because of alterations in their emotional state: Stress might be reduced because feelings of joy, relaxation or being carried away take over, which might lead to better skin barrier recovery as well.

However, these assumptions are speculative and based on theoretical considerations. It is up to future studies to unravel the relationship between musicality, the MEMS theory, stress and skin barrier recovery.

In summary it can be said that the results could not directly support the hypothesis that individuals who listen to music recover faster from subjective stress and skin impairment than a silent control (H_{1a} and H_{1c}). However, the results analysed to find an answer to H_{2a} and H_{2c}—whether the effects depend on the musicality of the individual—might explain the lack of evidence for H_{1a} and H_{1c}. The analysed data yielded preliminary evidence for H_{2c}, i.e., the individual who had scored high in the Gold-MSI had better SBR than the individual who had scored low. Thus, if we assume that only highly musical individuals profit from a music listening session, no effect was to be expected in the first place for H_{1a} and H_{1c}, as the individual of the music group who was investigated in the comparison of silence and music had scored low in the Gold-MSI.

However, this study could not show whether the effect found for H_{2c} was caused by musicality per se or if other aspects, like the MEMS concept or liking of the music playlist, played a role.

Strengths and Limitations

To the best of my knowledge, this project was the first to combine music, TEWL and subjective stress as well as musicality in one design. Moreover, in a large part of previous studies subjective stress was operationalized with state anxiety instead of directly asking for subjectively felt stress. Although this is a reasonable approach since anxiety is part of the emotional response to a stressful experience (de Witte et al., 2019), we aimed to tackle the phenomenon of subjective stress more directly. Therefore, one strength of this research project is that participants were asked for their subjective stress level directly and not by means of related concepts like anxiety. Furthermore, this study combined subjective and physiological outcomes through the investigation of subjective stress and transepidermal water loss.

Despite the interesting findings, the results are only tentative and come along with several limitations. Some of them result directly from the study design. However, the biggest limitation of this study appeared to be the small sample size. Because of the very small sample size as well as the fact that only young German speaking women in a specific phase of their menstrual cycle were tested, the results cannot be generalized to other populations. Furthermore, the sample was a convenience sample, which adds to the limited generalizability. As mentioned in the theoretical background section of this thesis, statements about effects of musicality can only be made in cultures in which individuals are assumed to differ in their degree of musicality which is not the case in some countries. Hence, no statements can be made about other cultures concerning the effects of musicality on stress and skin barrier recovery, which further limits generalizability of this study.

Although single case analyses have the potential to yield interesting results and serve as basis for future research, they do not replace statistical analyses of large samples in studies like the one presented in this thesis. To study the effects of music on skin barrier recovery as well as the effects of musicality on this relationship, single case studies are not sufficient. It can never be ruled out that the results are random. For example, it might be possible that the one case studied constitutes an exception or an extreme case, and that the selection of another case would yield different results. Hence, the analysis method itself can be seen as limitation.

One major limitation of this study is that the research project in which it was carried out was not designed to test for the hypotheses 2a, 2b and 2c. H_{1a} and H_{1c} could be tested without restrictions caused by the project design, but the analysis of H_{2a} and H_{2c} which dealt with musicality suffered from the fact that inclusion and exclusion criteria for the study project decidedly excluded professional musicians or individuals who professionally deal with music in any other way (H_{1b} and H_{2b} could not be addressed, either, because of missing salivary cortisol

analysis, which will be discussed in detail below). Although it can and should not be said that every professional musician is more musical than any other hobby musician anyway, it still can be assumed that variance in musicality in the study sample was restricted to some extent due to the given exclusion criteria. Moreover, even if they had not been excluded, the Gold-MSI probably would not have been able to differentiate precisely in the upper extremes as this questionnaire, which tests for "the musicality of non-musicians" (Müllensiefen et al., 2014, p.1), was not constructed for this purpose. Furthermore, in the studied sample variance was not only limited in the upper values but in the lower values as well. None of the participants scored extremely low (i.e. ≤25th percentile) in the Gold-MSI. However, this seems to be an insignificant limitation, as the results even revealed an effect of musicality in the comparison of a highly musical and a mediocre musical participant.

Although the playlists used in the study were created conscientiously and tested for their effectiveness, the design is still afflicted with some limitations regarding the chosen music. First, only low tempo music was used, therefore no propositions can be made about stimulating music. Second, participants did not choose every single piece they wanted to listen to but could only decide between existing playlists of different genres. Thus, it was possible that a playlist contained pieces that the participants liked and others that they did not. Additional to that, the playlists were exactly 30 minutes long, which means that participants did not have the possibility to skip a piece in case they did not like it, as the music listening session had to last exactly 30 minutes. As the degree of liking for the music was found to be crucial for the effectiveness of musical interventions (Stratton & Zalanowski, 1984), this must be seen as limitation.

Another major limitation of this study is the lack of analysis of salivary cortisol values. At the time of completion of this master's thesis, saliva samples have not been analysed yet. Hence, H_{1b} and H_{2b} could not be addressed in the analysis. As described at the beginning of this thesis, it is assumed that cortisol mediates the negative effects of psychological stress on skin barrier recovery. Analysing cortisol in this study would have offered the opportunity to directly test for the relationship between stress, cortisol, and transepidermal water loss. Unfortunately, this was not possible as part of this master's thesis but will be done in the further course of the research project.

One of the biggest limitations of this study appeared to be the fluctuations of the TEWL values in unexpected directions and the sometimes insufficient impairment of the skin barrier, which lead to odd SBR courses, exclusion of single measurement sites, or even exclusion of participants. In single case studies, such anomalies come to bear heavily.

Finally, the instrument used for the measurement of subjective stress—one single item that had to be answered with a visual analogue scale—can be criticized. As already mentioned above, the VAS is not an objective measure of stress, but participants indicate their subjectively felt stress level on their own. This implicates that each participant has their own reference point for what is extreme high and extreme low stress. Thus, we cannot be absolutely sure that true subjective stress values are displayed reliably, without any bias, and validly.

Future Directions

Despite the limitations of this pilot study, the results could serve as a basis for further research on how music affects skin barrier recovery and the interactions of this relationship with stress and musicality. The first step towards this goal will be the continuation of this research project with a larger sample which will yield more insights into this issue. With a larger sample, greater variance in musicality can be expected and powerful statistical analyses can be performed. Moreover, cortisol analyses are crucial for the understanding of the underlying mechanisms and should therefore always be taken into account in studies investigating the relationship between music, stress and skin barrier recovery.

Additionally, to gain more insights into the underlying mechanisms of the relationship between music, stress and skin barrier recovery, it would be interesting to not only investigate cortisol but immune markers found in blood samples as well to test for the role of the immune system in the music-stress-skin barrier recovery pathway. This knowledge can then be used as a starting point for further research testing for other health outcomes, like skin diseases, cancer, or other diseases related to impaired immune system function.

As already described in the discussion, a potentially influencing factor for the relationship between music, stress and SBR is the MEMS-theory (Kreutz et al., 2008). Future research should take this into account and also study the relationship between musicality and MEMS. Furthermore, it would be interesting to investigate whether differences exist between the single subscales of the Gold-MSI in their power to influence how music affects stress and SBR, as this was not investigated in this study.

One limitation of this study is restricted generalizability, mostly due to the given inclusion criteria. Future studies should also include other populations of different gender, age, culture or phases of their menstrual cycle, like the luteal phase. Furthermore, professional musicians should not be excluded from the study as investigating extreme populations could yield more insight into the relationship between music, musicality and health. Moreover, further

studies should test the effects of music on skin barrier recovery for other types of music, for example stimulating music, which was not included in this study, or self-selected music.

Knowledge gained from such studies could be used to develop tailored interventions for specific clinical populations. Therefore, it is interesting to investigate if only highly musical individuals profit from musical interventions subjectively as well as biologically and physically, or if such interventions can be applied to broader populations. This issue was already tackled in this research project. The results seem to provide some first indications that music has positive effects on health most of all in highly musical individuals. However, as already discussed, this should also be studied more comprehensively in a larger sample.

As mentioned by de Witte et al. (2019), music might have the potential to replace anxiolytic medication, at least in some populations and under certain circumstances. Future research should investigate this issue and compare the effectiveness of music versus medication in patients who find themselves in stressful circumstances, like preoperative patients.

Conclusion

The presented results do not support the hypothesis that individuals who listen to music after experiencing experimentally induced acute stress profit more from a music listening session regarding the recovery in subjective stress and skin barrier recovery than individuals of a silent control group. The analysis of salivary cortisol is still pending.

The hypothesis that highly musical individuals recover faster than less musical individuals from subjectively felt stress after a music listening session could not be confirmed, either. However, preliminary evidence could be found that music has a stronger positive effect on skin barrier recovery in highly musical individuals than in less musical individuals. Future studies should test these hypotheses more comprehensively and in larger samples.

References

Adorno, T. W. (1940). [Review of the book *Psychology of music,* by C. E. Seashore]. *Gesammelte Schriften 19, Musikalische Schriften VI*, 375–381. Frankfurt: Suhrkamp.

Alexander, H., Brown, S., Danby, S., & Flohr, C. (2018). Research techniques made simple: Transepidermal water loss measurement as a research tool. *Journal of Investigative Dermatology, 138*(11), 2295–2300. doi:10.1016/j.jid.2018.09.001

Altemus, M., Rao, B., Dhabhar, F., Ding, W., & Granstein, R. (2001). Stress-induced changes in skin barrier function in healthy women. *Journal of Investigative Dermatology, 117*(2), 309–317. doi:10.1046/j.1523-1747.2001.01373.x

Barlow, D. H. (2002). *Anxiety and its disorders* (2nd ed.). New York: Guilford.

Baron-Cohen, S., Knickmeyer, R. C., & Belmonte, M. K. (2005). Sex differences in the brain: implications for explaining autism. *Science, 310*(5749), 819–823. doi:10.1126/science.1115455

Billroth, T. (1895). *Wer ist musikalisch?* Berlin: Gebrüder Paetel.

Blacking, J. (1973). *How musical is man?* Seattle: University of Washington.

Blacking, J. (1990). Music in children's cognitive and affective development: Problems posed by ethnomusicological research. In F. R. Wilson & F. L. Roehmann (Eds.), *Music and child development* (pp. 68–78). St. Louis: MMB Music.

Capobianco, L., Morris, J. A., & Wells, A. (2018). Worry and rumination: Do they prolong physiological and affective recovery from stress? *Anxiety, Stress & Coping, 31*(3), 291–303. doi:10.1080/10615806.2018.1438723

Chafin, S., Roy, M., Gerin, W., & Christenfeld, N. (2004). Music can facilitate blood pressure recovery from stress. *British Journal of Health Psychology, 9*(3), 393–403. doi:10.1348/1359107041557020

Chanda, M. L., & Levitin, D. J. (2013). The neurochemistry of music. *Trends in Cognitive Sciences, 17*(4), 179–193. doi:10.1016/j.tics.2013.02.007

Chang, H.-C., Yu, C.-H., Chen, S.-Y., & Chen, C.-H. (2015). The effects of music listening on psychosocial stress and maternal-fetal attachment during pregnancy. *Complementary Therapies in Medicine, 23*(4), 509–515. doi:10.1016/j.ctim.2015.05.002

Chin, T., & Rickard, N. S. (2012). The Music USE (MUSE) Questionnaire: An instrument to measure engagement in music. *Music Perception: An Interdisciplinary Journal, 29*(4), 429–446. doi:10.1525/mp.2012.29.4.429

Choi, E., Brown, B., Crumrine, D., Chang, S., Man, M., Elias, P., & Feingold, K. (2005). Mechanisms by which psychologic stress alters cutaneous permeability barrier homeostasis and stratum corneum integrity. *Journal of Investigative Dermatology, 124*(3), 587–595. doi:10.1111/j.0022-202x.2005.23589.x

de Witte, M., Spruit, A., van Hooren, S., Moonen, X., & Stams, G.-J. (2019). Effects of music interventions on stress-related outcomes: a systematic review and two meta-analyses. *Health Psychology Review, 6*, 1–31. doi:10.1080/17437199.2019.1627897

Fancourt, D., Ockelford, A., & Belai, A. (2014). The psychoneuroimmunological effects of music: A systematic review and a new model. *Brain, Behavior, and Immunity, 36*, 15–26. doi:10.1016/j.bbi.2013.10.014

Fukuda, S., Baba, S., & Akasaka, T. (2015). Psychological stress has the potential to cause a decline in the epidermal permeability barrier function of the horny layer. *International Journal of Cosmetic Science, 37*(1), 63–69. doi:10.1111/ics.12169

Garg, A., Chren, M., Sands, L., Matsui, M., Marenus, K., Feingold, K., & Elias, P. (2001). Psychological stress perturbs epidermal permeability barrier homeostasis. *Archives of Dermatology*, *137*(1), 53–59. doi:10.1001/archderm.137.1.53

Gembris, H. (1997). Historical phases in the definition of musicality. *Psychomusicology: A Journal of Research in Music Cognition, 16*(1–2), 17–25. doi:10.1037/h0094070

Gilbert, P., McEwan, K., Mitra, R., Franks, L., Richter, A., & Rockliff, H. (2008). Feeling safe and content: A specific affect regulation system? Relationship to depression, anxiety, stress, and self-criticism. *The Journal of Positive Psychology, 3*(3), 182–191. doi:10.1080/17439760801999461

Glaser, R., & Kiecolt-Glaser, J. K. (2005). Stress-induced immune dysfunction: implications for health. *Nature Reviews Immunology, 5*(3), 243–251. doi:10.1038/nri1571

Heinrichs, M., Baumgartner, T., Kirschbaum, C., & Ehlert, U. (2003). Social support and oxytocin interact to suppress cortisol and subjective responses to psychosocial stress. *Biological Psychiatry, 54*(12), 1389–1398. doi:10.1016/s0006-3223(03)00465-7

Holmes, T. H., & Rahe, R. H. (1967). The Social Readjustment Rating Scale. *Journal of Psychosomatic Research, 11*(2), 213–218. doi:10.1016/0022-3999(67)90010-4

Jiang, J., Rickson, D., & Jiang, C. (2016). The mechanism of music for reducing psychological stress: Music preference as a mediator. *The Arts in Psychotherapy*, *48*, 62–68. doi:10.1016/j.aip.2016.02.002

Jiang, J., Zhou, L., Rickson, D., & Jiang, C. (2013). The effects of sedative and stimulative music on stress reduction depend on music preference. *The Arts in Psychotherapy*, *40*, 201–205. doi:10.1016/j.aip.2013.02.002

Joseph, D. N., & Whirledge, S. (2017). Stress and the HPA axis: balancing homeostasis and fertility. *International Journal of Molecular Sciences, 18*(10), 2224. doi:10.3390/ijms18102224

Juslin, P. N., Liljeström, S., Västfjäll, D., Barradas, G., & Silva, A. (2008). An experience sampling study of emotional reactions to music. *Emotion, 8*, 668–683. doi:10.1037/a0013505

Kanner, A., Coyne, J., Schaefer, C., & Lazarus, R. (1981). Comparison of two modes of stress measurement: Daily hassles and uplifts versus major life events. *Journal of Behavioral Medicine, 4*(1), 1–39. doi:10.1007/BF00844845

Khalfa, S., Bella, S., Roy, M., Peretz, I., & Lupien, S. (2003). Effects of relaxing music on salivary cortisol level after psychological stress. *Annals of the New York Academy of Sciences, 999*(1), 374–376. doi:10.1196/annals.1284.045

Kiecolt-Glaser, J. K., Marucha, P. T., Mercado, A. M., Malarkey, W. B., & Glaser, R. (1995). Slowing of wound healing by psychological stress. *The Lancet, 346*(8984), 1194–1196. doi:10.1016/s0140-6736(95)92899-5

Kirschbaum, C., Kudielka, B. M., Gaab, J., Schommer, N. C., & Hellhammer, D. H. (1999). Impact of gender, menstrual cycle phase, and oral contraceptives on the activity of the hypothalamus-pituitary-adrenal axis. *Psychosomatic Medicine, 61*(2), 154–162. doi:10.1097/00006842-199903000-00006

Kirschbaum, C., Pirke, K., & Hellhammer, D. (1993). The 'Trier Social Stress Test' –A tool for investigating psychobiological stress responses in a laboratory setting. *Neuropsychobiology*, *28*(1–2), 76–81. doi:10.1159/000119004

Knight, W. E., & Rickard, D. N. (2001). Relaxing music prevents stress-induced increases in subjective anxiety, systolic blood pressure, and heart rate in healthy males and females. *Journal of Music Therapy, 38*(4), 254–272. doi:10.1093/jmt/38.4.254

Knoll, N., Scholz, U., & Rieckmann, N. (2013). *Einführung Gesundheitspsychologie* (3. Auflage). München/Basel: Ernst Reinhart.

Kreutz, G., Schubert, E., & Mitchell, L. A. (2008). Cognitive styles of music listening. *Music Perception, 26*(1), 57–73. doi:10.1525/mp.2008.26.1.57

Kudielka, B. M., Hellhammer, D. H., & Kirschbaum, C. (2007). Ten years of research with the Trier Social Stress Test – Revisited. In E. Harmon-Jones (Ed.), *Social Neuroscience: Integrating biological and psychological explanations of social behavior* (pp.56–83). New York: Guilford.

Labbé, E., Schmidt, N., Babin, J., & Pharr, M. (2007). Coping with stress: the effectiveness of different types of music. *Applied Psychophysiology and Biofeedback, 32*(3–4), 163–168. doi:10.1007/s10484-007-9043-9

Lai, H. L., & Li, Y. M. (2011). The effect of music on biochemical markers and self-perceived stress among first-line nurses: a randomized controlled crossover trial. *Journal of Advanced Nursing, 67*(11), 2414–2424. doi:10.1111/j.1365-2648.2011.05670.x

Law, L. N., & Zentner, M. (2012). Assessing musical abilities objectively: construction and validation of the profile of music perception skills. *PLoS One, 7*(12): e52508. doi:10.1371/journal.pone.0052508

Lazarus, R., & Folkman, S. (1984). *Stress, appraisal, and coping*. New York: Springer.

Losquadro, W. D. (2017). Anatomy of the skin and the pathogenesis of nonmelanoma skin cancer. *Facial Plastic Surgery Clinics*, *25*(3), 283–289. doi:10.1016/j.fsc.2017.03.001

Lovallo, W. R. (2015). *Stress and health: Biological and psychological interactions* (3rd ed.). Thousand Oaks: Sage.

Mahdipour, R., & Nematollahi, M. (2012). The effect of the music listening and the intensive care unit visit program on the anxiety, stress and depression levels of the heart surgery patients candidates. *Iranian Journal of Critical Care Nursing, 5*(3), 133–138. Retrieved from https://www.sid.ir/en/Journal/JournalList.aspx?ID=12625

May, E. (1973). [Review of the book *How musical is man?*, by J. Blacking]. *Yearbook of the International Folk Music Council, 5*, 193–195. doi:10.2307/767511

McEwen, B. S. (1998). Stress, adaptation, and disease: Allostasis and allostatic load. *Annals of the New York Academy of Sciences, 840*(1), 33–44. doi:10.1111/j.1749-6632.1998.tb09546.x

Michaelis, K. F. (1805). Über die Prüfung musikalischer Fähigkeiten. *Berlinische Musikalische Zeitung, 56*, 222–230.

Muizzuddin, N., Matsui, M., Marenus, K., & Maes, D. (2003). Impact of stress of marital dissolution on skin barrier recovery: tape stripping and measurement of trans-epidermal water loss (TEWL). *Skin Research and Technology, 9*(1), 34–38. doi:10.1034/j.1600-0846.2003.00354.x

Müllensiefen, D., Gingras, B., Musil, J., & Stewart, L. (2014). The musicality of non-musicians: an index for assessing musical sophistication in the general population. *PLoS One, 9*(2): e89642. doi:10.1371/journal.pone.0089642

Murphy, C. (1999). How far do tests of musical ability shed light on the nature of musical intelligence? *British Journal of Music Education, 16*(1), 39–50. doi:10.1017/s0265051799000133

Nater, U. M., Ditzen, B., & Ehlert, U. (2011). Stressabhängige körperliche Beschwerden. In H.-U. Wittchen & J. Hoyer (Eds.), *Klinische Psychologie & Psychotherapie* (2nd ed., pp. 1039–1052). Heidelberg: Springer.

Orion, E., & Wolf, R. (2012). Psychological stress and epidermal barrier function. *Clinics in Dermatology, 30*(3), 280–285. doi:10.1016/j.clindermatol.2011.08.014

Pelletier, C. (2004). The effect of music on decreasing arousal due to stress: A meta-analysis. *Journal of Music Therapy, 41*(3), 192–214. doi:10.1093/jmt/41.3.192

Proksch, E., Brandner, J. M., & Jensen, J. M. (2008). The skin: an indispensable barrier. *Experimental Dermatology, 17*(12), 1063–1072. doi:10.1111/j.1600-0625.2008.00786.x

Reiche, E. M. V., Nunes, S. O. V., & Morimoto, H. K. (2004). Stress, depression, the immune system, and cancer. *The Lancet Oncology, 5*(10), 617–625. doi:10.1016/s1470-2045(04)01597-9

Robinson, H., Jarrett, P., & Broadbent, E. (2015). The effects of relaxation before or after skin damage on skin barrier recovery: A preliminary study. *Psychosomatic Medicine, 77*(8), 844–852. doi:10.1097/PSY.0000000000000222

Robinson, H., Ravikulan, A., Nater, U. M., Skoluda, N., Jarrett, P., & Broadbent, E. (2017). The role of social closeness during tape stripping to facilitate skin barrier recovery: preliminary findings. *Health Psychology, 36*(7), 619–629. doi:10.1037/hea0000492

Robles, T. F. (2007). Stress, social support, and delayed skin barrier recovery. *Psychosomatic Medicine, 69*(8), 807–815. doi:10.1097/PSY.0b013e318157b12e

Rousset, L., & Halioua, B. (2018). Stress and psoriasis. *International Journal of Dermatology, 57*(10), 1165–1172. doi:10.1111/ijd.14032

Schaal, N. K., Bauer, A. K. R., & Müllensiefen, D. (2014). Der Gold-MSI: Replikation und Validierung eines Fragebogeninstrumentes zur Messung musikalischer Erfahrenheit anhand einer deutschen Stichprobe. *Musicae Scientiae, 18*(4), 423–447. doi:10.1177/1029864914541851

Schmidt, N. B., Richey, J. A., Zvolensky, M. J., & Maner, J. K. (2008). Exploring human freeze responses to a threat stressor. *Journal of Behavior Therapy and Experimental Psychiatry, 39*(3), 292–304. doi:10.1016/j.jbtep.2007.08.002

Schneiderman, N., Ironson, G., & Siegel, S. D. (2005). Stress and health: psychological, behavioral, and biological determinants. *Annual Review of Clinical Psychology, 1*, 607–628. doi:10.1146/annurev.clinpsy.1.102803.144141

Seashore, C.E. (1938). *Psychology of music*. New York: Dover.

Selye, H. (1976). Stress without distress. In G. Serban (Ed.), *Psychopathology of human adaptation* (pp. 137–146). Boston: Springer.

Steptoe, A., & Kivimäki, M. (2012). Stress and cardiovascular disease. *Nature Reviews Cardiology, 9*(6), 360–370. doi:10.1038/nrcardio.2012.45

Sterling, P., & Eyer, J. (1988) Allostasis: A new paradigm to explain arousal pathology. In S. Fisher & J. Reason (Eds.), *Handbook of life stress, cognition and health* (pp. 629–649). New York: John Wiley & Sons.

Stewart, T. J., Tong, W., & Whitfeld, M. J. (2018). The associations between psychological stress and psoriasis: a systematic review. *International Journal of Dermatology, 57*(11), 1275–1282. doi:10.1111/ijd.13956

Stratton, V. N., & Zalanowski, A. H. (1984). The relationship between music, degree of liking, and self-reported relaxation. *Journal of Music Therapy, 21*(4), 184–192. doi:10.1093/jmt/21.4.184

Tan, X., Yowler, C. J., Super, D. M., & Fratianne, R. B. (2012). The interplay of preference, familiarity and psychophysical properties in defining relaxation music, *Journal of Music Therapy, 49*(2), 150–179. doi:10.1093/jmt/49.2.150

Thoma, M. V., La Marca, R., Brönnimann, R., Finkel, L., Ehlert, U., & Nater, U. M. (2013). The effect of music on the human stress response. *PloS One, 8*(8): e70156. doi:10.1371/journal.pone.0070156

Vanstone, A. D., Wolf, M., Poon, T., & Cuddy, L. L. (2016). Measuring engagement with music: development of an informant-report questionnaire. *Aging & Mental Health, 20*(5), 474–484. doi:10.1080/13607863.2015.1021750

Ventura, T., Gomes, M., & Carreira, T. (2012). Cortisol and anxiety response to a relaxing intervention on pregnant women awaiting amniocentesis. *Psychoneuroendocrinology, 37*(1), 148–156. doi:10.1016/j.psyneuen.2011.05.016

Vollrath, M. (2001). Personality and stress. *Scandinavian Journal of Psychology, 42*(4), 335–347. doi:10.1111/1467-9450.00245

Wallentin, M., Nielsen, A. H., Friis-Olivarius, M., Vuust, C., & Vuust, P. (2010). The Musical Ear Test, a new reliable test for measuring musical competence. *Learning and Individual Differences, 20*(3), 188–196. doi:10.1016/j.lindif.2010.02.004

Werner, P. D., Swope, A. J., & Heide, F. J. (2006). The Music Experience Questionnaire: development and correlates. *The Journal of Psychology, 140*(4), 329–345. doi:10.3200/JRLP.140.4.329-345

Yehuda, N. (2011). Music and Stress. *Journal of Adult Development, 18*(2), 85–94. doi:10.1007/s10804-010-9117-4

Appendix

Appendix telephone screening guideline

Telefoninterview Leitfaden: Studie „Stress und Musik- oder Hörbuchhören“

Guten Tag, ich heiße [Name des Interviewers]. Könnte ich bitte mit <Name> sprechen?

[Falls ja]: Ich bin MitarbeiterIn der Abteilung für Klinische Psychologie der Universität Wien, Sie haben sich interessiert, an einer Studie zum Thema „Stress und Musik- oder Hörbuchhören“ teilzunehmen. Im Zuge dessen würde ich Ihnen gern einige Fragen stellen.

Bevor wir anfangen, möchte ich Ihnen noch einige Informationen geben. Ich lese Ihnen jetzt eine standardisierte Einleitung zur Studie vor. Das Interview wird ca. 10-20 Minuten Zeit in Anspruch nehmen [falls die Teilnehmerin gerade keine Zeit hat, einen anderen Termin vereinbaren]. Die an Sie gestellten Fragen werden sich inhaltlich auf Ihre Person, Ihre Gesundheit und medizinische Informationen konzentrieren. Ihre Angaben werden selbstverständlich vertraulich behandelt. Die hier gesammelten Daten werden ausschließlich von Mitarbeitern der Studie bearbeitet. Sie können jederzeit entscheiden, bestimmte Fragen nicht zu beantworten oder das Interview abzubrechen. Dieses Interview soll uns helfen zu entscheiden, ob Sie eine geeignete Kandidatin für die Studie sind. Wenn Sie alle Kriterien erfüllen, werden wir im Anschluss an das Interview einen weiteren Termin vereinbaren.

Wenn Sie noch weitere Fragen bezüglich Ihrer Rechte in dieser Studie haben, kann ich Ihnen gerne die Nummer des verantwortlichen Projektleiters geben, Prof. Dr. Urs Nater. Auch wenn Sie insgesamt noch weitere Fragen zu der Studie haben, können Sie Prof. Urs Nater an der Abteilung für Klinische Psychologie anrufen. Die Nummer kann ich Ihnen auch zukommen lassen.

(Univ. Prof. Dr. Urs Nater: +43 (1) 4277/47220)

INTERVIEWER: Haben Sie die Instruktionen verstanden? [bestätigen]

JA: [weitermachen]

NEIN: [die Instruktionen erneut vorlesen]

Sind Sie damit einverstanden, an diesem Interview teilzunehmen?

JA: [weitermachen]

NEIN: [Ausschluss – Screening beenden]

Interviewer [Kürzel] _____

Screening-Code für Telefoninterview [Kürzel_Datum_Nr]
_____

Wie sind sie auf die Studie aufmerksam geworden?

_____

Welches **Geschlecht** haben Sie?

□ weiblich

□ männlich [Ausschluss] □ anderes: _____ [Ausschluss]

Ausschluss anderes Geschlecht:

Vielen Dank für Ihre Antwort.
Wir sind uns bewusst, dass Geschlecht ein dimensionales Konstrukt ist. Da wir jedoch im Rahmen unserer Studie biologische Daten erheben, die durch Geschlechtshormone beeinflusst werden, ist es für unsere Studie unabdingbar, dass sich die Interessentinnen und Interessenten eindeutig einem biologischen Geschlecht zuordnen. Anderenfalls sind die biologischen Daten für uns nicht auswertbar.
Daher bitten wir um Ihr Verständnis, dass Sie die Kriterien für den Studieneinschluss nicht erfüllen und keine weiteren Termine auf Sie zukommen werden.
Falls Sie noch irgendwelche Fragen haben, können Sie uns gerne kontaktieren.
Vielen Dank!

Wie **alt** sind Sie?

_____ (Einschluss 18-35 Jahre)

Wann ist Ihr Geburtsdatum?

_____

BMI: Wieviel wiegen Sie und wie groß sind Sie?

Größe _____ cm

Gewicht _____ kg

BMI = Gewicht/Größe² (Einschluss 15-30)

BMI in Rekrutierung.xlxs im Reiter „BMI“ berechnen

Sind Sie **schwanger oder stillen** Sie derzeit?

□ Nein

□ Ja [Ausschluss]

Sind Sie **professionelle Musikerin**, **studieren Sie Musik** bzw. Musikwissenschaften, oder beschäftigen Sie sich ansonsten **beruflich mit Musik** (z.B. Tontechnikerin, Verkäuferin in Instrumentengeschäft, Musiklehrerin)?

□ Nein

□ Ja [Ausschluss]

Haben Sie ein **absolutes Gehör**?

□ Nein

□ Ja [Ausschluss]

Rauchen Sie?

□ Nein

□ Ja, nur am Wochenende, Party-/Gelegenheitsraucher?
→ solange nicht zu regelmäßig → nächste Frage

□ Ja, regelmäßig [Ausschluss]

Können Sie dreieinhalb Stunden nicht rauchen, ohne dass Sie Entzugserscheinungen oder starkes Verlangen nach einer Zigarette verspüren?

□ Ja

□ Nein [Ausschluss]

Trinken Sie regelmäßig **Alkohol**? (Substanzmissbrauch innerhalb der letzten 2 Jahren regelmäßiger bzw. übermäßiger Konsum [♀≥8]) 1 = kleines Getränk (z.B. 0,33l Bier oder 1/8 Wein)

□ Nein

□ Ja, Substanzmissbrauch > 2 Jahre; < 8 Getränke (1 = kleines Getränk (z.B. 0,33l Bier oder 1/8
Wein)

□ Ja, Substanzmissbrauch < 2 Jahre; ≥ 8 Getränke

Nehmen Sie **Drogen oder psychoaktive Substanzen** (z.B. Amphetamine, MDMA, Barbiturate, Cannabinoide, Benzodiazepine, Kokain, Opiate)?

□ Nein

□ Ja, Cannabis > 2 Wochen und Andere > 1 Jahr

□ Ja, Cannabis < 2 Wochen und oder Andere < 1 Jahr [Ausschluss]

Nehmen Sie **regelmäßig Medikamente**?

(UNSICHER: Bitte bringen Sie Ihre Medikamente zum Telefon und lesen Sie sie mir vor)

□ Nein

□ Ja, Psychopharmaka > 2 Wochen

□ Ja, Psychopharmaka [Ausschluss]

□ Ja, Herz-Medikamente (z.B. Betablocker) [Ausschluss]

□ Ja, immunosuppressive Medikamente (z.B. Prednison) [Ausschluss}

□ Ja, nämlich _____ (Abklären) → [Ausschluss?]

Nehmen Sie **regelmäßig Medikamente**, die einen Einfluss auf den Hormonhaushalt haben, oder auch hormonhaltige Kontrazeptiva, wie z.B. die Pille?

(UNSICHER: Bitte bringen Sie Ihre Medikamente zum Telefon und lesen Sie sie mir vor)

□ Nein

□ Ja, Hormonelle Kontrazeptiva (z.B. "Pille") → [Ausschluss]

□ Ja, nämlich _____ (Abklären) → [Ausschluss?]

Ist Ihre Periode in etwa regelmäßig / mehr oder weniger regelmäßig?

□ Ja

□ Nein, starke Schwankungen [Ausschluss]

→ Kennen Sie den Grund Ihrer unregelmäßigen Periode?

□ Nein

□ Unsicher

□ Peri-Menopause (letzte Blutung innerhalb des letzten Jahres her)

□ Post-Menopause (letzte Blutung länger als 1 Jahr her)

□ Ja, anderer Grund: _____

Sind Sie zurzeit gesund (keine Grippe, Erkältung)?

□ Nein [Ausschluss]

□ Ja

Leiden Sie an einer **chronischen körperlichen Erkrankung**?

□ Nein

□ Ja, nämlich _____ (Abklären) → [Ausschluss ?]

→ Liste auf nachfolgender Seite vorlesen und ankreuzen.

Krankheiten-Liste:

Nein	Ja	
□	□	**Schädigungen des Gehörs** (Bsp.: Hörbeeinträchtigung oder chronischer Tinnitus)
□	□	**Chronische oder akute entzündliche Hauterkrankungen**
□	□	**Allergien/Überempfindlichkeitsreaktionen** (Medikamente, Pflaster, Latexhandschuhe, Heuschnupfen, Gräser, Pollen)
□	□	**Herzerkrankungen** (Bsp.: koronare Herzerkrankung, Angina pectoris, Herzinfarkt, Herzrhythmusstörungen, Herzfehler, Herzinsuffizienz)
□	□	**Lungen- und Atemwegserkrankungen** (Bsp.: Lungenentzündung, Asthma, chronische Bronchitis, Tuberkulose)
□	□	**Lebererkrankungen** (Bsp.: Hepatitis, Gelbsucht, Leberverfettung)
□	□	**Bluthochdruck oder extrem niedriger Blutdruck**
□	□	**Chronischer Schmerz**
□	□	**Nieren- und Harnwegserkrankungen** (Nieren-/Nierenbeckenentzündung, Nieren-/Blasensteine)
□	□	**Stoffwechselerkrankungen** (Bsp.: Diabetes mellitus, Hypercholesterinämie, Hyperuricämie)
□	□	**Erkrankungen des Verdauungstraktes** (Bsp.: Magenerkrankungen, chronische Darmerkrankungen)
□	□	**Neurologische Erkrankungen**
□	□	**Infektionserkrankungen** (Bsp: HIV, Hep., TBC)
□	□	**Schilddrüsenerkrankungen**
□	□	**Autoimmunerkrankungen** (Bsp: Rheumatische E., Gastritis A, Neurodermitis, Schilddrüsen, MS)
□	□	**Erkrankungen des Skelettsystems/ Muskelerkrankungen**
□	□	**Bluterkrankungen** (Bsp.: entstehen blaue Flecken auch ohne besonderen Anlass, Anämie)
□	□	**Tropenaufenthalt die letzten 6 Monate**
□	□	**Impfungen die letzten 2 Wochen**
□	□	**(Zahn-)OPs in den letzten 8 Wochen** (Narkose, Art des Eingriffs, ausstehende Heilung)
□	□	**Sonstige Besonderheiten** (Bsp.: Hauterkrankungen, Tumorerkrankungen, Hirnhautentzündung, Unfall)

Haben Sie eine **Allergie gegen Pflaster oder Klebestreifen**?

□ Nein

□ Ja [Ausschluss]

Haben Sie **Ekzeme / Hautausschlag, Verbrennungen** oder Ähnliches am volaren (inneren) Unterarm?

□ Nein

□ Ja [Ausschluss]

Sind Sie **blind** oder in Ihrer **Sehfähigkeit** stark eingeschränkt?

(Anmerkung: starke Einschränkung, die nicht durch eine Brille/Kontaktlinsen behebbar ist)

(Anmerkung: eventuell abklären, ob Sehkraft soweit erhalten ist, dass ein selbständiges Ausfüllen der Fragebögen problemlos möglich ist UND Seh-Einschränkung nicht ab der Kindheit bestehen, da Gehör vermutlich dann besser geschult)

□ Nein

□ Ja, blind / wesentlich eingeschränkt [Ausschluss]

□ Unsicher (im Team besprechen), Grund: _____

Leiden Sie aktuell unter einer diagnostizierten **psychischen Störung**?

□ Nein

□ Ja, aktuelle Major Depression oder Angststörung [Ausschluss]

□ Ja, aktuelle Essstörung (innerhalb der letzten 5 Jahre) [Ausschluss]

□ Ja, Psychose/Schizophrenie [Ausschluss]

□ Ja, andere: _____ [Ausschluss?]

Waren Sie jemals in **psychotherapeutischer Behandlung**?

□ Nein

□ Ja

→ Warum und wann wurden Sie behandelt?

□ Derzeitige Major Depression oder Angststörung

□ Ein anderes psychologisches Problem, bitte beschreiben (falls unsicher, im Team abklären):

_____

Sprachkenntnisse: Nachfragen, falls nicht offensichtlich, dass Deutsch beherrscht wird.

Ist Deutsch Ihre Muttersprache / Sprechen sie flüssig Deutsch?

□ Ja

□ Nein [Ausschluss]

Vorerfahrung mit Stresstests

Haben Sie Vorerfahrungen mit Stresstests (z.B. Studium/Vorlesung, Studienteilnahme)?

□ Nein

□ Ja

Falls „Ja“, bitte beschreiben Sie die Stressaufgabe. Wie sah diese Aufgabe aus?

□ TSST [Ausschluss]

□ andere Stressaufgabe

Kennen Sie jemanden, der/die bei der Studie mitwirkt? Wenn ja, wen?

_____

Finale Entscheidung:

□ Einschluss

□ Ausschluss

Bei Ausschluss: Dürfen wir Sie ggf. noch einmal einladen?

□ Ja

□ Nein

Bei Eignung und Einverständnis zur Teilnahme seitens des Probanden:

Movisens/ Brustgurt:

Es folgen nun noch ein paar Informationen und Fragen zum Ablauf der Testung. Im Rahmen der Studie werden wir Sie bitten, Fragebögen auszufüllen und Speichelproben zu sammeln, um darin biologische Maße wie das Stresshormon Cortisol zu bestimmen. Außerdem möchten wir Ihre Herzfrequenz erfassen und würden Sie daher bitten, für die Zeit der Testung einen Brustgurt zu tragen.

Dafür müssten Sie kurz Ihr T-Shirt anheben. Ist dies für Sie in Ordnung? Ist es außerdem in Ordnung, **dass die Versuchsleitung, welche männlich oder weiblich sein kann, Ihnen diesen Brustgurt anlegt**?

□ Ja □ Nein

Tape Stripping:

Außerdem führen wir eine Messung der Haut durch. Dafür ist es notwendig, dass wir vor der Testung eine kleine Stelle des inneren Unterarms rasieren (in den meisten Fällen befinden sich auch ohne Rasieren keine sichtbaren Haare an dieser Stelle). Ist das für Sie in Ordnung?

□ Ja □ Nein

Für die Messung der Haut am Testtag ist es für uns wichtig zu wissen, ob sie Links- oder Rechtshänderin sind, um entsprechende Vorbereitungen zu treffen. Könnten Sie mir das kurz mitteilen?

□ Rechts □ Links

Terminvereinbarung

Für diese Studie ist es wichtig, dass die Testung in einem bestimmten Zeitraum des Menstruationszyklus stattfindet, der Follikelphase. Optimaler Weise in der zweiten Hälfte der Follikelphase, welche 4-7 Tage nach der Menstruation beginnt. Um diesbezüglich einen Termin für die Testung zu vereinbaren, bräuchte Ich noch folgende Angaben:

Durchschnittliche Zykluslänge _____ Tage

Durchschnittliche Menstruationslänge _____ Tage

Zeitpunkt des letzten Menstruationsbeginns _____ (Datum)

Zeitraum in File „Menstrual cycle – Testzeitraumkalkulator.xls“ berechnen

→ Möglicher Zeitraum von _____ bis _____

Bei Einschluss: Vielen Dank! Sie bekommen von mir jetzt noch eine Mail mit dem Link für den Online-Fragebogen. Wenn Sie möchten, können wir uns direkt einen Termin ausmachen. Hätten Sie am xxx. von 13:00 bis 17:00 Zeit?

Appendix study information and informed consent

TeilnehmerInneninformation und Einwilligungserklärung zur Teilnahme an der Studie:

Stress und Musik- oder Hörbuchhören

Sehr geehrte Teilnehmerin,

wir laden Sie ein, an der oben genannten Studie teilzunehmen.

Ihre Teilnahme an dieser Studie erfolgt freiwillig. Sie können jederzeit, ohne Angabe von Gründen, Ihre Bereitschaft zur Teilnahme ablehnen oder auch im Verlauf der Studie zurückziehen. Die Ablehnung der Teilnahme oder ein vorzeitiges Ausscheiden aus dieser Studie hat keine nachteiligen Folgen für Sie.

Diese Art von Studien ist notwendig, um verlässliche neue *wissenschaftliche* Forschungsergebnisse zu gewinnen. Unverzichtbare Voraussetzung für die Durchführung von Studien ist jedoch, dass Sie Ihr Einverständnis zur Teilnahme an dieser Studie schriftlich erklären. Bitte lesen Sie den folgenden Text als Ergänzung zum Informationsgespräch sorgfältig durch und zögern Sie nicht, Fragen zu stellen.

Bitte unterschreiben Sie die Einwilligungserklärung nur

- wenn Sie Art und Ablauf der Studie vollständig verstanden haben,
- wenn Sie bereit sind, der Teilnahme zuzustimmen und
- wenn Sie sich über Ihre Rechte als Teilnehmer/in an dieser Studie im Klaren sind.

1. Was ist der Zweck dieser Studie?

   Mit dieser Studie wollen wir verschiedene Einflussfaktoren auf die Wirkung von Stress untersuchen. Um diese Zusammenhänge überprüfen zu können, möchten wir mit Ihnen eine Untersuchung durchführen, die ähnlich wie bei einer Schulprüfung eine körperliche Stressreaktion hervorrufen wird. Auch soll anhand dieser Studie wissenschaftlich untersucht werden, wie das Hören verschiedener Arten von Musik und Hörbüchern sich auf das persönliche Befinden auswirkt.

2. Wie läuft diese Studie ab?

   Diese Studie wird an der Universität Wien, an der Fakultät für Psychologie, durchgeführt. Es nehmen insgesamt 80 Personen an der Studie teil. Die Studie umfasst mehrere Aufgaben und Messungen:

   1) Fragebögen
      Während des gesamten Experiments werden wir Ihnen zu bestimmten Zeitpunkten über

schriftliche Fragebögen einige Fragen zu Ihrem persönlichen Befinden oder zu Ihrem Empfinden des Stresstests oder der gehörten Musik bzw. des gehörten Hörbuchs stellen. Die Beantwortung der Fragen wird einige Minuten in Anspruch nehmen.

2) Messung der Herzfrequenz und Hautleitfähigkeit
Für die Zeit der Testung werden Sie einen Brustgurt zur Messung der Herzfrequenz tragen. Um diesen anzulegen, müssen Sie kurz Ihr T-Shirt anheben. Die Versuchsleitung, welche männlich oder weiblich sein kann, wird Ihnen diesen Brustgurt anlegen. Außerdem wird die Hautleitfähigkeit gemessen. Dafür werden an einer Hand Sensoren auf der Handinnenfläche angebracht.

3) Stresstest
Der Stresstest ähnelt einer Schulprüfung, wobei Sie mehrere Aufgaben zu erfüllen haben. Sie werden zu einem späteren Zeitpunkt über die genauen Aufgaben informiert.

4) Klebestreifen-Abriss-Prozedur und Hautmessungen
Nach dem Stresstest wird bei Ihnen ein sogenanntes „Klebestreifen-Abriss-Verfahren" ausgeführt. Bei dieser Prozedur wird an einer Hautstelle von wenigen cm^2 an der Innenseite Ihres Unterarms durch wiederholtes Aufkleben und Abreißen von Klebestreifen die dünne, oberste Hautschicht abgetragen. Diese Prozedur ist völlig harmlos und so gut wie schmerzlos, aber kann bei manchen Personen zu leichten, harmlosen Hautirritationen führen. Vor dem Verfahren ist es notwendig, eine kleine Stelle des inneren Unterarms zu rasieren. Direkt vor und nach der Klebestreifen-Abriss-Prozedur wird mit einem Sensor der Wasserverlust auf Ihrer Haut gemessen. Die Messung ist schmerzlos und dauert etwa 2 Minuten. Während des gesamten Experiments werden wir diese Hautmessung zu bestimmten Zeitpunkten wiederholen.

5) Liegestuhl
Nach der Klebestreifen-Abriss-Prozedur werden Sie auf einem Liegestuhl Platz nehmen und in manchen Fällen über Kopfhörer entweder eine Abspielliste mit Musikstücken oder ein informatives Hörbuch hören. In anderen Fällen werden sie keine Abspielliste bzw. kein Hörbuch hören. Sie können gegebenenfalls vorher aus mehreren Abspiellisten eine Abspielliste bzw. ein Hörbuch nach Ihren persönlichen Präferenzen auswählen. Während Sie auf dem Liegestuhl liegen, haben Sie keine bestimmte Aufgabe: Bleiben Sie einfach ruhig sitzen und hören Sie aufmerksam zu. Dieser Teil der Studie wird 30 Minuten in Anspruch nehmen.

6) Speichelproben
Während des gesamten Experiments werden wir zu bestimmten Zeitpunkten, insgesamt 8 Mal, Speichelproben entnehmen. Die Versuchsleitung wird Sie dazu noch genauer instruieren.

7) Zeitschriften Lesen
Nach dem Musik- oder Hörbuchhören müssen Sie noch etwa 1,5 Stunden im Testraum bleiben. Während dieser Zeit sind für Sie Zeitschriften zum Lesen verfügbar, zudem führen wir zu bestimmten Zeitpunkten weitere Hautmessungen bei Ihnen durch. Auch wird Ihnen noch einige Male eine Speichelprobe entnommen und ein Fragebogen ausgehändigt.

Am Ende der Untersuchung wird Ihnen die Versuchsleitung in einer Abschlussbesprechung für Fragen zur Verfügung stehen. Die Gesamtdauer der Studie beträgt 3,5 Stunden.

Voraussetzung für die Studienteilnahme ist, dass Sie die erforderlichen Einschlusskriterien erfüllen. Um diese feststellen zu können, wurde im Vorfeld ein Telefoninterview mit Ihnen durchgeführt. Eine Teilnahme an dieser Studie ist nicht möglich, wenn Sie unter 18 und über 35 Jahre alt sind, schwanger sind, stillen, bei Einnahme diverser Medikamente, wenn Sie Raucherin sind, Drogen konsumieren oder unter schweren körperlichen oder psychischen Erkrankungen leiden, die Sie in Ihrem Alltag beeinträchtigen, oder Schädigungen des Gehörs (chronischer Tinnitus, Hörbeeinträchtigung) haben. Zudem sollten Sie einen regelmäßigen Zyklus aufweisen, keine Medikamente mit Einfluss auf den Zyklus einnehmen und nicht hormonell verhüten.

3. **Worin liegt der Nutzen einer Teilnahme an der Studie?**

Es ist nicht zu erwarten, dass Sie aus Ihrer Teilnahme an dieser Studie einen direkten gesundheitlichen Nutzen ziehen werden. Durch Ihre Teilnahme erhalten Sie allerdings einen direkten Einblick in die psychologische Forschung zum Thema Musik und Gesundheit. Auch ermöglichen Sie durch Ihre Teilnahme, musikpsychologische Forschungsfragen zu beantworten. Langfristig gesehen tragen Sie somit ebenfalls einen wichtigen Teil dazu bei, musikbasierte Interventionen zur Gesundheitsförderung zu verbessern.

4. **Gibt es Risiken bei der Durchführung der Studie und ist mit Beschwerden oder anderen Begleiterscheinungen zu rechnen?**

Die Klebestreifen-Abriss-Prozedur wurde schon vielfältig eingesetzt und gilt als völlig harmlos und nahezu schmerzfrei. Trotzdem kann in Einzelfällen eine leichte Irritation oder vorübergehende Rötung der Haut auftreten. Diese sollte jedoch nach wenigen Stunden wieder abklingen und sich spätestens am Folgetag ganz zurückgebildet haben. Es sind keinerlei Spätfolgen bekannt. Falls Sie die Prozedur trotzdem als unangenehm empfinden, informieren Sie bitte die Versuchsleitung. Es ist zu jeder Zeit möglich, die Testung abzubrechen und aus der Studie auszuscheiden.

Wir gehen davon aus, dass die Durchführung des Stresstests unangenehm für Sie sein kann. Von den anderen Aufgaben sind für Sie keine negativen Begleiterscheinungen zu erwarten.

5. **Hat die Teilnahme an der Studie sonstige Auswirkungen auf die Lebensführung und welche Verpflichtungen ergeben sich daraus?**

Vor dem Testtermin ist es unerlässlich, dass gewisse Dinge beachtet und eingehalten werden, da bestimmte Aktivitäten bzw. Faktoren die Messwerte beeinflussen und unbrauchbar machen könnten. Am Tag des Testtermins sollten Sie eine Stunde vorher keine Mahlzeiten sowie alkoholische oder aufputschende Getränke zu sich zu nehmen (z.B. Koffein, Tein, Taurin, etc.) und eine Stunde vorher keiner exzessiven sportlichen Betätigung oder Yoga/Entspannungsverfahren nachgehen. Auch dürfen Sie einen Tag vorher keine Lotions, Cremes usw. auf der Haut des Unterarms verwenden.
Der Testtermin wird in unserem Music & Health Labor zwischen 13:00 und 17:00 Uhr stattfinden, da wir mögliche tageszeitliche Schwankungen der biologischen Messungen konstant halten möchten.

6. Was ist zu tun beim Auftreten von Beschwerdesymptomen, unerwünschten Begleiterscheinungen und/oder Verletzungen?

   Es ist unwahrscheinlich, dass im Rahmen der Studie unerwünschte Begleiterscheinungen oder Beschwerdesymptome auftreten werden. Sollten bei Ihnen im Laufe der Studie dennoch körperliche oder sonstige Beschwerden auftreten, bitten wir Sie, diese unverzüglich der Versuchsleitung mitzuteilen. Kontaktdaten der Versuchs- und Projektleitung können Sie unter Punkt 10 einsehen.

7. Wann wird die Studie vorzeitig beendet?

   Ihre Teilnahme an dieser Studie ist freiwillig. Sie können jederzeit, auch ohne Angabe von Gründen, Ihre Teilnahmebereitschaft widerrufen und aus der Studie ausscheiden, ohne dass Ihnen dadurch irgendwelche Nachteile entstehen. Wenn Sie auf die Teilnahme an dieser Studie verzichten, haben Sie keinerlei Nachteile zu erwarten. Das Gleiche gilt, wenn Sie Ihre dazu gegebene Einwilligung zu einem späteren Zeitpunkt widerrufen. Diese Möglichkeit haben Sie während der gesamten Untersuchung. Einen etwaigen Widerruf Ihrer Einwilligung bzw. einen Rücktritt von der Studie müssen Sie nicht begründen. Im Falle eines Widerrufs werden auf Ihr Verlangen die im Rahmen der Studie erhobenen Speichelproben vernichtet und sämtliche erhobene Daten gelöscht. Kontaktieren Sie bitte den verantwortlichen Projektleiter (siehe 10), um diese Schritte einzuleiten. Bei einem freiwilligen Studienabbruch werden die Gründe, sofern sie genannt werden, festgehalten.

   Ihre Teilnahme kann zudem durch das Studienpersonal abgebrochen werden, falls Sie die Teilnahmekriterien nicht erfüllen, Sie sich nicht an die Anweisungen des Studienpersonals halten oder die Studienleitung zur Annahme gelangt, dass eine weitere Teilnahme nicht zu Ihrem Besten wäre.

8. In welcher Weise werden die im Rahmen dieser Studie gesammelten Daten verwendet?

   In dieser Studie werden persönliche Daten von Ihnen erfasst. Alle erhobenen Daten werden unter strenger Beachtung der gesetzlichen Regelungen zum Datenschutz aufbewahrt. Es werden nur personenbezogene Daten erhoben, die für das Erreichen des Studienziels erforderlich sind. Ihre Speichelproben werden im biochemischen Labor des Arbeitsbereichs Klinische Psychologie des Erwachsenenalters ausgewertet. Das an der Studie beteiligte Personal unterliegt der Schweigepflicht.

   Ihre wissenschaftlichen Daten werden zunächst in pseudonymisierter Form elektronisch abgespeichert. Pseudonymisierung bedeutet, dass ein Dokument erstellt wird, das Ihren Namen mit anderen Studiendaten über einen Code verbindet. Dieses Dokument wird an einem separaten Ort aufbewahrt und ausschließlich dem verantwortlichen Studienleiter zugänglich gemacht. Sobald die Datenauswertung abgeschlossen ist, wird dieses Dokument vernichtet. Ab diesem Zeitpunkt sind die Daten anonymisiert. Eine Zuordnung zwischen den Daten im Datensatz und Ihrer Person ist dann nicht mehr möglich. Entsprechend ist nach Abschluss der Datenauswertung auch keine gezielte Löschung Ihres persönlichen Datensatzes mehr möglich, da wir diesen nicht mehr zuordnen können. Die anonymisierten Daten werden für die Dauer von mindestens 10 Jahren aufbewahrt.

   Die Ergebnisse und Daten dieser Studie werden als wissenschaftliche Publikationen veröffentlicht. Dies geschieht in anonymisierter Form, d.h. ohne dass die Daten einer spezifischen Person

zugeordnet werden können. Die vollständig anonymisierten Daten dieser Studie werden als offene Daten im Internet in einem gesicherten Datenarchiv zugänglich gemacht. Dies ermöglicht eine künftige Nachnutzung der anonymisierten Daten durch andere Wissenschaftler, deren Zweck und Umfang zum aktuellen Zeitpunkt nicht absehbar ist. Damit folgt diese Studie den Empfehlungen der Deutschen Forschungsgemeinschaft (DFG) und der Deutschen Gesellschaft für Psychologie (DGPs) zur Qualitätssicherung in der Forschung.

Der Projektleiter ist verantwortlich für die Einhaltung der nationalen und internationalen Richtlinien zum Datenschutz in dieser Studie. Sie können jederzeit (jedoch nur vor der Anonymisierung der Daten vor Abschluss der Datenauswertung) Auskunft über Ihre gespeicherten Daten verlangen. Sie haben das Recht, fehlerhafte Daten zu berichtigen oder Daten löschen zu lassen und Sie haben das Recht, die Einwilligung zur Verarbeitung Ihrer personenbezogenen Daten zu widerrufen. Bitte kontaktieren Sie hierfür den verantwortlichen Projektleiter, Herrn Prof. Dr. Urs M. Nater (Liebiggasse 5, A-1010 Wien, Raum O1.39, Tel.: +43 – 1 – 4277 – 47220, E-Mail: urs.nater@univie.ac.at).

9. Entstehen für die Teilnehmerinnen Kosten? Gibt es einen Kostenersatz oder eine Vergütung?

Abgesehen von der Anreise zu den Untersuchungsterminen kommen keinerlei Kosten auf Sie zu. Dies trifft auch im Falle eines freiwilligen oder unfreiwilligen Studienabbruchs zu. Sie erhalten eine Aufwandsentschädigung von 40 Euro am Ende des Untersuchungszeitraumes. Sollten Sie Ihre Teilnahme an der Studie vorzeitig beenden wollen, erhalten Sie eine anteilige Aufwandsentschädigung.

10. Möglichkeit zur Diskussion weiterer Fragen

Für weitere Fragen im Zusammenhang mit der Studie steht Ihnen die Studienleitung gerne zur Verfügung. Auch beantworten wir Ihnen selbstverständlich gerne Fragen, die die Rechte für Sie als Teilnehmerin an der Studie betreffen.

Bei Unklarheiten bezüglich der Studie und bei unerwarteten oder unerwünschten Ereignissen, die während der Studie oder nach deren Abschluss auftreten, können Sie sich jederzeit an Herrn Prof. Dr. Urs M. Nater (Tel.: +43 – 1 – 4277 – 47220) wenden.

Namen der der Kontaktpersonen für Rückfragen:

Leiter	Name: Univ.-Prof. Dr. Urs M. Nater E-Mail: urs.nater@univie.ac.at Tel.: +43 – 1 – 4277 – 47220
Versuchsleiter/in	Name: Dr. Jasminka Majdandžić E-Mail: jasminka.majdandzic@univie.ac.at Teo.: +43 – 1 – 4277 - 47242
Weitere relevante Personen	Name: Yichen Song, Msc E-Mail: yichen.song@univie.ac.at Tel.: +43 1 4277-47205

11. Einwilligungserklärung

Name der teilnehmenden Person in Druckbuchstaben: .....

Geb. Datum: .....

Ich erkläre mich bereit, an der Studie *Stress und Musik- oder Hörbuchhören* teilzunehmen.

Ich bin von „.....“ *(VersuchsleiterIn)* ausführlich und verständlich über Zielsetzung, Bedeutung und Tragweite der Studie und die sich für mich daraus ergebenden Anforderungen aufgeklärt worden. Ich habe darüber hinaus den Text dieser TeilnehmerInneninformation und Einwilligungserklärung gelesen, insbesondere den 4. Abschnitt (Gibt es Risiken, Beschwerden und Begleiterscheinungen?). Aufgetretene Fragen wurden mir von der Studienleitung verständlich und ausreichend beantwortet. Ich hatte genügend Zeit, mich zu entscheiden, ob ich an der Studie teilnehmen möchte. Ich habe zurzeit keine weiteren Fragen mehr.

Ich werde die Hinweise, die für die Durchführung der Studie erforderlich sind, befolgen, behalte mir jedoch das Recht vor, meine freiwillige Mitwirkung jederzeit zu beenden, ohne dass mir daraus Nachteile entstehen. Sollte ich aus der Studie ausscheiden wollen, so kann ich dies jeder Zeit schriftlich oder mündlich bei Univ.-Prof. Dr. Urs Nater veranlassen.

Ich bin zugleich damit einverstanden, dass meine im Rahmen dieser Studie erhobenen Daten aufgezeichnet und ausgewertet werden.

Ich stimme zu, dass meine Daten dauerhaft in anonymisierter Form elektronisch gespeichert werden. Die Daten werden in einer nur der Projektleitung zugänglichen Form gespeichert, die gemäß aktueller Standards gesichert ist.

Sollte ich zu einem späteren Zeitpunkt die Löschung meiner Daten wünschen, so kann ich dies schriftlich oder telefonisch ohne Angabe von Gründen bei Univ.-Prof. Dr. Urs Nater (Liebiggasse 5, A-1010 Wien, Raum O1.39, Tel.: +43 – 1 – 4277 – 47220, E-Mail: urs.nater@univie.ac.at) veranlassen.

Den Aufklärungsteil habe ich gelesen und verstanden. Ich konnte im Aufklärungsgespräch alle mich interessierenden Fragen stellen. Sie wurden vollständig und verständlich beantwortet.

Eine Kopie dieser TeilnehmerInneninformation und Einwilligungserklärung habe ich erhalten. Das Original verbleibt bei der Studienleitung.

(Datum und Unterschrift der Teilnehmerin)

.....

(Datum, Name und Unterschrift der Studienleitung)

.....

Der Gold-MSI Fragebogen

Deutsche Version

Bitte umkreisen Sie die am besten zutreffende Kategorie:	**1 Stimme ganz und gar nicht zu**	**2 Stimme nicht zu**	**3 Stimme eher nicht zu**	**4 Weder noch**	**5 Stimme eher zu**	**6 Stimme zu**	**7 Stimme voll und ganz zu**
1. Ich beschäftige mich in meiner Freizeit viel mit musikbezogenen Aktivitäten.	1	2	3	4	5	6	7
2. Ich suche oft Musik aus, bei der ich eine Gänsehaut bekomme.	1	2	3	4	5	6	7
3. Ich schreibe gerne über Musik, z. B. in Internetblogs oder Foren.	1	2	3	4	5	6	7
4. Wenn jemand anderes ein Lied singt, welches ich nicht kenne, kann ich normalerweise mitsingen.	1	2	3	4	5	6	7
5. Ich kann beurteilen, ob jemand gut singt oder nicht.	1	2	3	4	5	6	7
6. Meistens weiß ich, ob ich ein Lied zum ersten Mal höre.	1	2	3	4	5	6	7
7. Ich kann auswendig singen oder Musik spielen.	1	2	3	4	5	6	7
8. Ich bin fasziniert von Musikstilen, mit denen ich nicht vertraut bin, und möchte mehr darüber erfahren.	1	2	3	4	5	6	7
9. Musikstücke rufen selten Gefühle in mir hervor.	1	2	3	4	5	6	7
10. Ich bin in der Lage, die richtigen Töne zu treffen, wenn ich zu einer Aufnahme mitsinge.	1	2	3	4	5	6	7

Bitte umkreisen Sie die am meisten zutreffende Kategorie:	1 Stimme ganz und gar nicht zu	2 Stimme nicht zu	3 Stimme eher nicht zu	4 Weder noch	5 Stimme eher zu	6 Stimme zu	7 Stimme voll und ganz zu
11. Ich finde es schwierig Fehler festzustellen, die ein Sänger macht, selbst wenn ich das Lied kenne.	1	2	3	4	5	6	7
12. Ich kann zwei Interpretationen oder Versionen desselben Musikstücks miteinander vergleichen und über die Unterschiede diskutieren.	1	2	3	4	5	6	7
13. Es fällt mir schwer, ein bekanntes Lied zu erkennen, wenn es auf eine andere Weise oder von einem anderen Interpreten gespielt oder gesungen wird.	1	2	3	4	5	6	7
14. Ich bin noch nie für meine musikalischen Fähigkeiten gelobt worden.	1	2	3	4	5	6	7
15. Ich lese oder suche oft im Internet nach Dingen, die mit Musik zu tun haben.	1	2	3	4	5	6	7
16. Ich suche häufig eine bestimmte Musik aus, um mich zu motivieren oder zu begeistern.	1	2	3	4	5	6	7
17. Wenn jemand anders ein Lied singt, das ich kenne, kann ich eine zweite Stimme dazu singen.	1	2	3	4	5	6	7
18. Ich kann beurteilen, ob jemand nicht im Rhythmus mit der Musik singt oder spielt.	1	2	3	4	5	6	7
19. Ich kann identifizieren, was das Besondere an einem bestimmten Musikstück ist.	1	2	3	4	5	6	7
20. Ich bin in der Lage, über meine Gefühle, die durch Musik hervorgerufen werden, zu sprechen.	1	2	3	4	5	6	7

Bitte umkreisen Sie die am meisten zutreffende Kategorie:	**1 Stimme ganz und gar nicht zu**	**2 Stimme nicht zu**	**3 Stimme eher nicht zu**	**4 Weder noch**	**5 Stimme eher zu**	**6 Stimme zu**	**7 Stimme voll und ganz zu**
21. Ich gebe nicht viel Geld meines verfügbaren Einkommens für Musik aus.	1	2	3	4	5	6	7
22. Ich kann beurteilen, ob jemand falsch oder richtig singt oder spielt.	1	2	3	4	5	6	7
23. Wenn ich singe, habe ich keine Ahnung, ob ich richtig oder falsch singe.	1	2	3	4	5	6	7
24. Musik ist für mich eine Art von Sucht - ohne sie könnte ich nicht leben.	1	2	3	4	5	6	7
25. Ich singe nicht gerne in der Öffentlichkeit, weil ich Angst habe, falsche Töne zu treffen.	1	2	3	4	5	6	7
26. Wenn ich ein Musikstück höre, kann ich normalerweise die Stilrichtung erkennen.	1	2	3	4	5	6	7
27. Ich würde mich selbst nicht als Musiker/-in bezeichnen.	1	2	3	4	5	6	7
28. Ich halte mich auf dem Laufenden, was neue Musik angeht (z. B. neue Künstler oder Aufnahmen).	1	2	3	4	5	6	7
29. Wenn ich einen Song zwei- oder dreimal gehört habe, kann ich ihn meistens alleine singen.	1	2	3	4	5	6	7
30. Ich brauche eine neue Melodie nur einmal zu hören, dann kann ich sie auch Stunden später noch singen.	1	2	3	4	5	6	7
31. Musik kann bei mir Erinnerungen an Personen und Orte hervorrufen.	1	2	3	4	5	6	7

Bitte umkreisen Sie die am meisten zutreffende Kategorie:

32. Ich habe regelmäßig und täglich ein Instrument (einschließlich Gesang) für **0 / 1 / 2 / 3 / 4-5 / 6-9 / 10 oder mehr** Jahre geübt.

33. An dem Höhepunkt meines Interesses habe ich mein Hauptinstrument **0 / 0,5 / 1 / 1,5 / 2 / 3-4 / 5 oder mehr** Stunden pro Tag geübt.

34. Ich habe **0 / 1 / 2 / 3 / 4-6 / 7-10 / 11 oder mehr** Live-Events als Zuschauer innerhalb der letzten 12 Monate besucht.

35. Ich habe **0 / 0,5 / 1 / 2 / 3 / 4-6 / 7 oder mehr** Jahre Unterricht in Musiktheorie (außerhalb der Schule) erhalten.

36. Ich habe **0 / 1 / 2 / 3 / 4-5 / 6-9 / 10 oder mehr** Jahre Musikunterricht auf einem Instrument (einschließlich Gesang) in meinem bisherigen Leben gehabt.

37. Ich kann **0 / 1 / 2 / 3 / 4 / 5 / 6 oder mehr** verschiedene Instrumente spielen.

38. Ich höre jeden Tag aufmerksam Musik für **0-15min / 15-30min / 30-60min / 60-90min/ 2 Std / 2-3 Std / 4 Std oder mehr.**

39. Das Instrument (einschließlich Gesang), welches ich am besten spiele ist _____

Appendix data norms for the German version of the Gold-MSI

Tabelle A3. Perzentile der Gold-MSI-Teilskalen und des Globalfaktors *Allgemeine Musikalische Erfahrenheit* (*N* = 641).

		F1	F2	F3	F4	F5	F6
		Aktiver Umgang mit Musik	Wahrnehmungs-fähigkeiten	Musikalische Ausbildung	Emotionen	Gesangs-fähigkeiten	Allgemeine Musikalische Erfahrenheit
Min.		10	12	7	12	7	23
Max.		58	63	49	42	49	121
Mittelwert		32,99	45,84	22,85	30,67	27,55	70,41
SD		9,45	8,62	10,62	5,55	8,87	19,94
Perzentil	5	18	31	8	19	13	39
	10	20	34	9	23	16	45
	15	22	37	10	25	18	48
	20	25	38	12	26	20	53
	25	26	40	14	27	21	56
	30	28	42	15	28	23	58
	35	29	43	17	29	24	61
	40	30	44	18	30	25	64
	45	32	46	20	31	26	67
	50	33	46	22	32	27	70
	55	34	47	24	32	28	74
	60	36	49	26	33	30	76
	65	37	49	28	33	31	80
	70	38	50	30	34	33	82
	75	40	52	31	35	34	85
	80	41	54	33	35	36	89
	85	43	55	36	36	38	93
	90	45	57	38	37	40	97
	95	49	59	40	39	41	102
	100	58	63	49	42	49	121

Source: Schaal, Bauer, and Müllensiefen (2014)

Appendix Visual Analogue Scale (VAS) for subjective stress