MASTERARBEIT | MASTER'S THESIS

Titel | Title

The role of trait absorption in the relationship between music, stress reduction and skin barrier recovery

verfasst von | submitted by

Lukas Bacher BA BSc

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

Master of Science (MSc)

Wien | Vienna, 2024

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
Betreut von | Supervisor:	Univ.-Prof. Dr. Urs Markus Nater
Mitbetreut von | Co-Supervisor:	Dr. Jasminka Majdandzic

Declaration on cooperation with other master's students

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

Table of Contents

List of abbreviations

ACTH: adrenocorticotropic hormone

ANS: autonomic nervous system

AUC: area under the curve

bpm: beats per minute

CFS: chronic fatigue syndrome

CNS: central nervous system

CRF: corticotropin-releasing factor

GR: glucocorticoid receptors

HPA axis: Hypothalamic–pituitary–adrenal axis

MDBF: Der Mehrdimensionale Befindlichkeitsfragebogen

PD: Parkinson's disease

PNS: parasympathetic nervous system

PVN: paraventricular nucleus

SBR: skin barrier recovery

SNS: sympathetic nervous system

TABS: Tellegen Absorption Scale (German version)

TAS: Tellegen Absorption Scale

TEWL: transepidermal water loss

TSST: Trier Social Stress Test

TTPAS: Types of Positive Affect Scale

VAS: visual analogue scale

Abstract

Objectives

Listening to music has been shown to alleviate the stress response through influencing a variety of psychological and biological mechanisms, such as reducing cortisol secretion or subjective stress levels. This study investigates the effect of music listening following acute stress on skin barrier recovery and on the reduction of subjective stress. In addition, this study investigates the effect of absorption, which, by informing attentional engagement and thus music reward, may moderate stress reduction and skin barrier recovery from listening to music following acute stress.

Method

39 participants (all female) were randomly assigned to two different groups (silent control group, music group). Stress was experimentally induced using the Trier Social Stress Test (TSST). After the TSST, the participants' skin barrier was impaired. The participants then had to sit in silence or listen to music for 30 minutes. Skin barrier recovery was calculated by measuring excess water evaporation (transepidermal water loss). Subjective stress was measured using a visual analogue scale. Absorption was measured using the German version of the Tellegen Absorption Scale (TABS). Statistical analysis was performed to test for differences between conditions and to investigate the effect of absorption on skin barrier recovery and stress reduction.

Results and conclusions

The results showed no significant difference in the reduction of subjective stress and skin barrier recovery between the two conditions (silent control group, music group). Furthermore, absorption did not predict the reduction of subjective stress or skin barrier recovery in the music condition. Further studies with larger sample sizes are needed to draw definitive conclusions.

Abstract

Ziele

Das Hören von Musik vermindert die Stressreaktion, indem es eine Reihe von biologischen und psychologischen Mechanismen beeinflusst (z.B. Cortisolausschüttung). In dieser Studie wird die Wirkung des Musikhörens nach akutem Stress auf die Regeneration der Hautbarriere und auf die Verringerung des subjektiven Stressempfindens untersucht. Zusätzlich wird in dieser Studie die Wirkung der Eigenschaft Absorption untersucht. Absorption steht im Zusammenhang mit dem Belohnungsgefühl, das durch das Hören von Musik ausgelöst wird. Es wird die Hypothese untersucht, dass Absorption einen positiven Einfluss auf die stressreduzierende Wirkung von Musik hat und sich dabei positiv auf die Verringerung des subjektivem Stressempfindens und die Regeneration der Hautbarriere auswirkt.

Methode

39 Teilnehmerinnen wurden randomisiert zwei verschiedenen Gruppen zugeteilt (Stille & Musik). Akuter Stress wurde mit dem Trier Social Stress Test (TSST) induziert. Nach dem TSST wurde die Hautbarriere der Teilnehmerinnen beschädigt. Anschließend mussten die Probandinnen 30 Minuten in Stille sitzen oder Musik hören. Die Regeneration der Hautbarriere wurde anhand der Messung des transepidermalen Wasserverlustes berechnet. Subjektiver Stress wurde mit einer visuellen Analogskala gemessen. Absorption wurde mit der deutschen Version der Tellegen-Absorptionsskala (TABS) gemessen. Es wurden statistische Analysen durchgeführt, um Unterschiede zwischen den Bedingungen (d.h. Stille & Musik) festzustellen und um die Auswirkungen von Absorption auf die Reduktion von subjektivem Stress und auf die Regeneration der Hautbarriere zu untersuchen.

Resultate

Die Ergebnisse zeigten keinen signifikanten Unterschied bezüglich der Verringerung des subjektiven Stresses und der Erholung der Hautbarriere zwischen den beiden Bedingungen. Außerdem hatte Absorption keinen signifikanten Effekt auf die Verringerung des subjektiven Stresses oder auf die Erholung der Hautbarriere durch das Hören von Musik. Weitere Studien mit größeren Stichproben sind erforderlich, um endgültige Schlussfolgerungen ziehen zu können.

1. Introduction

Because the word contains so many meanings, dealing with stress is like fighting the mythical hydra, which had a limitless ability to grow new heads to replace the ones Hercules cut off. (unknown)

Over the years the complex nature of stress has inspired numerous definitions. Its most concise can be traced back to the "father" of stress research: Hans Selye. The Viennese-born physician described stress as "the nonspecific response of the body to any demand". Selye was one of the first scientists to recognise the negative impact of stress on human biology, a realisation that has been carried forward and confirmed by modern stress research. Stress increases the risk of becoming susceptible to several physical conditions and plays a major role in the development of many mental disorders (McEwen, 2008). As a further consequence, stress imposes a significant financial burden on our society through its involvement in the development of disease (Nater et al., 2006). Thus, it has become increasingly important to understand the mechanisms underlying the human stress response, its consequences and how stress can be alleviated.

One method by which our stress response can be alleviated is through listening to music (Pelletier, 2004). Music has emerged as an important area of interest when it comes to the reduction of stress. It is easily accessible, non-invasive and cost-effective (Thoma et al., 2013). Listening to music has been shown to reduce the physiological stress response. It also (Chanda & Levitin, 2013). Music can accelerate the reduction of stress and reduce cortisol secretion after exposure to an acute stressor (Khalfa et al., 2003). In addition, listening to music also appears to reduce subjective stress (De Witte, 2020).

One way in which stress negatively affects our physical health is by impairing the regenerative capacity of our skin barrier (specifically the outermost layer of our skin: lat. stratum corneum; Choe et al., 2018). After mild damage to the skin barrier, people who experience stress show a slower recovery of their skin barrier compared to people who are not under stress (Altemus et al., 2001). The negative effect of stress on our skin appears to be linked to the heightened activation of the HPA axis, leading to an increase in cortisol secretion, which slows down skin regeneration (Choe et al., 2018). As one of the pathways by which music may reduce the stress response is by reducing the secretion of glucocorticoids, it can be hypothesised that listening to music may have a beneficial effect on skin barrier recovery following exposure to an acute stressor. (Nguyen et al., 2016; Slominski & Żmijewski, 2017).

The beneficial effects of listening to music seem to depend on a variety of factors. Some of which are external, such as the characteristics of the music itself, while others are more internal, such as the gender of the listener (Pelletier, 2004). A central aspect of the process underlying the stress-reducing effects of music is the sense of reward that the listener experiences while listening to music (Cepeda et al., 2006). This experience of reward can be operationalized by a construct aptly named *“music reward”*. Music reward describes the ability of people to perceive listening to music as differentially rewarding (Mas-Herrero et al., 2012). This is important because the stress-reducing effect of listening to music appears to be linked to the activation of several neural reward circuits in our brain (Blood & Zatorre, 2001; Koelsch et al., 2005; Mavridis, 2014). The activation of reward pathways has been shown to suppress cortisol secretion, which in turn leads to a reduction in the stress response (Chanda & Levitin, 2013).

One construct that is highly correlated with music reward is absorption (Cardona et al., 2022). High levels of absorption may lead to a deeper involvement with the objects of consciousness (Jamieson, 2005). During a state of high absorption, a person may experience a heightened sense of connection to the universe, along with feelings of joy and ecstasy (Yaden et al., 2017). Absorption may affect the processing of stimuli (Balakrishnan & Dwivedi, 2021; Occa & Morgan; 2022) and was originally described as “A disposition for having episodes of ‘total’ attention that fully engage one's representational resources” (Tellegen & Atkinson, 1974, p. 268). Since absorption is correlated with music reward, which is potentially of great importance when it comes to the stress-reducing effect of music, it is plausible that people who score high in trait absorption would benefit more from listening to music as a means of stress reduction than people who score low in trait absorption. Answering this question would further corroborate the notion that the feeling of reward that one gets from listening to music is highly involved in the process of stress reduction and that this sense of reward is informed by high attentional engagement with the presented stimuli (in this case music), as measured by trait absorption.

Stress

Trying to find *one* definition that encompasses stress in all of its different facets may be as impossible as it is flawed. Over the years, stress has been viewed through the lens of various scholars from different scientific backgrounds, such as psychology, biology, medicine, sociology, or neurology. Reducing the phenomenon of stress to the perspective of a single individual or scientific discipline does a disservice to the complexity of the construct and leads to an oversimplified understanding of stress. Therefore, the following chapter attempts to paint a more holistic picture of stress by not only introducing three important figures in stress research, but also by delving deeper into their views on the phenomenon of stress and describing their scientific contributions.

American psychologist *Richard Lazarus* (1922-2002) was one of the leading figures in 20th century stress research (Rohmer, 2013). He developed the *transactional stress model*, describing stress as the result of the interactive process between situation and individual. According to Lazarus the individual's *appraisal* (a term coined by Lazarus that refers to the individual's assessment/evaluation of a stressor regarding its potential danger) of a situation is of crucial importance to the stress response. The appraisal of a stressor is highly individual. What may seem like a life-threatening situation to one person may appear harmless to another. Lazarus distinguished between primary appraisal, secondary appraisal and reappraisal. While primary appraisal involves the individual's assessment of the threat of the situation, secondary appraisal focuses on the availability and use of potential *coping* strategies (personal strategies to manage the challenges presented by a stressor). Finally, reappraisal occurs: by evaluating the success of the coping strategies used, the situation may be seen in a different light and may no longer elicit a stress response (Lazarus, 1966).

No article on stress would be complete without mentioning the father of stress research, *Hans Selye* (1907-1982). Selye, a Viennese-born endocrinologist, was one of the first scientists to study stress from a biological perspective, describing stress as “the nonspecific response of the body to any demand” (Selye, 1974). One of Selye's most important contributions to stress research was his description of the *General Adaption Syndrome* (G.A.S.), a term which he later simplified, rebaptising it *stress response.* Selye's understanding of stress (particularly regarding the involvement of the HPA axis) and the processes described in the General Adaptation Syndrome laid the foundation for modern stress research. In addition, Selye discovered the influence of mineralocorticoids and glucocorticoids (named by Selye) on the immune system through their anti- and pro-inflammatory actions (Szabo et al., 2012). The General Adaptation Syndrome is a model that demonstrates the effects of a stressor on the human organism. According to Selye (1950) the G.A.S. develops in three stages: The Alarm Reaction, The Stage of Resistance and The Stage of Exhaustion. In the first stage the body reacts to an acute stressor by providing extra energy through various mechanisms (e.g. by increasing blood pressure and blood sugar levels). After a short stage of alarm, the body enters The Stage of Resistance and attempts to reduce the level of stress. This is achieved through the action of mineralocorticoids. Finally, if the body is exposed to stress for an extended period of time, it may enter The Stage of Exhaustion (Selye, 1950). This can potentially lead to a variety of health complications, including mental disorders such as depression or other health problems such as gastrointestinal disorders (Nerdinger et al., 2019; "The Handbook Of Stress And Health", 2017).

Finally, the American physiologist *James Paget Henry* (1914-1996) provides us with a model of stress that integrates psychosocial variables with cardiovascular and neuroendocrinological factors. Unlike many of his predecessors, Henry distinguishes between different types of stress and places particular emphasis on the emotional response that a stressor may elicit. In fact, he uses the emotional response to a given stressor as a differentiating criterion, distinguishing between stressors that induce anxiety, stressors that induce anger, and stressors that induce depression. In his view, the primary function of stress is to increase the chances of survival in potentially life-threatening situations. A stressor triggers anxiety when a flight response ensures the best chance of survival. This specific reaction is accompanied by a release of adrenaline. Stressors that trigger anger usually occur when a fight response is needed to ensure survival. Increased secretion of testosterone and norepinephrine ensues. Lastly, Henry describes stressors that trigger depression. The onset of depression results from a situation where neither fight nor flight is the appropriate response. This reaction is linked to an increase in cortisol levels and a decrease in testosterone, which negatively affects mood and subsequently leads to social subordination (Henry, 1992).

The biology of stress

To better understand the biology of stress it is critical to first introduce the concept of homeostasis, which is at the centre of the genesis of stress. It is fundamental to the survival of all living organisms to maintain a constant state of relative equilibrium (homeostasis). This state of equilibrium is of paramount importance to the functioning of most biochemical processes in our body and consequently to our survival. There are a variety of factors that have the potential to disrupt homeostasis, resulting in a deviation from the organism's optimal living conditions (Chrousos, 1992). These factors (e.g. physical or psychological trauma) are often experienced as stress (Dinan & Cryan, 2012). Paradoxically, our body's efforts to restore a state of equilibrium can also be interpreted as stress (McCorry, 2007). A quote traced back to a physician in the 1950s perfectly describes the often ambiguous nature of stress:

"Stress, in addition to being itself, was also the cause of itself, and the result of itself." (Humphrey, 2005, as cited in Persson & Zakrisson, 2015, p. 149)

This statement further highlights the complexity of stress which is reflected in the biological processes of the stress response itself. Both the central nervous system (CNS) and the body's endocrine system play a critical role in our stress response. In particular, the hypothalamus, which links the nervous system to the endocrine system via the pituitary gland, is heavily involved in the regulation of stress. The paraventricular nucleus (PVN) in the hypothalamus is responsible for detecting potential stressors. When an event is identified as a stressor, the hypothalamus synthesizes corticotropin-releasing factor (CRF), which in turn regulates the secretion of several other hormones, such as adrenocorticotropic hormone (ACTH) in the pituitary and glucocorticoids (e.g. cortisol) in the adrenal glands. The release of glucocorticoids initiates a negative feedback loop that inhibits further production of CRF (Tsigos & Chrousos, 2002). This process occurs through the binding of cortisol and other steroid hormones to glucocorticoid receptors in the brain, which reduces the release of ACTH and restores a state of homeostasis after acute activation of the hypothalamic-pituitary-adrenal axis (HPA axis; Smith & Vale, 2006). The disruption of homeostasis (e.g. through psychological or physiological trauma) and subsequent activation of the HPA axis triggers a variety of different processes. These biological mechanisms either restore homeostasis or free up additional resources and energy reserves to respond to the demands placed on the organism by the stressor. The HPA axis, in concert with input from the CNS, regulates both the sympathetic (SNS) and parasympathetic (PNS) branches of the autonomic nervous system (ANS) (Carrasco & Van De Kar, 2003). Activation of the SNS leads to an increased heart rate and secretion of epinephrine from the adrenal medulla (among many other things), while the activation of the PNS helps the body to return to homeostasis (e.g. through an increased activity of the digestive system). In addition to regulating the cardiovascular and the metabolic system, the HPA axis also influences the functioning of our immune system and behavioural responses (Smith & Vale, 2006).

Stress and health: A global pandemic

Stress exerts its negative effects on our bodies through a variety of different mechanisms and pathways, informing a wide range of adverse health outcomes. Crucially, stress plays a major role in the development of cardiovascular disease (CVD; Schnall et al., 2019). CVD is the leading cause of death in most developing regions of the world, accounting for approximately 30 percent of deaths worldwide (Gaziano & Gaziano, 2012). CVD and its risk factors, such as hypertension and metabolic syndrome can be traced back to the rapid process of economic globalization which is characterized by an increase in work-related psychosocial stressors (Johnson, 2008). Stress-inducing job characteristics such as job strain, job insecurity, and shift work (among other factors) lead to an increased prevalence of CVD through three different mechanisms. The first mechanism is purely physiological: the demands and stressors of our modern work environment lead to changes in blood pressure, obesity and sleep disturbances. The second mechanism relates to stress-induced unhealthy behavioural practices such as smoking, alcohol and decreased physical activity. Finally, there is also a psychological mechanism which includes negative mental health outcomes related to stress such as depression and burnout (Landsbergis et al., 2011). In addition, conditions of high demand often lead to elevated cortisol levels. Chronically elevated cortisol levels may in part explain the negative health outcome of job stressors by raising blood pressure levels and ultimately increasing the probability to suffer from CVD (Schnall et al., 2000).

One disease that has received a great deal of scientific attention in recent years due to its association with the COVID-19 pandemic is ME/CFS (Myalgic Encephalomyelitis/ Chronic Fatigue Syndrome). Stress appears to play a critical role in the etiology of chronic fatigue syndrome. In Austria, approximately 80,000 people suffer from ME/CFS (ME/CFS: New Practice Guide Published, 2024). Due to the long term effects of COVID that number is expected to double in the upcoming years (Medical University of Vienna, 2024). The illness is characterized by severe fatigue lasting at least six months. Symptoms are extremely heterogeneous and vary from patient to patient, ranging from a sore throat to cognitive difficulties (Grinde, 2017). Stress is one of the antecedents of CFS in patients. Studies report that patients with CFS report more stressful life events in the year before the onset of their illness than a control group. They also tend to have higher overall chronic stress levels (Masuda et al., 2002; Faulkner & Smith, 2008). Studies with CFS patients report stress-induced changes in immunological factors in the blood which lead to chronic inflammation (Appel et al., 2007; Lattie et al., 2012).

Another way in which stress may be involved in the etiology of disease is through its effect on the outbreak of viruses. Supressed immune function caused by stress could lead to a viral infection, which otherwise might not present itself (Grinde, 2008) and there is evidence suggesting that stress may lead to a reactivation of latent viruses (e.g. herpes; Kiecolt-Glaser, 2005). Other scientists speculate that severe stress may weaken the blood-brain barrier, allowing a virus to more easily enter the CNS, ultimately triggering disease (Moen et al., 2003). Stress may also play a role in the etiology of cancer. While some sources report that the inflammatory response triggered by stressful events might increase the risk of cancer (Kiecolt-Glaser, 2005) other scientists are more doubtful whether a link between the incidence of cancer and stress exists. The evidence on stress as a risk factor for cancer is still largely inconclusive, with large discrepancies between studies and no clear explanation of which pathway might explain a relationship between stress and cancer (Johansen et al., 2017).

In addition to its negative impact on our physical health, stress also has a significant negative impact on our mental health. Stressful life events are often at the root of mood disorders (Gold & Chrousos, 2002), and chronic stress appears to be strongly associated with depression, making it one of the most important risk factors for the disease (McGonagle & Kessler, 1990). Furthermore, the localization of glucocorticoid receptors (GR) suggests a potential involvement of stress in several disease processes. GRs are localized in a variety of regions implicated in depressive and neurological pathologies, including the prefrontal cortex, the hippocampus, the striatum, the limbic system, the nucleus accumbens, and the ventral midbrain (Van Craenenbroeck et al., 2005). In addition, the HPA axis appears to be involved in a variety of neurodegenerative diseases such as Alzheimer's disease and Parkinson's disease (PD; Hemmerle et al., 2012). Elevated cortisol levels in PD patients may accelerate neurodegeneration (Kibel & Drenjancevic-Peric, 2008). Finally, stress also negatively affects sleep and physiological recovery and plays an important role in the development of burnout (Toker & Melamed, 2017).

In summary, the empirical evidence clearly demonstrates the devastating impact that stress can have on a wide range of physiological outcomes, ultimately contributing to disease and death. The detrimental effect of stress on our mental and physical well-being places a huge financial burden on our society and is often overlooked. In the United States alone, the direct and indirect costs of work-related stress amount to $300 billion per year (Rosch, 2001). A figure that pales in comparison to the human cost, as stress negatively impacts human life in ways that are as all-encompassing as they are inconceivable.

Stress and skin

> *The skin, our body's largest organ, serves as a visible and revealing canvas that mirrors the intricate interplay of internal factors and health-related conditions. Regarded as a faithful reflection of overall well-being, the skin unveils subtle cues and overt signals about the body's internal dynamics. Changes in its appearance or condition often provide valuable insights into various underlying issues that extend beyond the surface. (Sahawneh, 2024, p. 1)*

Human skin is composed of two main layers: the epidermis (outer layer) and the dermis (inner layer). The dermis is made up of the stratum reticulare and the stratum papillare. It consists of nerve endings, sebaceous glands, hair follicles, and blood and lymphatic vessels. The epidermis on the other hand, is mainly responsible for protection against chemical and physical environmental pollutants and consists of four sublayers: the stratum basale, the stratum spinosum, the stratum granulosum, and the stratum corneum (Woodby et al., 2020). The stratum corneum, being the outermost layer of the skin, acts as the main "barrier", protecting the skin from mechanical or chemical damage (Elias, 2005).

The results of previous studies suggest a link between skin health, mental health and other psychosocial factors such as stress and mood (Sahawneh, 2024). Patients with depressive disorder seem to suffer from skin conditions such as seborrheic dermatitis at a higher rate than people from a healthy population (Maietta et al., 1990). Furthermore, depression-induced alterations in cortisol production may lead to inflammation and interfere with the body's ability to repair skin damage (Sahawneh, 2024). Stress appears to play an important role in skin health, often acting as a trigger for the onset of skin conditions such as psoriasis (Rousset & Halioua, 2018; Woodruff et al., 1997). Stress negatively affects wound healing, resulting in delayed recovery (Kiecolt-Glaser et al., 1995). In addition, stress may negatively affect skin barrier recovery. Several studies suggest that the experience of acute stress slows down skin barrier regeneration after mild stratum corneum damage (Altemus et al., 2001; Choi et al., 2005; Muizzuddin et al., 2003; Robles, 2007). More specifically, acute stress appears to delay the skin's ability to regain its function as a barrier against excessive transepidermal water loss (TEWL) following injury. Although most studies report a negative effect of stress on the recovery rate of the human skin barrier, there is also some contrary evidence suggesting that there is no association between stress and skin barrier regeneration (Benham, 2015).

Choe et al. (2018) investigated the mechanism by which stress may impair skin barrier functioning, highlighting the role of cortisol as the main disruptive force slowing down skin barrier recovery. Stress-induced secretion of cortisol appears to disrupt the synthesis of lipids crucial to the regenerative processes of the stratum corneum, consequently delaying skin barrier recovery (Orion & Wolf, 2012). Thus, skin barrier recovery and particularly the measurement of TEWL after mild stratum corneum damage provide excellent insight into the effect of acute stress on the human organism.

Stress and music

Given the potentially devastating effects of stress on our body researchers are on a constant look out for effective methods to reduce stress. Music listening has long been at the centre of that research and has emerged as a valid method to alleviate stress. Music is an especially favourable tool to attenuate stress for a variety of different reasons. With the advent of the internet music consumption has essentially become free and easily accessible to most people. In addition, listening to music is non-invasive and free of negative side effects. What's more, listening to music as a form of therapy does not require the constant supervision of a clinician or any form of training, making it easy to integrate into everyday life.

There is a large body of evidence suggesting that listening to music has a positive effect on stress reduction. Not only does music appear to reduce subjective stress (Knight & Rickard, 2001), but it also has a positive effect on several physiological markers of stress. Listening to music in stressful situations can reduce heart rate, as shown in a study by Liu et al. (2015), in which participants who listened to a recommended music playlist showed a reduction in heart rate during a simulated long-haul flight. Other studies have shown similar promise. Thoma et al. (2013) randomly assigned sixty healthy female volunteers into three different groups. In the first condition the subjects listened to relaxing music, the second condition consisted of participants having to listen to the sounds of rippling water and in the third group there was no acoustic stimulation. They repeatedly assessed a variety of different stress-related measures such as salivary cortisol and salivary alpha-amylase (sAA), heart rate (HR), respiratory sinus arrhythmia (RSA), subjective stress perception and anxiety. Their hypothesis that listening to relaxing music prior to a psychosocial stress test would yield greater stress-reducing outcomes across all measures than the conditions in which participants did not listen to music was partially confirmed: the three conditions differed significantly in terms of sAA (p = 0.026). However, there was no difference between conditions in terms of heart rate and psychological measurers. Similar results were reported in a study done by

(Poveda et al., 2017), where listening to music before experimentally inducing a psychosocial stressor ameliorated the subsequent stress response as measured by salivary cortisol. Listening to relaxing music *after* being exposed to a stressor also seems to reduce the secretion of cortisol: when participants in one study listened to music after being exposed to an acute stressor, salivary cortisol levels stopped rising, while cortisol levels of participants who did not listen to music continued to rise for 30 minutes following the exposure to the stressor (Khalfa et al., 2003). Other stress-related biomarkers, such as oxytocin, also appear to be affected by music listening. Ooishi et al. (2017) reported an increase in salivary oxytocin when participants in their study listened to low-tempo music. Additionally, listening to music may decrease blood pressure (Mir et al., 2020) and facilitate blood pressure recovery after experiencing acute stress (Chafin et al., 2004). Furthermore, in a study by Ventura et al. (2012) listening to music reduced plasma cortisol and state anxiety.

While the exact mechanisms underlying the stress-reducing effect of music are still unclear, there appear to be several factors, whether related to the properties of the music itself, the circumstances of music listening, or the participants, that are especially conducive to stress reduction. De Witte et al. (2020) report in their meta-analysis (47 studies and 2.747 participants) that the stress-relieving effect of music therapy significantly differs between participants from different parts of the world with participants from western countries profiting more from music listening as a method to reduce stress than participants from non-western countries. In addition, music tempo emerged as a moderating factor in reducing stress through music listening. Music with a tempo between 60 and 90 bpm (beats per minute) produced the greatest stress-reducing effect. There were also significant differences regarding music style and music selection. The effect was greatest when there was a pre-selected list of music to choose from (d = 1.059 [.66–1.46]), while music selected by the patient had a smaller effect on stress reduction (d = .766 [.47–1.06]). Differences were also found in music style, with relaxing music (d = .826 [.49-1.16]) and own-preference music having a greater effect on stress reduction than classical music (d = .562 [-.07 to 1.19]). In addition, multiple listening sessions appeared to have a greater stress reduction effect than a single session. Finally, listening to music in a group setting led to more favourable results. Interestingly, variables such as gender and age had no moderating effect on stress-related outcomes. Overall, De Witte et al. (2020) found a significant medium to strong effect (d = .723, [.51-.94]) of music therapy on stress-related outcomes in mental health and medical settings.

An earlier meta-analysis (22 studies) conducted by Pelletier (2004) revealed an effect of similar magnitude of music-assisted relaxation techniques on stress-related arousal (d = .67). But in contrast to the results of the meta-analysis conducted by Witte et al. (2020), the age of the sample did influence stress reduction, with participants under the age of 18 benefiting more from music-assisted stress relaxation techniques than participants over the age of 18. Furthermore, individual interventions yielded greater stress reduction than group interventions while De Witte et al. (2020) reported the exact opposite. But there are also parallels between the studies with researcher-selected music having a greater stress-buffering effect than self-selected music. Additionally, subjects with musical experience benefitted more from music-assisted relaxation than subjects without any musical experience. Finally, adolescents preparing for labour seemed to benefit the most from music listening as a means to reduce stress.

A meta-analysis by Dalli and colleagues in 2022 found less promising results regarding the beneficial effects of music. Music did not have a significant effect on respiratory rate across all studies (11 studies included). Similar results were found in relation to heart rate and blood pressure. However, music did reduce anxiety in patients. Listening to music yielded a greater anxiety-reducing effect than standard care. But when the music listening condition was compared to a noise cancellation group, there was no significant difference between the groups (Dalli et al., 2022). While these results don't seem very encouraging, it should be noted that the meta-analysis by Dalli et al. only included studies with participants in intensive care. In addition, several other stress related outcomes, such as cortisol levels, were not included in the study. Furthermore, a meta-analysis (14 studies, 140 participants) conducted by Adiasto et al. (2022), which only included experimental studies with healthy participants, found no significant effect of listening to music on stress recovery.

Finally, although it is often difficult to compare studies due to differences in participants and methodology, and although music and stress research, like most other areas of science, suffers from publication bias which may lead us to overestimate the benefits of listening to music, a clear pattern is emerging in favour of the stress-relieving effect of music.

Absorption

There are a myriad of factors potentially moderating the stress-reducing effect of music. And while most studies analyse musical properties, intervention settings or demographics, there is little focus on individual attributes that may inform cognitive processes such as attention, consequently leading to differences in the perception (and effect) of music (see De Witte et al., 2019, 2020). Following this idea, I propose that one's level of *absorption* may lead to differences in stress reduction when listening to music. Tellegen & Atkinson who first developed the construct, describe absorption as: “A disposition for having episodes of ‘total’ attention that fully engage one's representational (i.e., perceptual, enactive, imaginative, and ideational) resources” (Tellegen & Atkinson, 1974, p. 268). As the following paragraph illustrates, the idea of absorption influencing treatment outcomes isn't entirely new, but its promise has yet to be explored in the context of music listening, stress reduction and, specifically, skin barrier recovery.

> […] it seems important to explore those human characteristics that may contribute to the efficacy of mind–body interventions in those who are most likely to benefit. One such characteristic, absorption, reflects an individual’s cognitive capacity for involvement in sensory and imaginative experiences in ways that alter an individual’s perception, memory, and mood with behavioral and biological consequences. Thus, one’s level of absorption may potentially create differential treatment effects in mind–body intervention outcomes. (Menzies et al., 2008, p. 1)

Music reward

Interestingly, there appears to be a relationship between absorption and music listening, more specifically, *music reward*. In a study by Cardona et al. (2022), 370 participants completed a scale measuring music reward (Barcelona Music Questionnaire, BMRQ) as well as a scale measuring absorption (Absorption in Music Scale, AIMS). The results showed a high correlation between the two constructs ($r = 0.78$, $p < 0.001$). Music reward describes a construct that indicates individual differences in the propensity to experience reward while listening to music (Mas-Herrero et al., 2012). Crucially, various studies have shown that the feeling of reward derived from listening to music is accompanied by the activation of emotion and reward-related brain circuits (Koelsch et al., 2005; Mavridis, 2014; Menon & Levitin, 2005; Weigmann, 2017). The activation of the reward system appears to play an important role in stress reduction and stress resilience (Chanda & Levitin, 2013; Dutcher, 2022; Dutcher & Creswell, 2018; Park et al., 2022).

Individual differences in how people experience a sense of reward from music or music-related activities may be due to physiological variations in functional connectivity between the nucleus accumbens (NAcc; part of the brain's reward system) and the right superior temporal gyrus (STG; involved in auditory processing; Martínez-Molina et al., 2019; Menon & Levitin, 2005; Salimpoor et al., 2013). A study by Noly-Gandon et al. (2023) supports this idea by highlighting the functional connectivity between the brain's reward system and the auditory cortex as a significant marker of individual differences in music reward sensitivity. The authors concluded that increased music reward sensitivity was associated with increased connectivity between the right hemisphere auditory cortex and frontal regions involved in music processing and reward. In addition, in a study by Martínez-Molina et al. (2019), the authors investigated whether individual variations in neuroanatomy, based on differences in white matter microstructure, account for individual differences in music-related reward sensitivity. They concluded their findings as follows:

> Overall, our results provide further support for the idea that the exchange of information among perceptual, integrative, and reward systems is important for musical pleasure, and that individual differences in the structure of the relevant anatomical connectivity influences the degree to which people are able to derive such pleasure. (Molina et al., 2019, p. 1)

In summary, there is considerable evidence for a neuroanatomical basis explaining individual differences in music reward. This suggests that the construct of music reward is stable over time, making it a useful indicator of the propensity to experience rewarding sensations from listening to music. Most importantly, the high correlation between absorption and music reward supports the idea that individual differences regarding the experience of musical pleasure may be partially explained by individual differences in attentional processes as indicated by trait absorption.

Stress and reward

There is a large body of evidence demonstrating that emotional responses, and in particular experiences of reward such as those elicited by music, are associated with physiological changes that may lead to beneficial health outcomes (Chanda & Levitin, 2013; Dutcher, 2022; Fuentes-Sánchez et al., 2021; Ferreri et al., 2019; Gold et al., 2023; Godara et al., 2019). Various studies point to the importance of the brain's reward circuitry as one of the main drivers of stress reduction and resilience. (Dutcher, 2022; Chanda & Levitin, 2013; Park et al., 2022). Several authors propose potential interactive mechanisms between stress and the reward system. First, the experience of acute stress appears to be associated with an increase in reward sensitivity, which allows for better coping through the recruitment of reward-related neural circuits (Ironside et al., 2018). Further studies suggest that the reward system plays an important role in optimising behavioural and physiological responses to aversive and stressful events. These coping processes are triggered through exposure to stressful events and involve modulation of the dopaminergic reward system (Bloomfield et al., 2019; Thierry et al., 1976). The experience of reward prior to acute stress appears to act as a buffer, reducing the subsequent stress response. Rats that received a reward prior to being exposed to acute stress, showed less anxiety-related behaviours than rats that did not receive a reward (Ulrich-Lai et al., 2010). Similar results have been found in human studies. Infants cried less during a blood draw when they were given a sweet liquid (the control group received water; Abad et al., 1996). It appears that reward may modulate the cortisol response by interacting with the HPA axis. In an experiment by Cresswell et al. (2013), men viewed rewarding erotic images prior to being exposed to a stress-inducing laboratory task. Viewing the images reduced neuroendocrine cortisol reactivity when exposed to a stressor. In addition, there are several studies suggesting that the activation of reward regions in the brain contributes to the downregulation of cortisol overreaction following the exposure to a stressor (Chanda & Levitin, 2013; Dutcher, 2022; Dutcher & Cresswell, 2018; Tabibnia, 2020). Looking into potential mechanisms involved in the development of depression provides us with further evidence for the interaction between the brain's reward circuitry and the regulation of stress. The neurogenesis of depression appears to be partially linked to a dysfunction of the reward system in response to stressful stimuli. Major depressive disorder (MDD) and its symptoms (specifically anhedonia) have been associated with structural abnormalities and hypoactivation in reward-related brain circuits, possibly leading to increased stress sensitivity (Bogdan et al., 2013; W. Liu et al., 2016).

In summary, there is a large body of evidence indicating the importance of the reward system in (down)-regulating the human stress response through a variety of mechanisms. The fact that listening to music activates reward-related brain regions lends further credence to the idea that music is indeed an effective tool for reducing stress. Crucially, differences in attentional processing, such as those mediated by trait absorption, may explain individual variability in the experience of musical reward consequently leading to differences in stress regulation, with people who score higher on absorption benefiting more from the stress-reducing effects of music.

2. Proposed model

As outlined in the previous chapters and as demonstrated by the results of several meta-analyses (De Witte et al., 2019; De Witte et al., 2020; Pelletier, 2004), there appears to be a beneficial effect of music listening on stress reduction. If we further consider that stress can impair skin barrier recovery by interacting with the regenerative process through the secretion of glucocorticoids, then we can assume that listening to music after exposure to an acute stressor may have a beneficial effect on the rate of skin barrier recovery. However, the stress-reducing effect of music may be influenced by several factors. I suggest that trait absorption is one of them. Through its correlation with music reward, absorption may lead to greater activation of reward-related neural regions, resulting in a greater stress-reducing effect. More specifically, a greater sense of reward and the corresponding greater activation of reward circuits in the brain may lead to greater disinhibition of the stress response through the downregulation of cortisol secretion, which potentially accelerates stress recovery.

Thus, individuals who score high on trait absorption should benefit more from the stress-reducing effect of music following exposure to an acute stressor (as opposed to individuals who score low on trait absorption). This should be reflected in a greater reduction in subjective stress. In addition, the outlined mechanism may also affect the rate of skin barrier recovery. Again, individuals high in trait absorption should benefit more from the stress-reducing effects of music following exposure to an acute stressor (as opposed to individuals low in trait absorption). This should result in a faster rate of skin barrier recovery due to the greater inhibition of cortisol secretion, resulting in less interference of glucocorticoids with the skin barrier regeneration process, ultimately speeding up recovery.

Research questions and hypotheses

Whilst there is a long history of research into the relationship between music and stress, there is still a lack of understanding as to how cognitively based individual characteristics, such as absorption impact the stress-reducing effect of music regarding subjective stress and skin barrier recovery. The present study attempts to fill this gap by investigating the relationship between music listening, reduction of subjective stress, skin barrier recovery and absorption. The following questions are therefore posed:

- RQ_{1a}: Do individuals who listen to music after experimentally induced stress recover faster from subjectively perceived stress than individuals who sit in silence?

- RQ_{1b}: Does the skin barrier of individuals who listen to music after experimentally induced stress recover faster than that of individuals who sit in silence?

- RQ_{2a}: Does trait absorption affect the reduction of subjective stress in participants who listen to music after experimentally induced stress?

- RQ_{2b}: Does trait absorption affect skin barrier recovery in participants who listen to music after experimentally induced stress?

Answering these questions would help to understand the underlying mechanisms of music listening as a stress-relieving tool. It might support the idea that reward-related processes, mediated in part by attentional engagement, play an important role in the stress-reducing effect of music listening. This may help to answer the question of which individual tendencies in cognitive processing are more conducive to stress reduction through music listening. Finally, the study may provide additional insight into the relationship between music and the rate of skin barrier recovery. Based on the theoretical ideas and scientific evidence presented in the previous chapters, the following hypotheses are being posed:

- H_{1a}: Individuals who listen to music after experimentally induced stress recover faster from the subjectively perceived stress than individuals who sit in silence.
- H_{1b}: The skin barrier of individuals who listen to music after experimentally induced stress recovers faster than that of individuals who sit in silence.
- H_{2a}: Trait absorption increases the reduction of subjective stress in participants who listen to music after experimentally induced stress.
- H_{2b}: Trait absorption increases skin barrier recovery in participants who listen to music after experimentally induced stress.

3. Methods

Study Design

The research project "*Stress und Musik-und Hörbuchhören*" conducted by Univ.-Prof. Dr. Urs Markus Nater and Dr. Jasminka Majdandžić at the University of Vienna (Faculty of Psychology, Music & Health Lab) analyses the effect of listening to music on several stress-related outcomes. The data collected is therefore perfectly suited for the research questions at hand. The research project was initiated in 2021 and is still active at the current date (September 2024). Participants in the study are vetted and recruited through an extensive screening process to ensure they meet the required criteria. Once the screening process is complete and the participant meets all the requirements, they are being asked to complete several online questionnaires via Unipark, including a questionnaire to measure trait absorption. The questionnaires must be completed prior to the laboratory study which takes place in the faculty building. The research project is divided into two separate experiments, namely *MuSkiBa1* and *MuSkiBa2*. While both experiments follow essentially the same design, only participants in *MuSkiBa2* undergo a stress-inducing experimental task. Participants are randomly assigned to one of three conditions (between-subjects design). In the first condition, participants must listen to music, while in the second condition, participants listen to an audio book. Participants in the third condition sit in silence.

To answer the previously posed research questions, participants were randomly assigned to two different groups (silence and music). The audiobook condition was excluded from the analysis, as there is no conclusive evidence that trait absorption affects the stress-reducing effect of audiobook listening. The dependent variables (reduction of subjective stress and skin barrier recovery) were measured using a visual analogue scale (VAS) and transepidermal water loss (TEWL), respectively. TEWL measurement points 1 to 4 (see study timeline) were used to compare skin barrier recovery between conditions. To compare the reduction of subjective stress between the two conditions, the difference in subjective stress between VAS-TSST and VAS-5 (see study timeline) was calculated. The independent variables were the conditions (i.e. music listening and silence) and trait absorption. Absorption was measured prior to the laboratory study via a survey on Unipark in order to test its effect on the stress-relieving effects of music listening following acute stress (i.e. reduction of subjective stress and skin barrier recovery).

Participants

The sample consisted solely of female participants between the age of 18 and 35. This allowed to control for possible age and gender-related effects (Allen et al., 2017; Liu et al., 2017). In addition, participants were all tested during the follicular phase of their menstrual cycle since cycle related differences in estrogen production may impact stress response (Kirschbaum et al., 1999; Montero-López et al., 2018). The participants were mainly recruited via the use of virtual flyers (see appendix) which were posted on various platforms, such as Facebook, WhatsApp, Instagram and Studo (a calendar app for students). Some flyers were also distributed at various university buildings (University of Vienna). The second part of the recruitment and screening process occurred via telephone and e-mail correspondence. In order to be eligible for participation, the participant had to meet the following criteria: first the participant must be a native German speaker or at least be fluent. Additionally, she also must meet various health related criteria, such as being generally healthy, not being over- or underweight (BMI between 17 and 25), not having any mental health problems and not having any chronic illnesses or any type of allergy. Furthermore, the participant must not use any hormonal contraception, nor drink excessively or take any mind-altering drugs and medication that may influence their hormonal profile. Finally, the participant must not have any previous experience with the TSST and cannot be a professional musician or be part of a music related occupational group, such as a sound engineer or a music teacher.

Materials and measures

Subjective stress (visual analogue scale)

Subjective stress was measured using a visual analogue scale (VAS, see appendix). The use of a visual analogue scale is a valid method for assessing subjective stress, as shown by several studies (Lesage et al., 2012; Lesage & Berjot, 2011). Since subjective measures of stress are more sensitive to individual differences in susceptibility to stress (Shields et al., 2022), they may be a better predictor of poor health than other measures of stress, such as measures of stress exposure (i.e. the occurrence of one or more stressors). The VAS for subjective stress used in the experiment consisted of a line exactly 100 mm long. Participants had to respond to the question “Wie sehr fühlen Sie sich gestresst (‘How stressed do you feel?’) at 8 repeated measurements (see study-timeline) and indicate their response on the line, with the negative end of the pole indicating no stress ('gar nicht' = 'not at all') and the positive end of the pole indicating the maximum level of perceived stress ('sehr stark' = 'very strong'). To quantify stress reduction the difference values between TSST-VAS and VAS-5 were calculated.

Skin barrier recovery (Transepidermal water loss)

Skin barrier recovery (SBR) was operationalised by measuring transepidermal water loss after impairment of the skin barrier using a tape stripping procedure. Tape stripping is harmless and poses no health risk to the participant. During the procedure, the upper layer of the epidermis (stratum corneum) was damaged by the repeated application and removal of tape. As one of the main functions of the stratum corneum is to prevent excessive water loss, the damage to the skin barrier caused by the tape stripping procedure results in a measurable increase in water evaporation through the skin. Water loss was measured using a specialised device (Tewameter® TM 300). The percentage of skin barrier recovery at timepoint x was calculated using the following formula:

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

Four measuring sites (one control and three testing sites) were marked with a green stamp on the participant's non-dominant forearm. Each site measured approximately $1cm^2$. The measuring sites were located approximately 2 cm away from the elbow crease. If necessary, the test site was dry shaved using a disposable razor. The participant was also informed that the measurement site on the forearm had to remain uncovered for the entire duration of the experiment. To ensure optimal measurement conditions, the room temperature (between 22.5°C and 23.5°C) and humidity (40-60%) were kept constant. In addition, the sensor of the Tewameter was heated to a temperature of 34°C.

In preparation for the tape stripping procedure, research assistants attached 50 strips of tape (Scotch Heavy Duty Packaging Tape) to a wooden board to ensure quick and convenient access to the tapes during the experiment. Baseline transepidermal water loss measurements taken between the TSST and the tape stripping procedure were used as a reference point for the change in water evaporation following skin damage. For the optimal conditions to measure TEWL, the skin damage caused by the tape stripping procedure had to result in a minimum change in water evaporation of 15 $g/h/m^2$. To achieve the desired value, the tapes were applied with light pressure and removed at a moderate speed. By alternating the side from which the tape was removed, the experimenters ensured that the damage to the skin was even. Participants whose TEWL values did not change by more than 5 $g/h/m^2$ following the use of 50 tapes were excluded from the data set. Cases where the datapoints from the three test sites were too far apart, were excluded from the analysis. Similarly, cases where skin barrier recovery continuously deteriorated after TEWL 1 and cases with negative values were excluded from the analysis. In addition, cases with large fluctuations (decreases with subsequent increases) between measurement points were also excluded.

Absorption (Tellegen Absorption Scale)

The Tellegen Absorption Scale was first developed by Tellegen & Atkinson (1974) in an attempt to test an individual's susceptibility to hypnosis. The scale measures openness to absorbing and self-altering experiences and consists of 34 items. The items in the original scale are scored dichotomously, requiring a 'true' or 'false' response. According to Tellegen (1982), the original scale has an internal reliability of r = .88 and a 30-day test-retest reliability of r = .91. The scale used in this experiment was translated into German by Thomas

Ritz with the help of several bilingual psychologists (TABS; Ritz & Dahme, 1995). The authors changed the scoring system to a 5-point Likert scale. Participants had to indicate the extent to which each of the 34 statements applies to them by choosing from the following answers: 0 = Trifft nicht zu; 1 = Trifft etwas zu; 2 = Trifft teilweise zu, 3 = Trifft überwiegend zu; 4 = trifft völlig zu (0 = Does not apply; 1 = Applies somewhat; 2 = Applies partially, 3 = Applies mostly; 4 = Applies completely). According to Ritz & Dahme the new modified and translated scale has an internal consistency of $\alpha = .88$ and a split-half reliability of $r = .86$. The participants completed the questionnaire as part of an online survey (via Unipark) that included several other scales measuring a variety of different variables. The survey had to be completed prior to the laboratory study.

Table 1

Sample items taken from the TABS

6. Ich beobachte gerne, wie Wolken ihre Form verändern.
22. Meine Gedanken erscheinen oft nicht als Worte sondern als Bilder.
24. Wenn ich Orgelmusik oder andere kraftvolle Musik höre, fühle ich mich manchmal wie in die Luft gehoben.
25. Manchmal kann ich Geräusche in Musik verwandeln, wenn ich auf eine bestimmte Art hinhöre.
31. Manchmal fühle ich die Anwesenheit einer Person, die physisch überhaupt nicht da ist.

The Trier Social Stress Test (TSST)

The Trier Social Stress Test (TSST) has been shown to be an ecologically valid method of inducing stress in an experimental setting. It is based on the stress response induced by public speaking. By incorporating social judgment and adding unpredictability through the addition of a surprise mental arithmetic task, the TSST has become the gold standard for inducing psychological stress. The TSST has been used in hundreds of research studies investigating the effects of acute stress on human neurobiology (Allen et al., 2017). The TSST was first devised in 1993 by Kirschbaum et al. in an attempt to develop a reliable and valid method of inducing acute stress under controlled conditions. Kirschbaum et al (1993) sought to design a task that would produce consistent activation of the HPA axis. The results of several studies investigating the effects of the TSST on the human stress response suggest that they have achieved their original goal, with the task consistently leading to an increase in cortisol levels. The TSST reliably induces increased activation of the HPA axis, resulting in a two- to threefold increase in cortisol levels in healthy participants (Frisch et al., 2015; Gu et al., 2022).

The TSST protocol was divided into two main tasks: in the first task, the participant took part in a mock job interview, while the second task consisted of an arithmetic test. Prior to the job interview, the participant was allowed a 3 minute long preparation phase. The TSST was conducted immediately after the first measurement timepoint (see study schedule). The test took place in a separate room, where a committee of two people dressed in white lab coats awaited the participant. The committee consisted of a male student (active stressor) and a female student (passive stressor), who were introduced as being two scientists specialising in behavioural psychology. The committee sat at a table with a camera behind them and a microphone in front of them facing the participant. As soon as the participant entered the room, she was informed about the following task: she has 3 minutes to prepare for a 5-minute job interview. The participant was also told that she is not allowed to talk about her previous work experience and that she should only focus on personal qualities that make her suitable for the job. After the interview, the participant had to take part in a surprise arithmetic task. The arithmetic task consisted of the participant having to count backwards from 2043 in steps of 17. If she made a mistake, she had to restart from the beginning. Throughout the TSST both stressors were instructed to maintain a neutral facial expression. They did not provide any words of encouragement or show any signs of sympathy towards the participant. Both members of the committee pretended to take notes during the test, but only the active stressor was allowed to talk to the participant. He reminded the participant to talk exclusively about her own personal attributes during the first task and made sure that the participant faced the camera and spoke into the microphone. He also intervened during the arithmetic task, urging the participant to calculate faster and pointing out her mistakes. If the participant stopped speaking before the time is up, the active stressor waited for about 20 seconds before breaking the silence and asking the participant to resume her job interview or calculating task.

Music

The music presented to the participants was selected by the researchers. Each playlist consists of music pieces that have no lyrics and a slow tempo. These musical characteristics are based on previous studies, which report that slow, relaxing music has the greatest stress-reducing effects (De Witte et al., 2019; Ooishi et al., 2017). According to De Witte et al. (2020), music with a tempo between 60 bpm and 90 bpm produces optimal results in terms of stress reduction. Participants were able to choose which playlist to listen to. This may increase the likelihood of participants enjoying the music, which has previously been identified as an important factor in stress reduction (Jiang et al., 2016). A preliminary study was carried out to see if the music chosen by the researchers effectively reduced stress. The researchers created six different playlists. Each playlist contained songs from different genres (ambient, classical, guitar, lo-fi, jazz and lounge). The songs included in the playlists had to meet the above criteria and had to be considered relaxing by the researchers. The pre-study was conducted with a sample size of 70 participants. The participants, all female, were randomly assigned to one of seven conditions, with six of the seven conditions each representing a different music playlist (and consequently a different music genre). In the seventh condition, participants listened to an audiobook about history. Participants had to complete a questionnaire before and after the listening session. The questionnaire (The Types of Positive Affect Scale; TTPAS) measured positive affect before and after listening to music. Participants were also asked to complete a questionnaire about the music or audiobook. The results showed that each music playlist had a positive effect on affect, with each playlist leading to a significant increase in relaxed positive affect (a construct measured by the TTPAS). According to a previous study, relaxed positive affect is negatively correlated with subjective stress (Gilbert et al., 2008), suggesting a stress-relieving effect of the music selected for the experiment. Interestingly, listening to the audiobook did not result in a significant increase in relaxed positive affect, and further analysis of the data revealed inconclusive results for the classical playlist, which ultimately led to its exclusion from the main study.

Procedure

Due to the diurnal nature of the cortisol cycle, with cortisol levels usually peaking in the morning, each experiment was scheduled at exactly the same time starting at 1 pm and ending at around 5 pm. On arrival to the study laboratory, participants were asked to complete a consent form allowing for the use of their data. They were also informed that they can discontinue the experiment at any time without disclosing a reason. Finally, they were given further practical information regarding the experiment (drinking and toilet breaks, food, etc.).

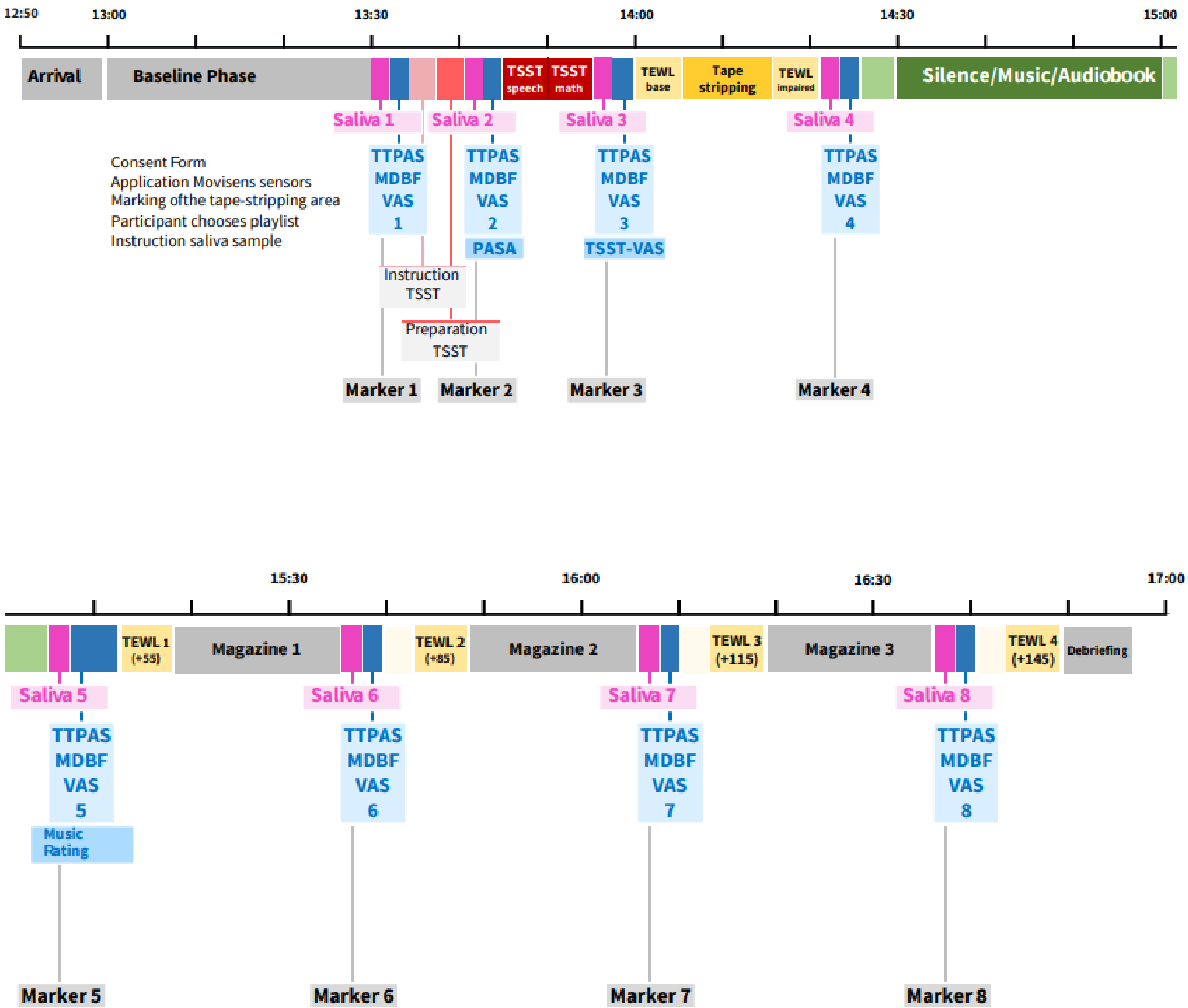
The experiment began with a baseline phase (25 minutes) during which participants completed a questionnaire about their current well-being, caffeine intake, and other information relevant to the experiment. The experimenter also explained how to provide the salivary cortisol sample. Participants were then asked to wear two devices which measure their heart rate and skin conductance response. A green mark was stamped on the participant's forearm, indicating the location for the tape stripping procedure and subsequent TEWL measurements. Finally, the participant was able to choose which music playlist or audio book (depending on the condition) to listen to. Participants in the music condition were able to choose from five different playlists. Each playlist contained songs belonging to a specific genre (ambient, guitar music, jazz, lo-fi, lounge). Participants were allowed to listen to each playlist for a few seconds in order to decide which playlist to choose. They were not told what genre the music belongs to. Participants in the audio book condition were able to choose from five science-related podcasts. Each podcast was different in terms of subject matter, and participants had to decide whether they want to listen to a podcast about biology, cosmology, history, philosophy or physics. None of the podcasts contained potentially arousing material. The participant was allowed to adjust the volume to her own liking (both conditions).

Following the baseline phase, the participant was asked to provide a saliva sample and to complete a questionnaire measuring subjective stress levels. The participant was then exposed to an experimentally induced stressor through the Trier Social Stress Test (TSST; Kirschbaum et al., 1993). The TSST consisted of two distinct tasks: a mock job interview and an arithmetic task. Both tasks were performed in front of a jury of two people (see chapter "Trier Social Stress Test" for a more detailed description). The TSST was followed by tests to measure the rate of skin barrier recovery. The stratum corneum was impaired by the repeated application and removal of several adhesive tapes on a small area on the forearm of the participant's non-dominant side. Transepidermal water loss was then measured as an indicator of the rate of skin barrier recovery (see chapter "Transepidermal water loss" for more information). Following the TEWL measurements, the participant was required to listen to one of five pre-selected music playlists (or one of five science-related audiobooks) or to sit in silence, depending on the condition to which they had been assigned (duration: 30 minutes). While listening to music, listening to an audio book, or sitting in silence, the participant was seated in an armchair. The auditory stimulus was delivered via headphones (Sennheiser HDR 160). To further standardise the procedure and eliminate possible noise interference participants in the silence condition also wore headphones.

After listening to the music (or listening to the audiobook/sitting in silence), measurements of subjective stress, salivary cortisol and TEWL were taken at various times during the experiment (see Figure 1 for a complete study timeline detailing each measurement). Between the last four measurement points, participants were allowed to read science-related magazines to avoid boredom. Following the final TEWL measurement, the participant was informed about the purpose and scientific background of the study. In addition, further explanations about the TSST were disclosed. Finally, the participant filled in a form with their bank details to ensure that they receive financial compensation (for full participation: MuSkiBa1: 35 €; MuSikBa2: 45 €). The research project was approved by the Ethics Committee of the University of Vienna (procedure number: 00494).

Figure 1

MuSkiBa2 – Study timeline



Note. MDBF: Der Mehrdimensionale Befindlichkeitsfragebogen | TTPAS: Types of Positive Affect Scale

4. Results

Sample description

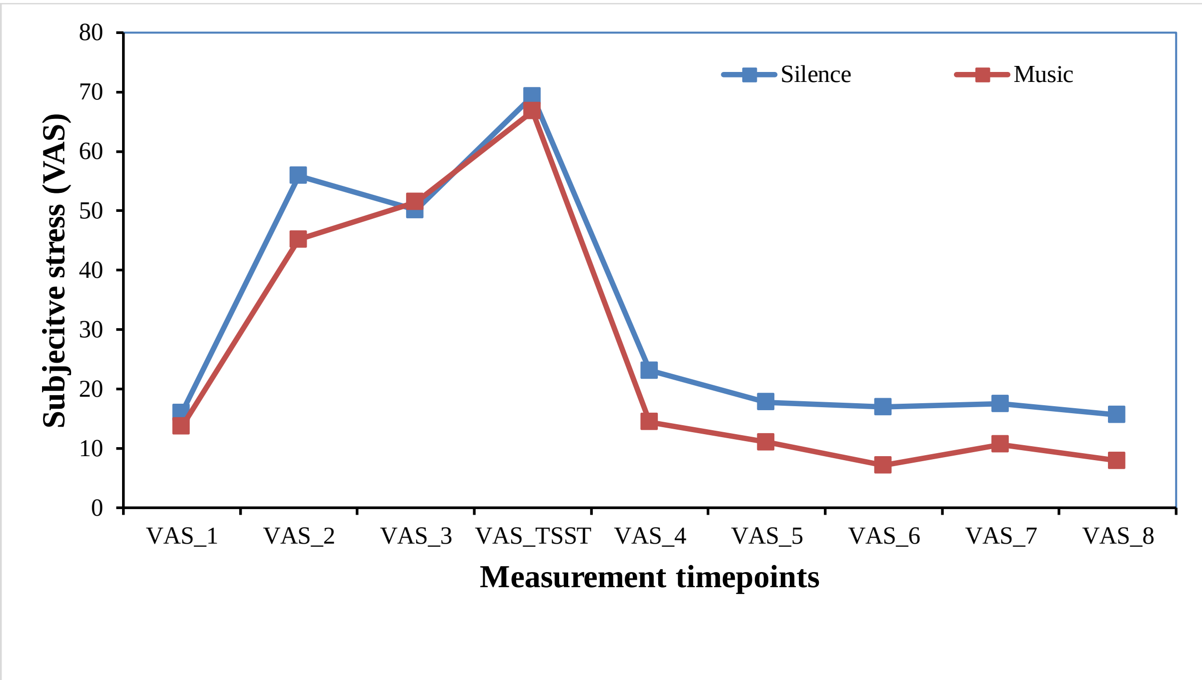
Participants were recruited and tested over a four-year period, from February 2020 to early July 2024. The preliminary sample consisted of 46 participants. Outliers in stress reduction ($N = 2$) and cases with missing values ($N = 5$) were excluded from the analysis. The final sample consisted of $N = 39$ participants, all female (silence: $N = 19$; music: $N = 20$). The mean age was 24.26 years ($SD = 4.02$). The sample was highly educated, with 38 out of 39 participants having completed the Matura/Abitur. 31 participants were studying at a university at the time of testing, and 22 participants reported having some form of employment (1 participant worked full-time and the rest had part-time jobs). Most participants ($N = 35$) came from German-speaking countries such as Austria, Germany and Luxembourg. All statistical analysis was performed with IBM SPSS (version 26).

Subjective stress and stress reduction

The VAS was assessed by measuring the distance from the zero point to the pencil mark set by the participant (minimum = 0 – maximum = 100). The distance was measured in millimetres using a ruler. Figure 2 shows average subjective stress VAS values for each measurement timepoint.

Figure 2

Subjective stress averaged across all participants for each measurement timepoint.



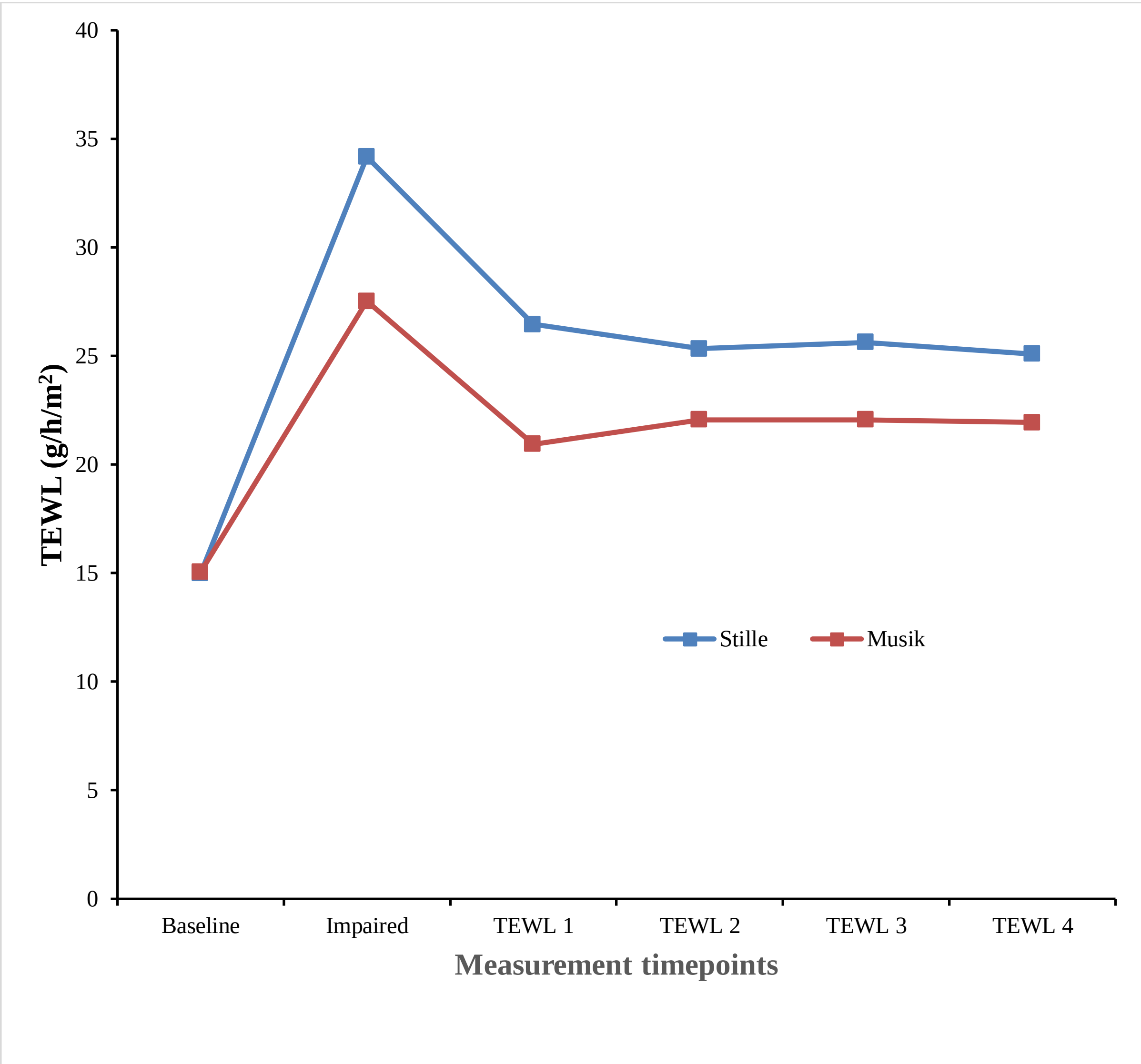
To measure stress reduction the difference in subjective stress between VAS-TSST and VAS-5 was calculated. Average stress reduction across both conditions was -59.17 (*SD* = 25.75) The Shapiro-Wilk test was positive indicating a non-normal distribution. The positive skewness of 0.81 indicates a right-skewed distribution. The positive kurtosis of 0.3 indicates a distribution with slightly heavier tails than a normal distribution. The Levene test for equality of variance was not significant (p = .38; silence and music).

Transepidermal water loss and skin barrier recovery

Skin barrier recovery values for each measurement point were calculated based on the average TEWL of the three test sites corresponding to the respective measurement point. Figure 3 shows TEWL averaged across all participants for each measurement point.

Figure 3

Transepidermal water loss averaged across all participants for each measurement timepoint.

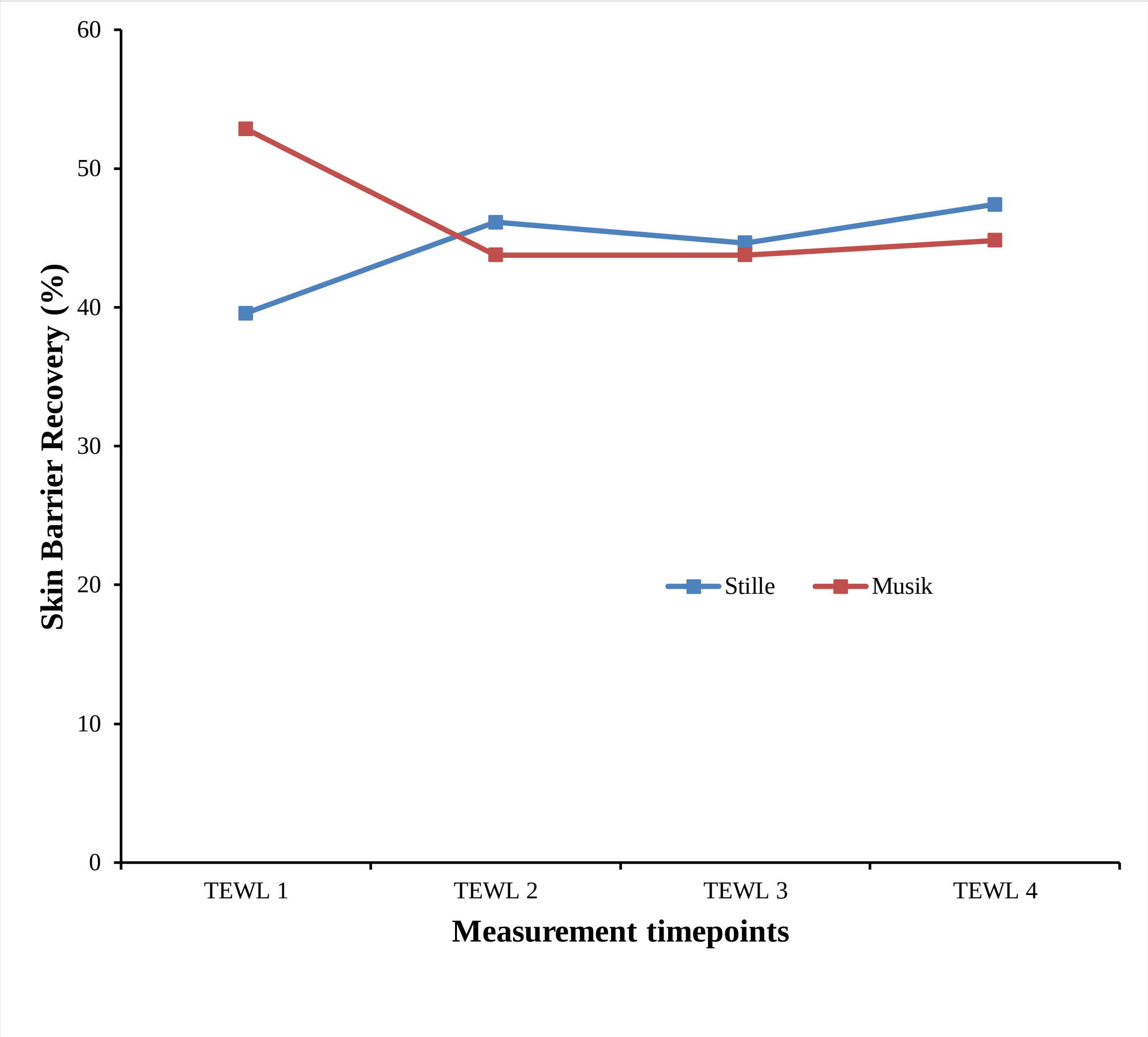


Cases that did not meet the required criteria (see chapter "Skin barrier recovery") were excluded from the analysis. The final sample consisted of 20 participants, 10 in the silence condition and 10 in the music condition. Figure 4 shows the percentage of skin barrier recovery averaged across all participants for each TEWL measurement point following the tape stripping procedure. Skin barrier recovery was calculated using the following formula:

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

Figure 4

Skin barrier recovery values averaged across all participants included in the analysis.



To compare skin barrier recovery between the two conditions (see hypothesis testing), the area under the curve (AUC) was calculated for each participant by using the skin barrier recovery values (percentage) for each measurement point. The AUC values were normally distributed (Shapiro-Wilk: p = .55) and the Levene test for equality of variance between the two conditions was not significant (p = .49). Boxplot analysis revealed no outliers.

Absorption

The Tellegen Absorption Scale (TAS) consisted of 34 items. Each item could be answered on a 5-point Likert scale (with the scoring ranging from 0 to 4). Results from the TAS showed an average score of 70.84 (SD = 23.91). The lowest reported score was 25 and the highest reported score was 117. Boxplot analysis revealed no outliers. The scale had a high internal consistency with a Cronbach α of .936. The result of the Shapiro-Wilk test for normality was not significant (p = .42), indicating a normal distribution. The skewness of the distribution was low and positive (|skewness| = 0.14, SE = .37). This indicates a lightly right-skewed distribution. The low negative kurtosis of -0.63 (SE = .74) indicates a relatively flat-topped distribution with most values are concentrated near the mean.

Testing of Hypotheses 1_a and 1_b

As the data for stress reduction were not normally distributed, a Mann-Whitney U test for independent samples was conducted to determine if there were differences in stress reduction between the conditions silence and music (silence: N = 19; music: N = 20). The results showed no significant difference in scores between the two groups, U = 163.5, Z = -.74, p = .46. This indicates that individuals who listen to music after experimentally induced stress did not recover faster from the subjectively perceived stress than individuals who sat in silence. An independent samples t-test was conducted to compare skin barrier recovery (AUC) between the conditions silence and music (silence: N = 10; music: N = 10). There was no significant difference in scores between the two groups, t(18) = .29, p = .49, *Cohen's d* = .13. This indicates that the skin barrier of individuals who listened to music after experimentally induced stress did not recover faster than that of individuals who sat in silence.

Testing of Hypotheses 2_a and 2_b

To test hypothesis 2_a a simple linear regression was conducted to predict stress reduction from absorption. The model was not statistically significant, F(1, 18) = 0.20, p = .65, R^2 = .01. This indicates that trait absorption did not predict the reduction of subjective stress in participants who listened to music after experimentally induced stress. Only participants in the music condition were included in the analysis (N = 20). To test hypothesis 2_b a simple linear regression was conducted to predict skin barrier recovery from absorption. The model was not statistically significant, F(1, 8) = 0.91, p = .36, R^2 = .1. This indicates that trait absorption did not predict skin barrier recovery in participants who listened to music after experimentally induced stress. Only participants in the music condition were included in the analysis (N = 10).

5. Discussion

The aim of this study was twofold: the first aim was to investigate the stress-relieving effect of music listening by comparing the effect of two conditions (silence/music listening) on two stress-related parameters (i.e. reduction of subjective stress and skin barrier recovery) following acute stress. The results showed no significant differences in scores between the silence and music listening conditions for the reduction of subjective stress and skin barrier recovery, respectively. The second aim was to investigate the effect of absorption on skin barrier recovery and stress reduction following acute stress and a music listening intervention. It was hypothesised that trait absorption may influence the stress-relieving effect of music listening by informing attentional engagement and thus music reward. The results showed no significant effect of absorption on either dependent variable (i.e. reduction of subjective stress and skin barrier recovery).

Discussion of Hypotheses 1_a and 1_b

In view of the results of the statistical analysis, hypothesis 1_a must be rejected. There was no difference in the reduction of subjective stress between individuals who listened to music and individuals who sat in silence after experiencing acute stress. A possible explanation for this result is the confounding of the stress-reducing effect of listening to music with the stress-reducing effect of time. 20 minutes elapse between the TSST-VAS, which takes place immediately after the stress test, and the intervention (music listening or sitting in silence; see study timeline). This was enough time for the subjective stress levels to return almost to baseline (see figure 2) leaving no more "room" for significant changes in the reduction of subjective stress and in turn notable differences between the conditions. In statistical analysis this phenomenon is often described as a "floor effect". In addition, the tape stripping procedure that occurs during this period may help to distract from the previous stressful experience, providing additional stress relief. Even the physical sensation of being touched on the arm (see Eckstein et al., 2020) during the tape stripping procedure may have helped to reduce stress. Finally, if there was a (small) effect of listening to music on stress reduction in this experiment, the sample size of N = 39 (N = 20, music condition; N = 19, silence condition) does likely not provide enough statistical power to detect such an effect.

Similarly, hypothesis 1b must be rejected. There was no significant difference in skin barrier recovery between those who listened to music and those who sat in silence after experiencing acute stress. Again, it is possible that time acts as a confounding variable. In addition to the factors mentioned above, 30 minutes of listening to music (or sitting in silence for 30 minutes) may be too long to detect meaningful differences between the two conditions after the intervention. This may be particularly true if we hypothesise that listening to music produces a rapid downward trend in stress that is relatively steep at the beginning but flattens out after a short time. Time also reduces stress, but probably less rapidly and more gradually. This would result in two stress curves that are more distinct at the beginning than at the end of the intervention. Thus, a shorter intervention may result in a scenario where the effect of the condition on stress reduction is easier to detect. This tentative explanation can be applied to both hypotheses, although it is probably more relevant to hypothesis 1_b since in hypothesis 1_a, there is more time between the measurement of the values used for comparison (VAS-TSST and VAS-5) and the intervention (see study timeline), which probably limits the confounding effect of the length of the intervention on stress reduction, since by then the values have already returned to (almost) baseline levels. Finally, it should be noted that explanations based on the nature of the study design and the temporal dynamics of stress are purely speculative and the small sample size (N = 39 for hypothesis 1_a and N = 20 for hypothesis 1_b) makes it difficult to draw any valid conclusions from the results.

Discussion of Hypotheses 2_a and 2_b

Hypotheses 2_a and 2_b both must be rejected. The data indicate that absorption did not predict stress reduction or skin barrier recovery in individuals who listened to music after experiencing acute stress. These results could be explained by a number of reasons. Firstly, the TAS (or in this case the German equivalent TABS) may not be the optimal instrument to measure attentional engagement with a musical stimulus. Its questions are often very vague and may confuse participants (e.g. "Sometimes I experience things as if they were doubly real"; "Sometimes I feel as if my mind could envelop the whole world"; "Things that might seem meaningless to others often make sense to me"). And although absorption (as measured by the TAS) has been shown to predict stress recovery (as measured by galvanic skin response) during music listening, the TAS lacks face validity for attentional engagement with musical stimuli. Only four of its 34 items specifically mention music (Sandstrom & Russo, 2011). It is also important to note that the TABS only measures trait absorption. For most individuals, there may be a large discrepancy between trait and state absorption. This gap may also be dependent on external factors such as the music itself or the current mood state, making the TABS an even less reliable and valid measuring instrument in the context of this study. Furthermore, the TABS was the last of 32 questionnaires in the Unipark online survey. Participants may have been tired by the time they reached the questionnaire, which could have affected their responses. Finally, both hypotheses suffer from the same problem as the first two hypotheses. The small sample size of $N = 20$ for hypothesis 2_a and $N = 10$ for hypothesis 2_b makes it difficult to draw any valid conclusions from the results.

Conclusions and future research directions

The aim of this study was to investigate the stress-relieving effects of listening to music on two different parameters (i.e. reduction of subjective stress and skin barrier recovery) following acute stress. The results showed no significant effect of music listening on either stress-related outcome. However, the small sample size and the temporal dynamics of stress reduction, exacerbated by the study design and potentially confounding the results, make it difficult to draw definitive conclusions. If anything, the results of this study show that one should be very aware of the confounding influence of time when investigating stress reduction. Future research could benefit from this insight by modulating their study design in such a way as to minimise the confounding effect of time on stress reduction (e.g. by shortening the duration of the stress-reducing intervention, or by paying more attention to the timepoints chosen to compare stress).

The second aim of this study was to investigate the effect of absorption on two stress-related parameters (i.e. reduction of subjective stress and skin barrier recovery) following acute stress and a music listening intervention. Although no statistically significant effect was found, I'm still convinced that absorption, or rather attentional engagement with musical stimuli, can be a useful predictor of stress reduction. However, I also suspect that there are more optimal instruments for measuring attentional engagement with music, such as the Absorption in Music Scale (AIMS; Sandstrom & Russo, 2011). The AIMS focuses more strictly on attentional engagement with music, which would be a major improvement over the TABS in terms of face validity.

In addition, as the disruption of skin barrier recovery is largely mediated by cortisol secretion, it would have been informative to look at salivary cortisol to check for differences between the two conditions. Unfortunately, salivary cortisol was not available for analysis at the time of writing. And while the main strength of this study is the novel investigation of the relationship between music listening, subjective stress, TEWL and absorption, which to my knowledge has never been done before, its main limitations are the small sample size and the lack of external validity, largely due to the very specific participant requirements (women in the follicular phase of their menstrual cycle). More participants are needed to detect meaningful effects of music listening on stress reduction and to further investigate the involvement of attentional factors such as absorption.

References

Abad, F., Diaz, N., Domenech, E., Robayna, M. & Rico, J. (1996). Oral sweet solution reduces pain-related behaviour in preterm infants. *Acta Pædiatrica*, *85*(7), 854–858. https://doi.org/10.1111/j.1651-2227.1996.tb14167.x

Adiasto, K., Beckers, D. G. J., Van Hooff, M. L. M., Roelofs, K. & Geurts, S. A. E. (2022). Music listening and stress recovery in healthy individuals: A systematic review with meta-analysis of experimental studies. *PLoS ONE*, 17(6), e0270031. https://doi.org/10.1371/journal.pone.0270031

Allen, A. P., Kennedy, P. J., Dockray, S., Cryan, J. F., Dinan, T. G. & Clarke, G. (2017). The Trier Social Stress Test: Principles and practice. *Neurobiology Of Stress*, *6*, 113–126. https://doi.org/10.1016/j.ynstr.2016.11.001

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

Appel, S., Chapman, J. & Shoenfeld, Y. (2007). Infection and vaccination in chronic fatigue syndrome: Myth or reality? *Autoimmunity*, *40*(1), 48–53. https://doi.org/10.1080/08916930701197273

Balakrishnan, J. & Dwivedi, Y. K. (2021). Role of cognitive absorption in building user trust and experience. *Psychology & Marketing*, *38*(4), 643–668. https://doi.org/10.1002/mar.21462

Benham, G. (2015). Skin Barrier Recovery is not Associated with Self-Perceived Stress. *Stress And Health*, *32*(5), 616–620. https://doi.org/10.1002/smi.2640

Blood, A. J. & Zatorre, R. J. (2001). Intensely pleasurable responses to music correlate with activity in brain regions implicated in reward and emotion. *Proceedings Of The*

National Academy Of Sciences Of The United States Of America, *98*(20), 11818–11823. https://doi.org/10.1073/pnas.191355898

Bloomfield, M. A., McCutcheon, R. A., Kempton, M., Freeman, T. P. & Howes, O. (2019). The effects of psychosocial stress on dopaminergic function and the acute stress response. *eLife*, *8*. https://doi.org/10.7554/elife.46797

Bogdan, R., Nikolova, Y. S. & Pizzagalli, D. A. (2013). Neurogenetics of depression: A focus on reward processing and stress sensitivity. *Neurobiology Of Disease*, *52*, 12–23. https://doi.org/10.1016/j.nbd.2012.05.007

Cardona, G., Ferreri, L., Lorenzo-Seva, U., Russo, F. A. & Rodriguez-Fornells, A. (2022). The forgotten role of absorption in music reward. *Annals Of The New York Academy Of Sciences*, *1514*(1), 142–154. https://doi.org/10.1111/nyas.14790

Carrasco, G. A. & Van De Kar, L. D. (2003). Neuroendocrine pharmacology of stress. *European Journal Of Pharmacology*, *463*(1–3), 235–272. https://doi.org/10.1016/s0014-2999(03)01285-8

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. https://doi.org/10.1348/1359107041557020

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

Choe, S. J., Kim, D., Kim, E. J., Ahn, J. S., Choi, E. J., Son, E. D., Lee, T. R. & Choi, E. H. (2018). Psychological Stress Deteriorates Skin Barrier Function by Activating 11β-Hydroxysteroid Dehydrogenase 1 and the HPA Axis. *Scientific Reports*, *8*(1). https://doi.org/10.1038/s41598-018-24653-z

Choi, E., Brown, B. E., Crumrine, D., Chang, S., Man, M., Elias, P. M. & Feingold, K. R. (2005). Mechanisms by Which Psychologic Stress Alters Cutaneous Permeability Barrier Homeostasis and Stratum Corneum Integrity. ˜ *The œ Journal Of Investigative*

Dermatology/Journal Of Investigative Dermatology, *124*(3), 587–595. https://doi.org/10.1111/j.0022-202x.2005.23589.x

Chrousos, G. P. (1992). The Concepts of Stress and Stress System Disorders. *JAMA*, *267*(9), 1244. https://doi.org/10.1001/jama.1992.03480090092034

Creswell, J. D., Pacilio, L. E., Denson, T. F. & Satyshur, M. (2013). The Effect of a Primary Sexual Reward Manipulation on Cortisol Responses to Psychosocial Stress in Men. *Psychosomatic Medicine*, *75*(4), 397–403. https://doi.org/10.1097/psy.0b013e31828c4524

Dalli, Ö. E., Bozkurt, C. & Yildirim, Y. (2022). The effectiveness of music interventions on stress response in intensive care patients: A systematic review and meta-analysis. *Journal Of Clinical Nursing*, *32*(11–12), 2827–2845. https://doi.org/10.1111/jocn.16401

Dattatreya, S. (2014). Can Stress Take the Cost of Life. *Social Science Research Network*. https://doi.org/10.2139/ssrn.2456211

De Witte, M., Da Silva Pinho, A., Stams, G., Moonen, X., Bos, A. E. & Van Hooren, S. (2020). Music therapy for stress reduction: a systematic review and meta-analysis. *Health Psychology Review*, *16*(1), 134–159. https://doi.org/10.1080/17437199.2020.1846580

De Witte, M., Spruit, A., Van Hooren, S., Moonen, X. & Stams, G. (2019). Effects of music interventions on stress-related outcomes: a systematic review and two meta-analyses. *Health Psychology Review*, *14*(2), 294–324. https://doi.org/10.1080/17437199.2019.1627897

Dinan, T. G. & Cryan, J. F. (2012). Regulation of the stress response by the gut microbiota: Implications for psychoneuroendocrinology. *Psychoneuroendocrinology*, *37*(9), 1369–1378. https://doi.org/10.1016/j.psyneuen.2012.03.007

Dutcher, J. M. (2022). Brain Reward Circuits Promote Stress Resilience and Health: Implications for Reward-Based Interventions. *Current Directions in Psychological Science*, *32*(1), 65–72. https://doi.org/10.1177/09637214221121770

Dutcher, J. M. & Creswell, J. D. (2018). The role of brain reward pathways in stress resilience and health. *Neuroscience & Biobehavioral Reviews/Neuroscience And Biobehavioral Reviews*, *95*, 559–567. https://doi.org/10.1016/j.neubiorev.2018.10.014

Eckstein, M., Mamaev, I., Ditzen, B. & Sailer, U. (2020). Calming Effects of Touch in Human, Animal, and Robotic Interaction—Scientific State-of-the-Art and Technical Advances. *Frontiers in Psychiatry*, *11*. https://doi.org/10.3389/fpsyt.2020.555058

Elias, P. M. (2005). Stratum Corneum defensive functions: an integrated view. ˜ *The œJournal Of Investigative Dermatology/Journal Of Investigative Dermatology*, *125*(2), 183–200. https://doi.org/10.1111/j.0022-202x.2005.23668.x

Faulkner, S. & Smith, A. (2008). A longitudinal study of the relationship between psychological distress and recurrence of upper respiratory tract infections in chronic fatigue syndrome. *British Journal Of Health Psychology*, *13*(1), 177–186. https://doi.org/10.1348/135910706x171469

Ferreri, L., Mas-Herrero, E., Zatorre, R. J., Ripollés, P., Gomez-Andres, A., Alicart, H., Olivé, G., Marco-Pallarés, J., Antonijoan, R. M., Valle, M., Riba, J. & Rodriguez-Fornells, A. (2019). Dopamine modulates the reward experiences elicited by music. *Proceedings Of The National Academy Of Sciences Of The United States Of America*, *116*(9), 3793–3798. https://doi.org/10.1073/pnas.1811878116

Frisch, J. U., Häusser, J. A. & Mojzisch, A. (2015). The Trier Social Stress Test as a paradigm to study how people respond to threat in social interactions. *Frontiers in Psychology*, *6*. https://doi.org/10.3389/fpsyg.2015.00014

Fuentes-Sánchez, N., Pastor, M. C., Eerola, T. & Pastor, R. (2021). Individual differences in music reward sensitivity influence the perception of emotions represented by music. *Musicae Scientiae*, *27*(2), 313–331. https://doi.org/10.1177/10298649211060028

Gaziano, T. A. & Gaziano, J. M. (2012). Global Burden of Cardiovascular Disease. In *Elsevier eBooks* (S. 1–20). https://doi.org/10.1016/b978-1-4377-0398-6.00001-9

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. https://doi.org/10.1080/17439760801999461

Godara, M., Sanchez-Lopez, A. & De Raedt, R. (2019). Music to my ears, goal for my eyes? Music reward modulates gaze disengagement from negative stimuli in dysphoria. *Behaviour Research And Therapy*, *120*, 103434. https://doi.org/10.1016/j.brat.2019.103434

Gold, B. P., Pearce, M. T., McIntosh, A. R., Chang, C., Dagher, A. & Zatorre, R. J. (2023). Auditory and reward structures reflect the pleasure of musical expectancies during naturalistic listening. *Frontiers in Neuroscience*, *17*. https://doi.org/10.3389/fnins.2023.1209398

Gold, P. W. & Chrousos, G. P. (2002). Organization of the stress system and its dysregulation in melancholic and atypical depression: high vs low CRH/NE states. *Molecular Psychiatry*, *7*(3), 254–275. https://doi.org/10.1038/sj.mp.4001032

Grinde, B. (2008). Is chronic fatigue syndrome caused by a rare brain infection of a common, normally benign virus? *Medical Hypotheses*, *71*(2), 270–274. https://doi.org/10.1016/j.mehy.2008.03.014

Grinde, B. (2017). Stress and Chronic Fatigue Syndrome. In *The Handbook of Stress and Health: A Guide to Research and Practice*. https://doi.org/10.1002/9781118993811

Gu, H., Ma, X., Zhao, J. & Liu, C. (2022). A meta-analysis of salivary cortisol responses in the Trier Social Stress Test to evaluate the effects of speech topics, sex, and sample size. *Comprehensive Psychoneuroendocrinology*, *10*, 100125. https://doi.org/10.1016/j.cpnec.2022.100125

Hall, D. L., Lattie, E. G., Antoni, M. H., Fletcher, M. A., Czaja, S., Perdomo, D. & Klimas, N. G. (2014). Stress management skills, cortisol awakening response, and post-exertional malaise in Chronic Fatigue Syndrome. *Psychoneuroendocrinology*, *49*, 26–31. https://doi.org/10.1016/j.psyneuen.2014.06.021

Hemmerle, A. M., Herman, J. P. & Seroogy, K. B. (2012). Stress, depression and Parkinson's disease. *Experimental Neurology*, *233*(1), 79–86. https://doi.org/10.1016/j.expneurol.2011.09.035

Henry, J. P. (1992). Biological basis of the stress response. *Integrative Physiological And Behavioral Science*, *27*(1), 66–83. https://doi.org/10.1007/bf02691093

Henry, J. P. & Stephens, P. M. (1977). *Stress, Health, and the Social Environment: A Sociobiologic Approach to Medicine*. http://ci.nii.ac.jp/ncid/BA20085382

Humphrey, J. H. (2005). *Anthology of Stress Revisited: Selected Works of James H. Humphrey*. Nova Publishers.

Ironside, M., Kumar, P., Kang, M. & Pizzagalli, D. A. (2018). Brain mechanisms mediating effects of stress on reward sensitivity. *Current Opinion in Behavioral Sciences*, *22*, 106–113. https://doi.org/10.1016/j.cobeha.2018.01.016

Jamieson, G. A. (2005). The Modified Tellegen Absorption Scale: A Clearer Window On The Structure And Meaning Of Absorption. Aus-tralian Journal Of Clinical And Experimental Hypnosis, 33(2), 119–139. https://psycnet.apa.org/record/2005-15698-002

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. https://doi.org/10.1016/j.aip.2016.02.002

Johansen, C., Katajavaara Sørensen, I., Lim Høeg, B., Bidstrup, P. E. & O. Dalton, S. (2017). Stress and Cancer. In *The Handbook of Stress and Health: A guide to research and practice.* https://doi.org/10.1002/9781118993811

Johnson, E. O., Kamilaris, T. C., Chrousos, G. P. & Gold, P. W. (1992). Mechanisms of stress: A dynamic overview of hormonal and behavioral homeostasis. *Neuroscience & Biobehavioral Reviews/Neuroscience And Biobehavioral Reviews*, *16*(2), 115–130. https://doi.org/10.1016/s0149-7634(05)80175-7

Johnson, J. V. (2008). Globalization, workers' power and the psychosocial work environment—is the demand–control–support model still useful in a neoliberal era? *Scandinavian Journal Of Work Environment & Health*, *34*(6), 15–21. https://jhu.pure.elsevier.com/en/publications/globalization-workers-power-and-the-psychosocial-work-environment-3

Khalfa, S., Bella, S. D., Roy, M., Peretz, I. & Lupien, S. J. (2003). Effects of Relaxing Music on Salivary Cortisol Level after Psychological Stress. *Annals Of The New York Academy Of Sciences*, *999*(1), 374–376. https://doi.org/10.1196/annals.1284.045

Kibel, A. & Drenjančević-Perić, I. (2008). Impact of glucocorticoids and chronic stress on progression of Parkinson's disease. *Medical Hypotheses*, *71*(6), 952–956. https://doi.org/10.1016/j.mehy.2008.06.036

Kiecolt-Glaser, J. K., Marucha, P. T., Malarkey, W. B., Mercado, A. M. & Glaser, R. (1995). Slowing of wound healing by psychological stress. *Lancet*, *346*(8984), 1194–1196. https://doi.org/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. https://doi.org/10.1097/00006842-199903000-00006

Kirschbaum, C., Pirke, K. & Hellhammer, D. H. (1993). The ‘Trier Social Stress Test’ – A Tool for Investigating Psychobiological Stress Responses in a Laboratory Setting. *Neuropsychobiology*, *28*(1–2), 76–81. https://doi.org/10.1159/000119004

Knight, W. E. J. & Rickard, N. S. (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. https://doi.org/10.1093/jmt/38.4.254

Koelsch, S., Fritz, T., Cramon, D. Y. V., Müller, K. & Friederici, A. D. (2005). Investigating emotion with music: An fMRI study. *Human Brain Mapping*, *27*(3), 239–250. https://doi.org/10.1002/hbm.20180

LaBerge, D. (1995). Attentional processing. In *Harvard University Press eBooks*. https://doi.org/10.4159/harvard.9780674183940

Landsbergis, P. A., Sinclair, R., Dobson, M., Hammer, L. B., Jauregui, M., LaMontagne, A. D., … Warren, N. (2011). Occupational health psychology. In D. Anna (Ed.), *The Occupational Environment: Its Evaluation, Control, and Management*, 3rd edn (pp. 1086–1130). Fairfax, VA: American Industrial Hygiene Association.

Lattie, E. G., Antoni, M. H., Fletcher, M. A., Penedo, F., Czaja, S., Lopez, C., Perdomo, D., Sala, A., Nair, S., Fu, S. H. & Klimas, N. (2012). Stress management skills, neuroimmune processes and fatigue levels in persons with chronic fatigue syndrome. *Brain, Behavior, And Immunity*, *26*(6), 849–858. https://doi.org/10.1016/j.bbi.2012.02.008

Lazarus, R. S. (1966). *Psychological stress and the coping process*. http://ci.nii.ac.jp/ncid/BA07451034

Lesage, F., Berjot, S. & Deschamps, F. (2012). Clinical stress assessment using a visual analogue scale. *Occupational Medicine*, *62*(8), 600–605. https://doi.org/10.1093/occmed/kqs140

Lesage, F. X. & Berjot, S. (2011). Validity of occupational stress assessment using a visual analogue scale. *Occupational Medicine*, *61*(6), 434–436. https://doi.org/10.1093/occmed/kqr037

Liu, H., Hu, J. & Rauterberg, M. (2015). Follow your heart. *Interaction Studies*, *16*(2), 303–339. https://doi.org/10.1075/is.16.2.12liu

Liu, J. J., Ein, N., Peck, K., Huang, V., Pruessner, J. C. & Vickers, K. (2017). Sex differences in salivary cortisol reactivity to the Trier Social Stress Test (TSST): A meta-analysis. *Psychoneuroendocrinology*, *82*, 26–37. https://doi.org/10.1016/j.psyneuen.2017.04.007

Liu, W., Roiser, J. P., Wang, L., Zhu, Y., Huang, J., Neumann, D. L., Shum, D. H., Cheung, E. F. & Chan, R. C. (2016). Anhedonia is associated with blunted reward sensitivity in first-degree relatives of patients with major depression. *Journal Of Affective Disorders*, *190*, 640–648. https://doi.org/10.1016/j.jad.2015.10.050

Maietta, G., Fornaro, P., Rongioletti, F. & Rebora, A. (1990). Patients with mood depression have a high prevalence of seborrhoeic dermatitis. *Acta Dermato-venereologica*, *70*(5), 432–434. https://doi.org/10.2340/0001555570432434

Martínez-Molina, N., Mas-Herrero, E., Rodríguez-Fornells, A., Zatorre, R. J. & Marco-Pallarés, J. (2019). White matter microstructure reflects individual differences in music reward sensitivity. ˜ *The œ Journal Of Neuroscience/˜ The œ Journal Of Neuroscience*, *39*(25), 5018–5027. https://doi.org/10.1523/jneurosci.2020-18.2019

Mas-Herrero, E., Marco-Pallares, J., Lorenzo-Seva, U., Zatorre, R. J. & Rodriguez-Fornells, A. (2012). Individual differences in music reward experiences. *Music Perception*, *31*(2), 118–138. https://doi.org/10.1525/mp.2013.31.2.118

Masuda, A., Munemoto, T., Yamanaka, T., Takei, M. & Tei, C. (2002). Psychosocial characteristics and immunological functions in patients with postinfectious chronic fatigue syndrome and noninfectious chronic fatigue syndrome. *Journal Of Behavioral Medicine*, *25*(5), 477–485. https://doi.org/10.1023/a:1020423124675

Mavridis, I. N. (2014). Music and the nucleus accumbens. *Surgical And Radiologic Anatomy*, *37*(2), 121–125. https://doi.org/10.1007/s00276-014-1360-0

McCorry, L. K. (2007). Physiology of the Autonomic Nervous System. *American Journal Of Pharmaceutical Education*, *71*(4), 78. https://doi.org/10.5688/aj710478

McEwen, B. S. (2008). Central effects of stress hormones in health and disease: Understanding the protective and damaging effects of stress and stress mediators. *European Journal Of Pharmacology*, *583*(2–3), 174–185. https://doi.org/10.1016/j.ejphar.2007.11.071

McGonagle, K. A. & Kessler, R. C. (1990). Chronic stress, acute stress, and depressive symptoms. *American Journal Of Community Psychology*, *18*(5), 681–706. https://doi.org/10.1007/bf00931237

ME/CFS: Neuer Praxisleitfaden erschienen. (2024). Abgerufen am 18. Juli 2024, von https://www.meduniwien.ac.at/web/ueber-uns/news/2024/me/cfs-neuer-praxisleitfaden-erschienen/

Medical University of Vienna. (2024, 15. Februar). *Chronic fatigue syndrome: Number of patients is expected to double due to long-term effects of the COVID-19 pandemic*. ScienceDaily. Abgerufen am 9. August 2024, von https://www.sciencedaily.com/releases/2024/02/240215113653.htm

Menon, V. & Levitin, D. (2005). The rewards of music listening: Response and physiological connectivity of the mesolimbic system. *NeuroImage*, *28*(1), 175–184. https://doi.org/10.1016/j.neuroimage.2005.05.053

Menzies, V., Taylor, A. G. & Bourguignon, C. (2008). Absorption. *Journal Of Holistic Nursing*, *26*(4), 297–302. https://doi.org/10.1177/0898010107307456

Mir, I. A., Chowdhury, M., Islam, R. M., Ling, G. Y., Chowdhury, A. A. B. M., Hasan, Z. M. & Higashi, Y. (2020). Relaxing music reduces blood pressure and heart rate among pre-hypertensive young adults: A randomized control trial. ˜ *The œ Journal Of Clinical Hypertension*, *23*(2), 317–322. https://doi.org/10.1111/jch.14126

Moen, E. M., Sagedal, S., Bjøro, K., Degré, M., Opstad, P. K. & Grinde, B. (2003). Effect of immune modulation on TT virus (TTV) and TTV-like-mini-virus (TLMV) viremia. *Journal Of Medical Virology*, *70*(1), 177–182. https://doi.org/10.1002/jmv.10356

Montero-López, E., Santos-Ruiz, A., García-Ríos, M. C., Rodríguez-Blázquez, M., Rogers, H. L. & Peralta-Ramírez, M. I. (2018). The relationship between the menstrual cycle and cortisol secretion: Daily and stress-invoked cortisol patterns. *International Journal Of Psychophysiology*, *131*, 67–72. https://doi.org/10.1016/j.ijpsycho.2018.03.021

Muizzuddin, N., Matsui, M. S., Marenus, K. D. & Maes, D. H. (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. https://doi.org/10.1034/j.1600-0846.2003.00354.x

Nater, U. M., Ditzen, B. & Ehlert, U. (2011). Stressabhängige körperliche Beschwerden. In *Springer-Lehrbuch* (S. 1039–1052). https://doi.org/10.1007/978-3-642-13018-2_48

Nater, U. M., Gaab, J., Rief, W. & Ehlert, U. (2006). Recent trends in behavioral medicine. *Current Opinion in Psychiatry*, *19*(2), 180–183. https://doi.org/10.1097/01.yco.0000214345.37002.77

Nerdinger, F. W., Blickle, G. & Schaper, N. (2019). Arbeits- und Organisationspsychologie. In *Springer-Lehrbuch*. https://doi.org/10.1007/978-3-662-56666-4

Nguyen, V. T., Farman, N., Maubec, E., Nassar, D., Desposito, D., Waeckel, L., Aractingi, S. & Jaisser, F. (2016). Re-Epithelialization of Pathological Cutaneous Wounds Is

Improved by Local Mineralocorticoid Receptor Antagonism. ˜ *The œ Journal Of Investigative Dermatology/Journal Of Investigative Dermatology*, *136*(10), 2080–2089. https://doi.org/10.1016/j.jid.2016.05.101

Noly-Gandon, A., Ai, M., Group, P. R., Zatorre, R. & Geddes, M. (2023). The influence of music reward sensitivity on resting-state functional connectivity in older adults at-risk for Alzheimer's disease. *Journal Of The Neurological Sciences*, *455*, 121980. https://doi.org/10.1016/j.jns.2023.121980

Occa, A. & Morgan, S. E. (2022). The role of cognitive absorption in the persuasiveness of multimedia messages. *Computers And Education/Computers & Education*, *176*, 104363. https://doi.org/10.1016/j.compedu.2021.104363

Ooishi, Y., Mukai, H., Watanabe, K., Kawato, S. & Kashino, M. (2017). Increase in salivary oxytocin and decrease in salivary cortisol after listening to relaxing slow-tempo and exciting fast-tempo music. *PloS One*, *12*(12), e0189075. https://doi.org/10.1371/journal.pone.0189075

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

Papadopoulos, A. S. & Cleare, A. J. (2011). Hypothalamic–pituitary–adrenal axis dysfunction in chronic fatigue syndrome. *Nature Reviews. Endocrinology*, *8*(1), 22–32. https://doi.org/10.1038/nrendo.2011.153

Park, J., Lee, E., Kwon, H., Baek, I., Seo, J., Kim, K. & Han, P. (2022). Behavioral Engagement With Playable Objects Resolves Stress-Induced Adaptive Changes by Reshaping the Reward System. *Biological Psychiatry*, *91*(7), 676–689. https://doi.org/10.1016/j.biopsych.2021.09.027

Persson, P. B. & Zakrisson, A. (2015). Stress. *Acta Physiologica*, 216(2), 149–152. https://doi.org/10.1111/apha.12641

Pelletier, C. L. (2004). The Effect of Music on Decreasing Arousal Due to Stress: A Meta-Analysis. ˜ *The œ Journal Of Music Therapy/Journal Of Music Therapy*, *41*(3), 192–214. https://doi.org/10.1093/jmt/41.3.192

Poveda, D. C. C., Gallo, W. R., Rodríguez-Angarita, Ó. & Prado-Rivera, M. A. (2017). La escucha de música antes del TSST regula los niveles de cortisol en saliva independiente de la preferencia musical. *Universitas Psychologica/Universitas Psychologica*, *15*(5). https://doi.org/10.11144/javeriana.upsy15-5.emrn

Raymond, C., Marin, M., Juster, R. & Lupien, S. (2017). Cortisol reactivity correlates with subjective stress in women in their luteal phase but not in women using oral contraceptives or men. *Psychoneuroendocrinology*, *83*, 33. https://doi.org/10.1016/j.psyneuen.2017.07.326

Ritz, T. & Dahme, B. (1995). Die Absorption-Skala: Konzeptuelle Aspekte, psychometrische Kennwerte und Dimensionalität einer deutschsprachigen Adaptation. *Diagnostica*.

Robles, T. F. (2007). Stress, Social Support, and Delayed Skin Barrier Recovery. *Psychosomatic Medicine*, *69*(8), 807–815. https://doi.org/10.1097/psy.0b013e318157b12e

Robles, T. F., Brooks, K. P. & Pressman, S. D. (2009). Trait positive affect buffers the effects of acute stress on skin barrier recovery. *Health Psychology*, *28*(3), 373–378. https://doi.org/10.1037/a0014662

Rohmer, S. (2013). *Stress Die Geschichte eines westlichen Konzeptes*. Universität Heidelberg.

Rosch, P. J. (2001). The quandary of job stress compensation. *Health and Stress*, No. 3, 1–4

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

Sahawneh, P. (2024). Factors Influencing Skin Health from Within. *Journal Of Integrated Health*, *3*(1), 156–163. https://doi.org/10.51219/jih/pamela-sahawneh/26

Salimpoor, V. N., Van den Bosch, I., Kovacevic, N., McIntosh, A. R., Dagher, A. & Zatorre, R. J. (2013). Interactions Between the Nucleus Accumbens and Auditory Cortices Predict Music Reward Value. *Science*, *340*(6129), 216–219. https://doi.org/10.1126/science.1231059

Sandstrom, G. M. & Russo, F. A. (2011). Absorption in music: Development of a scale to identify individuals with strong emotional responses to music. *Psychology Of Music*, *41*(2), 216–228. https://doi.org/10.1177/0305735611422508

Schnall, P. L., Dobsen, M. & Landsbergis, P. (2019). Work, Stress, and Cardiovascular Disease. In *The Handbook of Stress and Health: A Guide to Research and Practice*. Wiley. https://doi.org/10.1002/9781118993811

Selye, H. (1950). Stress and the General Adaptation Syndrome. *BMJ. British Medical Journal*, *1*(4667), 1383–1392. https://doi.org/10.1136/bmj.1.4667.1383

Shields, G. S., Fassett-Carman, A., Gray, Z. J., Gonzales, J. E., Snyder, H. R. & Slavich, G. M. (2022). Why is subjective stress severity a stronger predictor of health than stressor exposure? A preregistered two-study test of two hypotheses. *Stress And Health*, *39*(1), 87–102. https://doi.org/10.1002/smi.3165

Slominski, A. T. & Zmijewski, M. A. (2017). Glucocorticoids Inhibit Wound Healing: Novel Mechanism of Action. ˜ *The œ Journal Of Investigative Dermatology/Journal Of Investigative Dermatology*, *137*(5), 1012–1014. https://doi.org/10.1016/j.jid.2017.01.024

Slominski, A., Wortsman, J., Tuckey, R. C. & Paus, R. (2007). Differential expression of HPA axis homolog in the skin. *Molecular And Cellular Endocrinology, 265–266*, 143–149. https://doi.org/10.1016/j.mce.2006.12.012

Smith, S. M. & Vale, W. W. (2006). The role of the hypothalamic-pituitary-adrenal axis in neuroendocrine responses to stress. *Dialogues in Clinical Neuroscience, 8*(4), 383–395. https://doi.org/10.31887/dcns.2006.8.4/ssmith

Stress without distress. (1974). *Annals Of Internal Medicine*, *81*(5), 716. https://doi.org/10.7326/0003-4819-81-5-716_1

Szabo, S., Tache, Y. & Somogyi, A. (2012). The legacy of Hans Selye and the origins of stress research: A retrospective 75 years after his landmark brief "Letter" to the Editor#ofNature. *Stress*, *15*(5), 472–478. https://doi.org/10.3109/10253890.2012.710919

Tabibnia, G. (2020). An affective neuroscience model of boosting resilience in adults. *Neuroscience & Biobehavioral Reviews/Neuroscience And Biobehavioral Reviews*, *115*, 321–350. https://doi.org/10.1016/j.neubiorev.2020.05.005

Tellegen, A. (1982). Brief manual for the Multidimensional Personality Questionnaire. *Unpublished Manuscript, University Of Minnesota*.

Tellegen, A. & Atkinson, G. (1974). Openness to absorbing and self-altering experiences („absorption"), a trait related to hypnotic susceptibility. *Journal Of Abnormal Psychology*, *83*(3), 268–277. https://doi.org/10.1037/h0036681

The Handbook of Stress and Health. (2017). In *Wiley eBooks*. https://doi.org/10.1002/9781118993811

Thierry, A. M., Tassin, J. P., Blanc, G. & Glowinski, J. (1976). Selective activation of the mesocortical DA system by stress. *Nature*, *263*(5574), 242–244. https://doi.org/10.1038/263242a0

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. https://doi.org/10.1371/journal.pone.0070156

Toker, S. & Melamed, S. (2016). Stress, Recovery, Sleep, and Burnout. In *The Handbook of Stress and Health: A Guide to Research and Practice*. Wiley. https://doi.org/10.1002/9781118993811

Tsigos, C. & Chrousos, G. P. (2002). Hypothalamic–pituitary–adrenal axis, neuroendocrine factors and stress. *Journal Of Psychosomatic Research*, *53*(4), 865–871. https://doi.org/10.1016/s0022-3999(02)00429-4

Ulrich-Lai, Y. M., Christiansen, A. M., Ostrander, M. M., Jones, A. A., Jones, K. R., Choi, D. C., Krause, E. G., Evanson, N. K., Furay, A. R., Davis, J. F., Solomon, M. B., De Kloet, A. D., Tamashiro, K. L., Sakai, R. R., Seeley, R. J., Woods, S. C. & Herman, J. P. (2010). Pleasurable behaviors reduce stress via brain reward pathways. *Proceedings Of The National Academy Of Sciences Of The United States Of America*, *107*(47), 20529–20534. https://doi.org/10.1073/pnas.1007740107

Van Craenenbroeck, K., De Bosscher, K., Vanden Berghe, W., Vanhoenacker, P. & Haegeman, G. (2005). Role of glucocorticoids in dopamine-related neuropsychiatric disorders. *Molecular And Cellular Endocrinology*, *245*(1–2), 10–22. https://doi.org/10.1016/j.mce.2005.10.007

Van Steenbergen, H., De Bruijn, E. R., Van Duijvenvoorde, A. C. & Van Harmelen, A. (2021). How positive affect buffers stress responses. *Current Opinion in Behavioral Sciences*, *39*, 153–160. https://doi.org/10.1016/j.cobeha.2021.03.014

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. https://doi.org/10.1016/j.psyneuen.2011.05.016

Weigmann, K. (2017). Feel the beat. *EMBO Reports*, *18*(3), 359–362. https://doi.org/10.15252/embr.201743904

Woodby, B., Penta, K., Pecorelli, A., Lila, M. A. & Valacchi, G. (2020). Skin Health from the Inside Out. *Annual Review Of Food Science And Technology*, *11*(1), 235–254. https://doi.org/10.1146/annurev-food-032519-051722

Woodruff, P., Higgins, E., Du Vivier, A. & Wessely, S. (1997). Psychiatric illness in patients referred to a dermatology-psychiatry clinic. *General Hospital Psychiatry*, *19*(1), 29–35. https://doi.org/10.1016/s0163-8343(97)00155-2

Yaden, D. B., Haidt, J., Hood, R. W., Vago, D. R. & Newberg, A. B. (2017). The Varieties of Self-Transcendent Experience. Review Of General Psychology, 21(2), 143–160. https://doi.org/10.1037/gpr0000102

Appendix

List of inclusion criteria

Study 2 (with stressor)
General criteria / criteria for biomarker studies
Female
Age 18-35
Fluent in German
Non-smokers
No pregnancy, breastfeeding
Healthy, no current flu
No chronic somatic illnesses, including:
Allergies / hypersensitivity reactions *(medicines, patches, latex gloves, hay fever, grasses, pollen)*
Cardiovascular diseases *(coronary heart disease, angina pectoris, myocardial infarction, cardiac arrhythmia, heart failure , Arterial occlusive diseases)*
Pulmonary and respiratory diseases *(pneumonia, asthma, chronic bronchitis, tuberculosis)*
Liver diseases *(hepatitis, jaundice, fatty liver)*
Hypertension or extremely low blood pressure
Chronic pain
Kidney and urinary tract diseases *(kidney / bladder stones)*
Diabetes Mellitus or other metabolic diseases *(hypercholesterolemia, hyperuricemia)*
Diseases of the digestive tract *(stomach diseases, chronic intestinal diseases)*
Neurological diseases
Infectious diseases *(e.g. HIV, Hep., TBC)*
Thyroid abnormality
Autoimmune diseases
Diseases of the skeletal system / muscle diseases
Blood disorders *(bruises develop without special cause, anemia)*
No visual impairments (if not correctable with glasses or contact lenses)
No current mental disorder or psychiatric illness *(depression, psychosis, anxiety disorders, eating disorders within the last 5 years)*
No tropical stay in the last 6 months
No vaccinations the last 2 weeks
BMI: 18 – 25
No excessive alcohol use *(substance abuse within the last 2 years, regular consumption ≥8)*
No drug intake in the last year or cannabis in the past 14 days
No (dental) surgery in the last 8 weeks *(narcosis, type of procedure, pending cure)*
No other health-related anomalies (tumors, meningitis, accident, etc.)
No use of psychopharmaca in the past 14 days
No intake of cardiovascular medication (e.g. beta-blockers)
No use of medication that affects hormones
No hormonal contraception
Regular menstrual cycle
TSST-related criteria
No previous experience with TSST
No personal relationships with study team members
Music-related criteria
No hearing impairment or chronic tinnitus

No music-related profession / music related studies	
No absolute hearing	
Tape-stipping- specific criteria	
No chronic or acute inflammatory skin diseases	
No allergies to adhesive tape	
No eczema/rashes, burn marks etc. on the volar forearm	
No intake of immunosuppressive drugs (e.g. prednisone)	

Phone screening guide

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 _____________________________________

(z.B.: RK_01.11.19_01 (Initialen des Interviewers_TT.MM.JJ_Anrufnummer am Tag))

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 18-25)

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]

→ Bei „Ja“ (zweiter Option): Können Sie dreieinhalb Stunden nicht rauchen, ohne dass Sie Entzugserscheinungen oder starkes Verlangen nach einer Zigarette verspüren?

□ Ja

□ Nein [Ausschluss]

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

□ Nein

□ Ja, < 8 Getränke pro Woche (1 = kleines Getränk (z.B. 0,33 l Bier oder 1/8 l Wein)

□ Ja, ≥ 8 Getränke pro Woche [Ausschluss]

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

□ Nein

□ Ja, Cannabis länger als 2 Wochen her, und andere Drogen länger als 2 Jahre her

□ Ja, Cannabis kürzer als 2 Wochen her, oder andere Drogen kürzer 2 Jahre [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]

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.

<u>Krankheiten-Liste</u>:

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, oder geplant im Zeitraum bis zur Testung**
□	□	**(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 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 [Auschluss]

□ 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?

□ andere Stressaufgabe

□ TSST

Wären Sie einverstanden an einer etwas kürzeren Studie über Musik- und Hörbuchhören & persönliches Befinden teilzunehmen? Der Zeitaufwand dieser Studie wäre um eine halbe Stunde geringer und die Aufwandsentschädigung würde 35 Euro betragen.

□ Ja: [weiteres Vorgehen (nach Telefonscreening) siehe Muskiba I – SOP_Rekrutierung]

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

____

Finale Entscheidung:

□ Einschluss

□ Ausschluss

□ Eignung unsicher

Bei Ausschluss: Vielen Dank! Wir haben im Moment sehr strenge Ausschluss-Kriterien. Falls sich das ändert sollte, dürften wir uns erneut bei Ihnen melden?"

□ Ja

□ Nein

***Bei Eignung unsicher**:* „Vielen Dank, wir werden uns in Kürze wieder bei Ihnen melden."

Bei Eignung (Einschluss) und Einverständnis zur Teilnahme seitens der Probandin:

Movisens/ Brustgurt, Temperaturmessung:

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.

Auch wird am Anfang der Testung bei Ihnen und bei der Versuchsleitung eine kontaktlose Fiebermessung an der Stirn mittels Infrarotthermometer durchgeführt.

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 weiblich ist, 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 (1) von ____________ bis ____________

→ Möglicher Zeitraum (2) von ____________ bis ____________

Vielen Dank!

Wenn Sie möchten, können wir uns direkt einen Termin ausmachen. Hätten Sie am xxx. von 13:00 bis 17:00 Zeit?

Für die genauen Schritte siehe Rekrutierung. Muskiba II - SOP_Rekrutierung.docx (Seite 2)

Nach Terminvergabe: Vielen Dank für Ihre Zeit, wir werden Ihnen in Kürze einen Link mit Fragebögen zusenden. Wir bitten Sie, diesen möglichst zeitnah auszufüllen. Zudem senden wir Ihnen eine Checkliste mit Dingen, die Sie für Ihren Studientermin bitte beachten sollten.

Consent form

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 45 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

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)

....

German version of the Tellegen Absorption Scale (TABS)

TABS

Die folgenden Aussagen betreffen bestimmte Bereiche des Wahrnehmens und Erlebens. Diese können erfahrungsgemäß bei verschiedenen Personen sehr unterschiedlich ausgeprägt sein.
Bitte geben Sie zu jeder Aussage an, in welchem Ausmaß sie für Ihre Person zutrifft oder nicht zutrifft. Hierfür sind fünf Antwortmöglichkeiten vorgegeben, bitte entscheiden Sie sich bei jeder Aussage für eine davon. Behalten Sie dabei im Kopf, dass es letztlich keine richtigen oder falschen Antworten gibt.

	Trifft nicht zu	Trifft etwas zu	Trifft teilweise zu	Trifft überwiegend zu	Trifft völlig zu
Manchmal empfinde und erlebe ich Dinge wie in meiner Kindheit.	○	○	○	○	○
Wortgewandte oder poetische Sprache kann mich stark beeindrucken.	○	○	○	○	○
Filme, Fernsehspiele oder Theaterstücke können mich so mitreißen, dass ich mich und alles um mich herum vergesse und die Geschichte erlebe als wäre sie Realität und ich an ihr beteiligt.	○	○	○	○	○
Wenn ich ein Bild betrachte und danach wegsehe, habe ich manchmal ein Abbild davon, fast so als ob ich das Bild selber noch sehen würde.	○	○	○	○	○
Manchmal habe ich das Gefühl, mein Geist könnte die ganze Welt umfangen.	○	○	○	○	○
Ich beobachte gerne, wie Wolken ihre Form verändern.	○	○	○	○	○
Wenn ich will, kann ich Tagträume oder mir manche Dinge so lebhaft vorstellen, dass sie meine Aufmerksamkeit fesseln wie ein guter Film oder eine gute Geschichte.	○	○	○	○	○
Ich glaube, dass ich weiß, was manche Leute meinen, wenn sie von mystischen Erfahrungen sprechen.	○	○	○	○	○
Ich kann manchmal aus mir heraustreten und einen völlig anderen Seinszustand erfahren.	○	○	○	○	○
Stoffe – wie etwa Wolle, Sand oder Holz – erinnern mich manchmal an Farben oder Musik.	○	○	○	○	○

Manchmal erlebe ich die Dinge als wären sie doppelt wirklich.	○	○	○	○	○
Wenn ich Musik höre, kann sie mich so gefangen nehmen, dass ich nichts Anderes mehr beachte.	○	○	○	○	○
Wenn ich will, kann ich mir vorstellen, dass mein Körper so schwer ist, dass ich ihn nicht mehr bewegen kann, selbst wenn ich es wollte.	○	○	○	○	○
Oft kann ich die Gegenwart einer anderen Person spüren, noch bevor ich sie (oder ihn) wirklich sehe oder höre.	○	○	○	○	○
Das Knistern und die Flammen eines Holzfeuers regen meine Fantasie an.	○	○	○	○	○
Manchmal ist es mir möglich, mich völlig in Natur oder Kunst zu versenken, als ob sich mein Bewusstseinszustand vorübergehend verändert hätte.	○	○	○	○	○
Verschiedene Farben haben unterschiedliche und besondere Bedeutungen für mich.	○	○	○	○	○
Es kann mir passieren, dass ich während einer Routineaufgabe in Gedanken abschweife und dabei vergesse, was ich tue, bis ich nach einigen Minuten bemerke, dass ich die Aufgabe erledigt habe.	○	○	○	○	○
Ich kann mich manchmal an bestimme Erfahrungen aus meiner Vergangenheit so lebhaft und klar erinnern, als ob ich sie noch einmal durchleben würde.	○	○	○	○	○
Dinge, die anderen bedeutungslos erscheinen mögen, haben für mich oft einen Sinn.	○	○	○	○	○
Ich glaube, wenn ich in einem Stück eine Rolle spielen würde, könnte ich die Gefühle des dargestellten Charakters tatsächlich empfinden und für diese Zeit als die betreffende Person wirklich leben, mich selbst und das Publikum vergessend.	○	○	○	○	○

Meine Gedanken erscheinen oft nicht als Worte, sondern als Bilder.	○	○	○	○	○
Ich kann mich oft an kleinen Dingen erfreuen (wie die Farbe von Seifenblasen, oder ähnliches).	○	○	○	○	○
Wenn ich mir Orgelmusik oder andere kraftvolle Musik anhöre, fühle ich mich manchmal wie in die Luft gehoben.	○	○	○	○	○
Manchmal kann ich Geräusche in Musik verwandeln, wenn ich auf eine bestimmte Art hinhöre.	○	○	○	○	○
Einige meiner lebhaftesten Erinnerungen werden von Düften und Gerüchen geweckt.	○	○	○	○	○
Manche Musik erinnert mich an Bilder oder sich ändernde Farbmuster.	○	○	○	○	○
Oft weiß ich, was jemand sagen wird, noch bevor er (oder sie) es ausspricht.	○	○	○	○	○
Ich habe oft eine Art "körperliche Erinnerungen", z. B. wenn ich geschwommen bin, kann ich danach immer noch das Gefühl haben, im Wasser zu sein.	○	○	○	○	○
Der Klang einer Stimme kann so faszinierend für mich sein, dass ich einfach nur zuhöre.	○	○	○	○	○
Manchmal fühle ich die Anwesenheit einer Person, die physisch überhaupt nicht da ist.	○	○	○	○	○
Manchmal kommen mir Gedanken und Bilder ohne das geringste Hinzutun.	○	○	○	○	○
Ich finde, dass verschiedene Gerüche verschiedene Farben haben.	○	○	○	○	○
Ein Sonnenuntergang kann mich tief berühren.	○	○	○	○	○

Subjective stress visual analogue scale (VAS 1 – VAS 8)

Wie sehr fühlen Sie sich gestresst?

0 gar nicht — 100 sehr stark

Subjective stress visual analogue scale (VAS-TSST)

Die Situation war stressig für mich.

0 — 100

Recruitment flyer