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„The Role of Neuroticism in the Relationship between Stress, Music and Skin Barrier Recovery"

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Introduction

Stress is considered one of the main aspects adversely impacting our well-being and health (de Witte et al., 2020; Koelsch et al., 2016), which makes it a very important research topic. Physiological and psychological well-being is compromised, and various emotional and physiological problems can result from high stress levels (Brinkmann, 2014). Previous research found a positive correlation between psychological stress, depressive symptomatology, and social anxiety (Cohen et al., 1983). Other health issues related to stress are anxiety disorders, depression, burnout, addiction, chronic pain, cardiovascular diseases, and impaired immunity (American Psychological Association, 2017; Casey, 2017; Howe et al., 2013). Stress also negatively affects the skin. Reasons for that are, among others, immunological mechanisms (Choi et al., 2005; O'Sullivan et al., 1998). Skin barrier recovery (SBR) was shown to be impaired due to psychological stress in multiple studies (Altemus et al., 2001; Choi et al., 2005; Garg et al., 2001).

To live up to the high expectations in today´s achievement-oriented society, many people turn towards tranquilizing medications to cope with stress. These can hold various harmful side effects (Bandelow et al., 2015; de Witte et al., 2020; Olfson et al., 2015). Therefore, the demand and need for effective and nonpharmacological stress reduction approaches is high.

One promising area of research is music. Not only is music a cost-effective and non-invasive intervention without side effects, but it also shows a wide spectrum of positive effects on mental and physical health (de Witte et al., 2020). It is already used in various clinical settings for pain management, psychotherapy, or relaxation, but often there is a lack of evidence for its mechanisms (Chanda & Levitin, 2013). Therefore, more research is needed in this area.

Multiple studies found stress-reducing and relaxing effects of music (Chamorro-Premuzic & Furnham, 2007; de la Torre-Luque et al., 2017; Juslin et al., 2008; Pelletier, 2004). It is a ubiquitous part of the daily lives of most people across all cultures, which would make it a convenient and widely accepted stress reduction intervention. Research showed that music is positively linked to a broad range of psychological functions, especially to coping with stress and emotion regulation (Chamorro-Premuzic & Furnham, 2007). It is proven to be an effective stress reduction technique and influences the well-being of people (de la Torre-Luque et al., 2017). Physical health aspects, for example, parts of the immune system, are influenced by music as well (Núez et al., 2002).

One personality trait that is especially related to increased experience of stress is neuroticism (Gunthert et al., 1999; McCrae, 1990). It is part of the five-factor model of personality (Costa & McCrae, 1992a, 1992b). People high in this personality dimension tend to experience more stress overall and show heightened stress reactions (Suls, 2001). Also, bodily health issues and altered immune functioning are linked to this personality trait (Lahey, 2009). Another interesting circumstance is that neuroticism is related to the emotional use of music. Highly neurotic people are more sensitive to its effects and use it for emotion regulation purposes (e.g. Vella & Mills, 2017)

In the current study "*Effects of music listening on stress and skin barrier recovery*" by Dr. Jasminka Majdandžič and Univ.-Prof. Dr. Urs Nater, we investigate the positive effects of listening to music, as a stress-reduction technique, on skin barrier recovery. Particularly I look at the relationship between stress, music, and skin barrier recovery and how the personality trait neuroticism is involved.

This master´s thesis is structured as follows: In the first sections, I present empirical and theoretical work on the relationship between stress, neuroticism, and skin barrier recovery, followed by theoretical background about the influence of music on stress. Furthermore, I outline the role trait neuroticism plays in this relationship. Then, I derive my my research questions and hypotheses about this mechanism. Afterward, I summarize the theory behind the research question, describe my methodological approach, and present the results. Finally, I discuss the findings and integrate them with the theoretical background. I elaborate on limitations and provide suggestions for future research as well as give practical implications for potential application possibilities of my findings.

Stress and Neuroticism

Personality has an influence on the experience of stress, the stress response, and the use of coping strategies when dealing with stress (Gunthert et al., 1999; Schneider et al., 2012).

Stress is a term that is used extensively in our daily lives. Psychological stress can be defined as "a particular relationship between the person and the environment that is appraised by the person as taxing or exceeding his or her resources and endangering his or her well-being" (Lazarus & Folkman, 1984, p.19). Challenges and demands, that are regarded as important, put high strain on the individual. It is difficult for the person to cope with it in a healthy and non-distressing way.

Seyle (1956) stated, that “stress is a general activation reaction to a stimulus that could mean both a challenge (in a positive way) and a threat (in a negative sense)” (Seyle, 1956, p.32). Thus, stress per se is not necessarily regarded as negative, but as a neutral activation. Aldwin (2007) on the other hand, focused on the negative properties in his definition. According to him, “stress refers to that quality of experience, produced through a person-environment transaction, that, through either overarousal or under arousal, results in psychological or physiological distress” (Aldwin, 2007, p.24).

Consequently, there can be physiological as well as psychological and emotional effects of stress (de Witte et al., 2020). A crucial mechanism in the physiological context of stress is the activation of the hypothalamic-pituitary-adrenal axis (HPA-axis) (Thomason et al., 2011). It links the central nervous system with the endocrine system and is responsible for the regulation of glucocorticoids, for example cortisol secretion. (Stephens & Wand, 2012). Signs of physiological arousal due to stress can also be heightened heart rate and blood pressure (D. Evans, 2002; Han et al., 2010). These three properties, namely elevated heart rate, blood pressure, and cortisol levels, are main distinct stress biomarkers for physiological outcomes (Pfaff et al., 2007).

One of the main emotional reactions to a stressful experience is *state anxiety*. Further stress-related psychological outcomes can be nervousness, restlessness, and worrying (de Witte et al., 2020; Koelsch et al., 2011; Pittman & Kridli, 2011).

A personality trait, that is strongly related to the experience of stress is neuroticism. Neuroticism is one trait from the Big Five Personality traits, that is characterized by an increased experience of stress and negative affect. People who score high on this trait tend to experience events as highly threatening and experience more negative affect (Chamorro-Premuzic & Furnham, 2007; Costa & McCrae, 1992a, 1992b; Rusting & Larsen, 1997; Watson & Clark, 1984), as well as less positive affect (Schneider, 2004; Schneider et al., 2012). Their intensity of emotional affect is higher and emotions such as sadness, embarrassment, and fear are typical (Costa & McCrae, 1992a). While appraising threats as higher, they appraise their resources as lower (Vollrath, 2001).

Suls (2001) suggested that neuroticism intensifies stress reactions and leads to greater stress vulnerability. Thus, people high in this trait are very sensitive to stress.

Neurotic individuals are more susceptible to stress experience if the stressor is interpreted as a threat (Schneider, 2004). Regarding the transactional stress model from Lazarus, this will lead to increased stress experience (Lazarus & Folkman, 1984). Neuroticism can also be referred to as low emotional stability (Ashton & Lee, 2007). Less

emotionally stable people commonly regard daily life as stressful (Gunthert et al., 1999; McCrae, 1990). Moreover, they show elevated anxiety levels during stressful situations and overall experience more stress (Eysenck & Eysenck, 1985; Vollrath, 2001).

Neuroticism can have detrimental stress outcomes. A study discovered, that after exposure to a math stressor, individuals high in neuroticism showed different stress responses than individuals high in openness or extraversion. Neurotic individuals especially showed high threat appraisals and experienced high negative affect together with low positive affect (Schneider et al., 2012).

Another study found that people high in neuroticism show more negative affect after a standard negative mood induction task than people low in neuroticism. Their emotional reactivity was elevated (Larsen & Ketelaar, 1991).

Furthermore, people scoring high on this dimension show greater arousal after exposure to aversive stimuli in comparison to people who score low. Students viewed slides with a negative valence, which were emotionally arousing. The high-neuroticism group displayed higher physiological and subjective arousal (Vogeltanz & Hecker, 1999).

Moreover, neuroticism is found to be associated with larger and more prolonged electrodermal responses to emotionally evocative pictures (Norris et al., 2007).

There are mixed results regarding the sympathetic stress response and neuroticism. On one hand, the sympathetic stress response of individuals with high neuroticism scores after a stressor is found to be larger and prologued in comparison to less neurotic people (Lahey, 2009). Highly neurotic adolescents exhibited greater physiological stress reactivity after a social evaluation task than adolescents with lower neuroticism values (B. E. Evans et al., 2016).

In contrast to these results, another study found that high neuroticism predicted blunted HPA and sympathetic nervous system (SNS) reactivity after a social evaluative threat task, meaning when the person can be judged by others in a negative way (Poppelaars et al., 2019). Moreover, a dampened cortisol response after the Trier Social Stress Test (TSST) in women was linked to higher neuroticism scores (Oswald et al., 2006). This conflicting evidence highlights the need for further research in the field of stress reactivity and stress responses, especially in association with individual personality traits.

Referring to the above-mentioned body of research, I assume, that participants high in trait neuroticism would show higher subjective stress levels after a stressor than participants low in this trait.

Neuroticism and Skin Barrier Recovery

"Evidence supports an association between stable or chronic psychosocial factors and physical health" (Hutchinson & Ruiz, 2011, pp. 277). Multiple longitudinal studies have shown that high neuroticism is associated with increased mortality (e.g., Christensen et al., 2002; Mroczek et al., 2009; Mroczek & Spiro, 2007; Murberg et al., 2001). A link between high neuroticism and a deregulated autonomous nervous system was found in a twin study with female twins. Genetic effects might be responsible for this association (Riese et al., 2007).

Personality traits can influence the cardiovascular system. Blood pressure recovery for women who score high on neuroticism was poorer after a hostile social interaction stressor compared to a friendly interaction. The researchers suggest, that stress influences this effect from neuroticism on physical health (Hutchinson & Ruiz, 2011). Additionally, research showed, that neuroticism genetically correlates and has causal effects on cardiovascular disease and hypertensive disease. There is an indication for genetic variation acting as a mediator in the causal relationship between neuroticism and cardiovascular diseases (Zhang et al., 2021).

In the current study the skin barrier recovery after a stressful situation is investigated. The rate of skin barrier recovery crucially depends on an intact immune system (Choi et al., 2005; Smith et al., 2015).

Neuroticism is known to be related to changes in immune functioning. It was found to be partly responsible for altered functioning of the immune system during depression (Bouhuys et al., 2004). Evidence supports a correlation between neuroticism and activation of peripheral blood mononuclear cells (PBMC) in chronic Hepatitis C patients (Pawlowski et al., 2014). PBMCs are a critical part of the immune system (Pourahmad & Salimi, 2015). Moreover, natural killer (NK) cell activity is shown to differ among people depending on personality traits. Healthy military cadets high in neuroticism (low emotional stability) and state anxiety displayed mean decreases in NK cell lytic units under examination stress. Lytic units are used for expressing NK cell activity (Valiathan et al., 2012). In contrast, those low in neuroticism (high emotional stability) and anxiety showed mean increases in NK cell activity. Therefore, emotional stability/low neuroticism might play a role in immunoenhancement (Borella et al., 1999).

In a recent study about wound healing in living kidney donors, results indicated an influence of personality. The authors found a positive association between the trait *emotional stability* and wound healing (Maple et al., 2015).

The mentioned studies show that personality can influence physical health and immunity. The mechanisms are not fully understood yet. To my knowledge, there is a research gap for the negative effect of neuroticism on skin barrier recovery, which I try to address in the present research. The existing literature does not sufficiently explain this relationship. The influence of neuroticism on health and particularly wound healing and skin barrier recovery might be partly mediated by stress, as highly neurotic individuals are prone to heightened stress experience. I will illustrate the current research status on stress and skin barrier recovery in the next section.

Stress and Skin Barrier Recovery

In this passage, I will briefly present the current research on the topic of the relationship of stress with immunity and wound healing. Finally, I will elaborate on the influence of stress on skin barrier recovery.

Psychological stress can adversely affect our health, the immune system, and parts of the immune responses (Kiecolt-Glaser et al., 1995; Segerstrom & Miller, 2004). However, some results indicate that there might be an enhancement after a brief acute stressor in some functions of the natural immunity, while specific immune system parameters are impaired. (Segerstrom & Miller, 2004). The mode of action in the relationship between stress and immunity is not entirely understood yet.

We know, that skin barrier recovery (SBR) depends on an intact immune system (Smith et al., 2015), and, as previously mentioned, stress can suppress immune functioning (Segerstrom & Miller, 2004; Howe et al., 2013) and skin barrier recovery (Altemus et al., 2001; Robles, 2007).

First, I will outline results regarding stress and immunity.

In one study female participants showed increased proinflammatory cytokine production and altered regulation of this immune response after being exposed to a social-evaluative threat task. The ability of glucocorticoids to stop the inflammatory response was reduced. The task was a modified version of the TSST, which we also use for stress induction in the current study. Prolonged inflammation can lead to a large number of diseases (Dickerson et al., 2009).

Participants exhibited increased inflammatory activity in response to a social stressor (TSST) in another study as well (Slavich et al., 2010). Moreover, immune-related mediators (e. g. cortisol), endocrine, and metabolic processes are impacted by acute CO_2 stress in humans (Koelsch et al., 2016).

Another area where a well-functioning immune system is crucial, is vaccination. Caregivers, who typically experience a lot of psychological stress, did not show an adequate antibody increase four weeks after an influenza virus vaccine relative to a control group (Kiecolt-Glaser et al., 1995).

However, there is also some conflicting evidence when it comes to stress and immunity measures. Short-term stress was also found to enhance some immune parameters (Ackerman et al., 1998). Another example is NK cell activity. Sound stress over several days led to an NK cell activity decrease in rodents (Núez et al., 2002). Opposed to this finding, interview stress led to an increase in NK cell activity and number in human female participants (Altemus et al., 2001). While it is certainly hard to compare human and animal studies directly, this nevertheless shows that the effect of stress, whether it is chronic or acute, on immune measures is not fully clear at this moment. This knowledge gap is yet to be filled and more research is required.

Second, research results on stress and wound healing are presented. It is not new, that stress has adverse effects on wound healing. A study demonstrated that mucosal wounds in students healed slower under examination stress. It was a within-subject design. A punch biopsy wound took approximately 40% longer to heal during the examination period compared to during summer vacation. (Marucha et al., 1998).

Furthermore, another study showed that punch biopsy wounds of female caregivers of Alzheimer´s patients took significantly longer to heal than wounds of controls. The delay in the healing process was nine days on average, which amounts to 24%. Besides, the caregivers experienced significantly more stress. Their reported stress levels on the perceived stress scale (PSS) were above the mean of the standard population, while the scores of the control group were average. Thus, it could be that the stress of caregiving in daily life has affected the immune response and led to stress-related defects in wound healing (Kiecolt-Glaser et al., 1995).

Another study investigated the influence of stress on cutaneous wound healing in a murine model. Findings reveal that wounds of mice that underwent restraint stress (RST), where movements of the mice are blocked, took about three days longer to heal in comparison to control mice. RST mice exhibited increased corticosterone serum levels and inflammation. Inflammation and slower healing correlated with corticosterone levels, which suggests a neuroendocrine influence on wound healing (Padgett et al., 1998).

Most of the studies about SBR / wound healing and stress are performed with artificially created wounds. In contrast, one study investigated the wound healing process of

living kidney donors. Those wounds were not intentionally inflicted for research. Wound healing was measured by wound size and a marker of tissue fluid. Researchers found, that increased life stress one month before the operation was related to delayed wound healing (Maple et al., 2015).

Finally, the current research status on stress and SBR is addressed in the next sections. Skin constitutes of two main layers. The outer layer is called the epidermis and the inner layer the dermis. Skin functions include protecting against pathogens and inhibiting evaporative water loss. The outer layer of skin cells in the epidermis, namely the stratum corneum, helps to maintain a healthy skin barrier function. If this layer of cells is disrupted, for example due to tape strips, injuries or dry skin, the skin barrier function is decreased. This damage leads to increased trans epidermal water loss (TEWL), that can be measured with a Tewameter device. Across time, the skin barrier will recover. This is indicated by decreasing TEWL values (Pinnagoda et al., 1990; Robles, 2007).

What is known from multiple publications, is that stress has a negative impact on skin barrier recovery (e.g. Altemus et al., 2001; Robles, 2007), which can be used as a measure of immune function in the body (Smith et al., 2015).

Altemus et al. (2001) studied the influence of different stressors on skin barrier functions. They found that interview stress and sleep deprivation stress led to a delay in skin barrier function recovery in healthy women. They stated that this might be due to changes in cytokine secretion elicited by stress.

Another study found that short-term stress delayed recovery of the skin after disruption with tape stripping in healthy subjects. A brief laboratory stressor (TSST) led to a delay of skin barrier recovery by 10% at two hours after skin impairment (Robles, 2007). Research also showed, that a stressful life event, like marital separation, negatively impacts the recovery of the skin barrier after tape stripping (Muizzuddin et al., 2003). In contrast, a brief relaxation intervention (20 minutes of guided relaxation) either before or after skin disruption with tape stripping has a beneficial effect on wound healing (Robinson et al., 2015).

Students showed delayed skin barrier function recovery after tape stripping during times of increased perceived psychological stress (final examination period) compared with times of lower stress (during/after holidays). Subjects that reported the most extensive increase in subjective psychological stress exhibited the largest skin barrier function decline (Garg et al., 2001). These results strongly indicate that stress has a negative impact on SBR.

To conclude, stress is known to negatively affect skin barrier recovery of the human body and alter immune functioning. The mechanism is not fully clear yet. There is a great necessity for further research in this area to shed light on the ongoing mechanisms.

Music and Stress

In the next paragraphs, the influence of music on stress is described. First, I will outline the link between music and the psychological aspects of stress. Second, I will move on to the influence of music on physical stress parameters and immunity.

Music is linked to numerous positive outcomes in the field of health and well-being. It is proven to be an effective stress reduction technique and influences the well-being of people. A study showed, that listening to preferred music supports stress recovery (de la Torre-Luque et al., 2017). A meta-analytic review of 22 quantitative studies revealed, that arousal due to stress was decreased significantly by music on its own or music-assisted relaxation interventions. Physiological, behavioral, and self-report measures were included in the review (Pelletier, 2004).

Music listening in everyday life led to decreased subjective stress levels in university students. This effect was especially strong when `relaxation´ was the purpose of listening to music. Subjective stress decreased along with lowered cortisol concentration (Linnemann et al., 2015).

Music has an influence on people´s moods. Functional neuroimaging experiments revealed, that emotions, evoked by music, were able to alter activity in many areas of the brain, where emotion processing happens (Koelsch et al., 2010). Results from an experience sampling study indicated a higher frequency of positive emotions, for example, *happiness-elation,* during episodes of music listening, than negative emotions (Juslin et al., 2008).

Moreover, music listening lead to an increase in positive mood in participants compared to a control group, that listened to a neutral stimulus in a double-blind randomized study. Mood was also found responsible for modifications of bodily acute stress responses (Koelsch et al., 2016).

Important physical health aspects, such as immunological functions and parameters, for example, can be influenced by music as well. The topic of psychoneuroimmunology of music is gaining more and more interest (Cervellin & Lippi, 2011; Chanda & Levitin, 2013; Fancourt et al., 2014; Koelsch et al., 2016; Koelsch & Stegemann, 2012).

A previous study examined the effects of music on stress, immunity, and cancer development in rodents. Rats were injected with carcinosarcoma cells. One group was

exposed to sound stress over the course of eight days. The experience of stress led to decreased immune parameters (e.g., natural killer cell activity) and increased development of metastasis. Music was not only able to partly reverse these immunosuppressive effects of stress, but it also enhanced immunity in the non-stress control group (Núez et al., 2002).

Another systematic review and two meta-analysis including 104 randomized control trials, examined the effects of music interventions on psychological as well as on physiological stress levels. The results indicated a positive effect of music on stress measures. Music was found to be effective in reducing the psychological (stress, anxiety) and the physiological (e.g. heart rate, blood pressure, hormonal responses) effects of stress (de Witte et al., 2020).

Further, a study revealed that music might decrease the HPA axis stress response after an acute psychological stressor. Salivary cortisol levels stopped to increase directly after TSST in a music group, in comparison to a silence control group, where the cortisol levels continued to increase within 15 minutes after the stressor. Moreover, the cortisol concentration in the music group decreased faster than in the control group, that was not exposed to music during the recovery period. (Khalfa et al., 2003).

Similar results were found by Knight and Rickard (2001). Music listening averted stress-induced increases in heart rate, blood pressure, cortisol levels, and subjective anxiety in healthy male and female undergraduate students. They were exposed to a cognitive stressor task, during one group listened to Pachelbel's Canon in D major, and the other group was in silence (Knight & Rickard, 2001).

In another study, acute CO_2 stress was administered to healthy humans to study the effects of stress and the recovery on immune parameters and HPA-related hormones. The researchers also induced positive mood with the help of music, while also having a control group without music. The music group exhibited more positive mood and a stronger cortisol response to the acute stressor, which was interpreted as a more adequate stress response by the authors (Koelsch et al., 2016). This shows that the results regarding endocrine stress responses are not consistent.

The type of music might play a role in the modulation of stress responses. Classical music was found to facilitate cardiovascular recovery after acute stress. Participants who listened to classical music, compared to silence or jazz and pop music, had significantly lower blood pressure after a mental arithmetic task (Chafin et al., 2004).

Valence and arousal can influence stress recovery as well. Low arousal music and a positive valence was more effective in reducing physiological and subjective stress effects than negatively valenced or high arousal music (Sandstrom & Russo, 2010).

A Japanese study discovered that high-frequency music increased dopamine synthesis in hypertensive rats. The consecutive increase in dopamine led to a blood pressure reduction. D_2 receptors were involved in this mechanism (Akiyama & Sutoo, 2011).

Taken together these results highlight that there is a beneficial influence of music on stress.

Neuroticism and Music

Personality influences the way people use music and what type of music they prefer. A study showed, that personality also has an impact on music taste (Zweigenhaft, 2008). Moreover, how people use music, can differ, depending on their personalities. People high in openness use music as a form of cognitive stimulation, meaning that they seek cognitive enriching experiences and like to analyze the composition. Extraverts use it predominantly as background noise and during activities (Chamorro-Premuzic et al., 2009).

Neuroticism is especially related to the emotional use of music. As mentioned above, neurotic people use more emotion-focused coping strategies than problem-focused strategies.

A study showed, that they tend to engage in emotional use of music, to regulate their mood and emotions (Vella & Mills, 2017). It should help them to manage stress in situations with high strain. In the same study perceived stress correlated with emotional use of music. Besides that, neurotic individuals are more sensitive to the effects of music than more emotionally stable people (Chamorro-Premuzic & Furnham, 2007; Juslin & Sloboda, 2013).

In an experience sampling study, researchers found a correlation between neuroticism and the musical emotion *pleasure-enjoyment* (Juslin et al., 2008). Interestingly, an earlier study suggests, that musicians are likely to be higher in neuroticism than the population (Kemp, 1996). Possibly more neurotic persons are attracted to music, as it helps them regulate their moods and emotions.

In the current study, I look at the influence of the trait neuroticism on the relationship between music, stress, and skin barrier recovery. Since it has been shown, that highly neurotic people are very sensitive to the effects of music and use it for emotional reasons, it can be expected that people who score high on the trait neuroticism benefit particularly strongly from listening to music as a means of stress reduction and emotion regulation. Therefore, I would

expect neuroticism to modulate the effect of music listening on stress reduction, and, subsequently, skin barrier recovery.

To address my research question, a mixed study design was applied. Neuroticism was assessed before the experimental session. Subjective stress was assessed at the beginning and multiple times during the experimental session. During the session a stress induction intervention was performed followed by the first TEWL measurement and a relaxation period with three different listening conditions (music, audiobook, silence). In the course of the experimental session TEWL values were also measured multiple times.

Aim of Study and Research Questions

In the following, I will summarize the theoretical background on the topic of neuroticism, stress, and SBR and explain the first research questions.

Highly neurotic people incline toward experiencing more stress, show greater stress reactivity after a stressor and an enlarged stress response. Taking this into account, I assume that the acute stress response after a stressor would be elevated for highly neurotic people compared to people who score lower on neuroticism.

As explained above, skin barrier recovery should be slower for people high in neuroticism. The recovery could take longer because immune functioning might be impaired. A reason for that might be, that people high in neuroticism are more prone to experiencing stress and show greater stress responses after a stressful experience.

Thus, stress might act as a mediator in the presumed relationship between neuroticism and skin barrier recovery. The first research model is displayed in Figure 1.

This brings me to my first research questions: Is neuroticism related to slower skin barrier recovery? And does stress mediate this effect?

The hypotheses are:

H1a: Neuroticism is associated with increased subjective stress.

H1b: Neuroticism has a negative effect on skin barrier recovery.

H1c: Stress mediates the effect of neuroticism on skin barrier recovery.

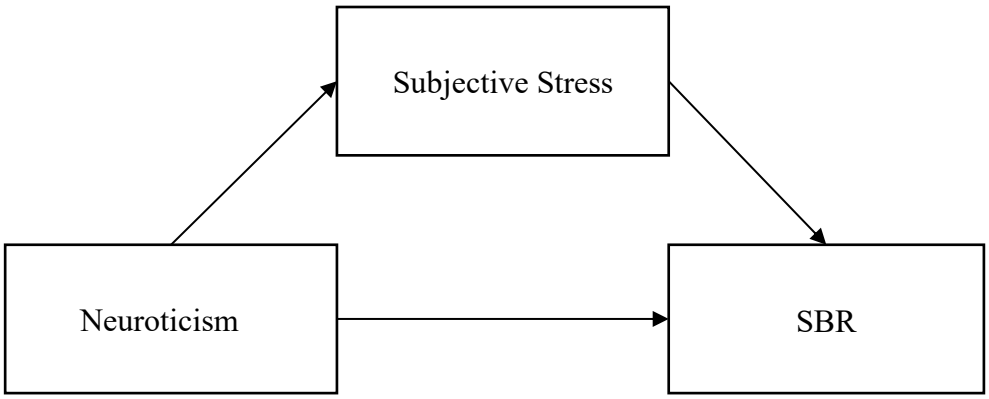

Figure 1. Research model for the first research question

The second research question involves the variables music, stress, and neuroticism. Since it has been shown, that highly neurotic people are very sensitive to the effects of music and use it for emotional reasons, it can be expected that people who score high on the trait neuroticism benefit a lot from listening to music as a means of stress reduction and emotion regulation.

Thus, people high in neuroticism might show a larger reduction in subjective stress between stress directly after the stress induction and after the music intervention, than individuals low in neuroticism.

At the same time, there may be floor effects for people low in neuroticism. It might be the case, that people low in neuroticism report lower stress levels and recover faster regardless of music listening, because of their predisposition to experience less stress. Only the difference of improvement of subjective stress through music listening might be greater for people high in neuroticism, compared to people low in neuroticism. The second research model is displayed in Figure 2. The listening condition during the relaxation period after the stressor is either music, audiobook, or silence. There should only be an interaction between neuroticism and music regarding the effect on the subjective stress level, and not for neuroticism and the control conditions.

The second research question is the following: Is the effect of music listening on stress moderated by neuroticism?

The hypothesis is:

H2: Neuroticism enhances the effect of listening to music (versus listening to an audiobook or silence) on stress

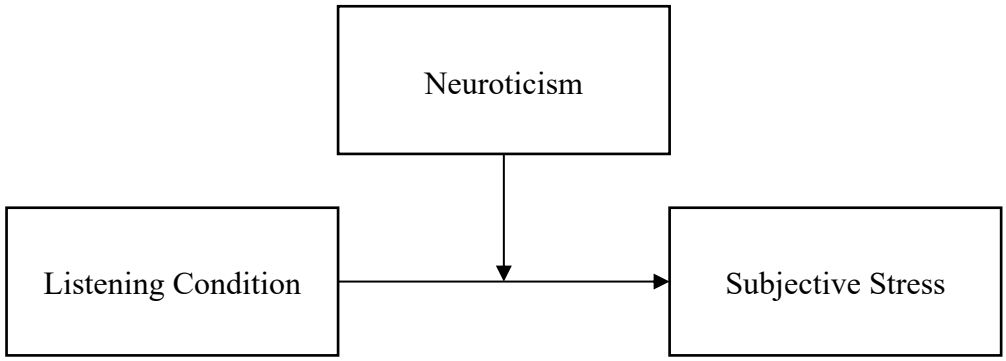

Figure 2. Research model for the second research question.

Methods

Participants

Inclusion and Exclusion Criteria

Women within the age range between 18 and 35 were allowed to take part in this experiment. Their body mass index had to be between 17 and 30 and they should speak German fluently. Furthermore, as stress hormones are measured (not relevant for the current research question), a regular menstrual cycle and no hormonal medication or hormonal contraception were a prerequisite. The experimental session took place at the beginning of the follicular phase of the menstrual cycle to control for hormonal changes. Pregnancy or breastfeeding were exclusion criteria.

There were several other criteria concerning physical and mental health. The following diseases lead to exclusion: hearing impairment for example tinnitus or hearing loss, blindness, or strong visual impairment, chronic or acute infectious skin diseases, allergies and hypersensitivity reactions, heart diseases (e.g., coronary heart disease, cardiac arrhythmias, angina pectoris). Lung and respiratory diseases (e.g. tuberculosis, chronic bronchitis, asthma), liver diseases (hepatitis, jaundice, very high or very low blood pressure, chronic pain, kidney and urinary tract diseases, metabolic diseases, digestive tract diseases (e.g. chronic enteropathy, intestinal disease), neurological diseases, infectious diseases (e.g. HIV), thyroid diseases, autoimmune diseases (e.g. multiple sclerosis, neurodermatitis), skeletal and muscle

diseases, blood diseases, and mental disorders (e.g. major depression, anxiety disorder, eating disorder, schizophrenia, psychosis).

Furthermore, participants must not have been in a tropical region in the past six months, have had surgery in the past eight weeks, and vaccination in the past two weeks. They must be able to refrain from smoking for more than 3.5 h and were excluded if they exhibited regular and problematic alcohol consumption or regular intake of medication (e.g., psychotropic drugs, and/or psychotropic drugs, mental disorders (major depression, anxiety disorder, eating disorder, substance abuse, psychosis, schizophrenia, bipolar disorder).

Moreover, no absolute pitch, no career in music, and no prior experience with the stress tests like the TSST were required.

The project is still going on and the data collection is not completed yet. Until the beginning of the analysis for this thesis, the sample consisted of fifteen (N = 15) mentally and physically healthy females between 20 and 32 years (M = 25.73, SD = 3.73) in total. Ten are from Austria, four from Germany, and one participant from Chilly. All of them, except for one, have at least a high-school degree.

I used different subsamples for the different research questions and hypotheses. The reason was the relatively small sample size and the different prerequisites of the hypotheses.

For the analysis of SBR six participants were excluded, due to flawed TEWL measurements. One reason for that was, that the trans-epidermal water loss increased with time. This should not be the case because usually the skin barrier recovers, and the water loss decreases over time. In other cases, the three values from the three test sites were too far apart from each other, which indicates flawed measuring as well. For one person the first TEWL measurement had a negative value.

Recruitment and Screening

The recruiting for the study mostly took place online on various social media pages and through a database for psychological experiments. A flyer was used for advertising, which is included in the appendix. The participants were offered a monetary compensation of 45 euros for participation. First, after a potential participant expressed interest by e-mail, a telephone screening interview was conducted to see if the candidates meet the general inclusion criteria and were eligible for participation. The e-mail account was created for that project and only members of the projects had access.

In the first part of the interview, after the participant consented to take part in the interview, information about the physical and mental health and the aforementioned requirements was collected. If the participant met the criteria, further information about the

study and laboratory procedure was provided in the second part. When the participant agreed to finally take part in the study, a suitable date had to be found. As the experimental session had to be done at the beginning of the follicular phase of the menstrual cycle, the fitting time frame was calculated under consideration of the usual menstrual cycle and monthly period length.

After the successful screening interview, the participants received an e-mail with instructions for the testing day, a checklist, and a link, that led to an online questionnaire. They should complete it before the experimental session. It included various measures for personality, positive affect, stress, health, resilience, and musicality. The personality measure was of special interest for the current research question.

Study Design

The study design is a mixed design with three groups: the experimental group, which listens to music for 30 minutes, and two control groups, that either listen to an audiobook or are in silence for 30 minutes respectively. The participants were randomly assigned to one of the three groups. The variables of interest are neuroticism, either on a low, average, or high level, and relaxed positive affect. Those were assessed in a questionnaire prior to the experimental session. Furthermore, the factors subjective stress, relaxed positive affect, and skin barrier recovery, that were measured multiple times during the experimental session.

Tasks, measures, questionnaires

The variables that are relevant for the current master´s thesis, are neuroticism, relaxed positive affect, subjective stress, skin barrier recovery, and music. Relaxed positive affect is part of an explorative analysis. All variables and their assessment are explained in the following.

Neuroticism

Neuroticism was assessed with the NEO-FFI (NEO-Fünf-Faktoren-Inventar), a multidimensional self-report personality inventory (Borkenau & Ostendorf, 2008). Only the subscale neuroticism is relevant for the current analysis. It consists of twelve items and is a 5-point-likert scale (1 = "*starke Ablehnung*", 2 = "*Ablehnung"*, 3 = "*Neutral"*, 4 = "*Zustimmung"*, 5 = "*starke Zustimmung*"). Sample items are "*Ich fühle mich oft angespannt und nervös.*" and „*Wenn ich unter starkem Stress stehe, fühle ich mich manchmal, als ob ich zusammenbräche.*" (Borkenau & Ostendorf, 2008). The scale was part of the online questionnaire prior the experimental session.

Cronbach's alpha was calculated for reliability analysis. In previous research, the inventory showed a respectable and good internal consistency between α = .72 and α = .87. The retest reliability after five years is between r = .71 and r = .82 (Borkenau & Ostendorf, 2008). In the current investigation, the reliability of the neuroticism scale was excellent with a Cronbach´s α of α = .93.

Relaxed Positive Affect

Relaxed positive affect was measured with the *Types of positive affect scale* (TTPAS) introduced by Gilbert et al. (2008). It is a self-report questionnaire to assess relaxed positive affect, as well as two other subscales related to positive affect. Participants fill it out eight times during the experimental session. The subscale *relaxed positive affect*, which consists of six items was used in the analysis. It expresses positive affect without activity and furthermore significantly predicts reduced stress (Gilbert et al., 2008). The response format is a five-point likert scale. Adjectives should be rated by the participants on how much they are feeling that way at that moment (1 = *gar nicht*, 5 = "*sehr*"). Sample items are "*entspannt*" and "*locker*". Reliability is good with a Cronbach´s α of α = .83 (Gilbert et al., 2008).

Subjective Stress

Subjective stress was measured eight times during the experimental session with one item *("Wie gestresst fühlen Sie sich?")* to directly assess how stressed the participant is feeling and to monitor changes over time. The item is a visual analog scale (VAS) with two dimensions from 0 (*gar nicht*) until 100 (*sehr*). The participant should mark the degree of subjective stress they are feeling at that moment. Due to the visuality of the measure, misunderstandings because of wording problems can be minimized. It is a quick and efficient method to assess stress. Moreover, it shows similar discrimination as the Cohen´s perceived stress scale (PSS) and actually measures perceived stress (Lesage et al., 2012). The VAS is included in the appendix.

Stress Induction

Stress was induced using the *Trier Social Stress Test* (TSST) (Allen et al., 2017; Kirschbaum et al., 1993), a widely used paradigm in stress research. This test provides the opportunity to evoke and assess the acute stress response of participants. Psychological as well as physiological stress responses, for example, increase in cortisol and heart rate, result from it (Kirschbaum et al., 1993).

The procedure was the following: The TSST consisted of an anticipation period of three minutes duration and a test period of ten minutes duration. The test period was divided into a five-minute fake job interview and a five-minute surprise arithmetic task in front of an

expert audience of two people. One of them was male and the other one was female. There also was a video camera and a microphone installed.

The participant was led to a second testing room and given paper and pencil for the preparation. In the anticipation period, the participant should prepare as an applicant for a fake job interview with the company´s staff managers (the committee of two people). Moreover, the participant was told that the audience was trained in behavioral analysis and that their performance was being video recorded for further video analysis The participant was allowed to take notes, but not to use them during the interview. The participant was standing in front of the committee, should introduce herself, and give a free speech over five minutes about why she would be the perfect applicant for the available position. The committee wore white laboratory coats and was advised to have a neutral gaze. They should not nod, smile, or interact with the participant in other nonverbal ways. The male active stressor was the one who talked, the female passive stressor "switched on" the camera and took notes during the session. The camera was switched off.

In the second part of the experimental session, the active stressor asked the participant to count backward in steps of 17 starting from the number 2043. Whenever she made a mistake, the active stressor responded in a standardized way with: "*Fehler - 2043 bitte*." Or "*Fehler, bitte noch einmal von vorne*." and she had to restart from the beginning from 2043. After five minutes the test conductor brought the participant back to the initial testing room.

Skin Barrier Recovery

Skin barrier recovery (SBR) was assessed by measuring the trans-epidermal water loss (TEWL), meaning the water evaporating through the epidermis (Altemus et al., 2001; Pinnagoda et al., 1990; Rogiers, 2001). For measuring the TEWL we used the "Tewameter® TM 300" device (https://www.courage-khazaka.de/de/16-wissenschaftliche-produkte/alle-produkte/89-tewameter-d).

The TEWL is a measure for skin barrier function (SBF). A baseline measure of the TEWL is taken with the *Tewameter*. Afterward, the skin barrier is disrupted using the tape stripping technique (Rogiers, 2001). The outer layer of the skin, the stratum corneum, at the volar forearm is removed until the water loss measure has increased at least 15g/hr/m^2 from baseline. The maximum is 40 tape strips. Adhesive tape was used for this procedure. There were three test sites and one control site on the volar forearm one centimeter from the elbow crease, as illustrated in Figure 3. The areas were marked with a stamp. Damage to the skin is defined by the increase in water loss. Skin barrier recovery (SBR) is measured by the decrease

in water loss in the hours after disruption. The SBR in percent is calculated with the following equitation:

$$SBR = (TEWL_{impairment} - TEWL_{measure}) / (TEWL_{impairment} - TEWL_{baseline}) \times 100$$

I used the TEWL mean values of the three impaired test sites. The TEWL was measured four times after the skin disruption to assess the change over time and the recovery rate and speed. In the first hour after disruption, major changes in skin regeneration are visible and the effects are quite distinct. Afterward, the recovery curves usually show a plateau (Robles, 2007). To achieve as accurate measures as possible it is important that the room temperature is at a constant level between 22,5 °C and 23, 5 °C because the measuring devices are very delicate to external disturbing factors. Windows must be closed, and air conditioning must be switched off to prevent air draught.

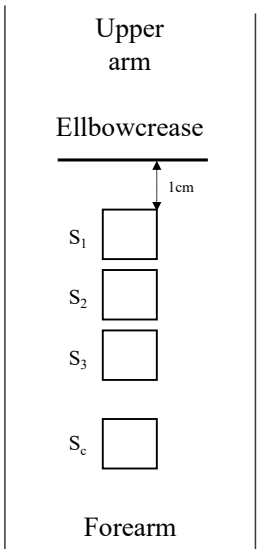

Figure 3. TEWL Test Site Scheme

Listening Condition: Music, Audiobook, Silence

For the 30 minutes music and audiobook listening intervention we used bluetooth overhead headphones. The participants could choose from a music or audiobook selection before the beginning of the experimental session. The music selection had been tested before,

to make sure it fulfills the purpose of relaxation and stress reduction. There were five different playlists with different genres of music: piano, ambient, jazz, guitar, lounge, and LoFi.

Consequently, there were different samples of audiobooks as well, of which the topics were biology, history, cosmology, art, philosophy, and physics.

The second control group remained in silence for 30 minutes and could read magazines during that time.

Procedure

Figure 4 displays the study timeline of the procedure in the laboratory and shows the time points where various measures are taken. The saliva sampling is not relevant for the present research question within this study.

On the test day, the participant should arrive in the laboratory at 12:50 pm. Each experimental session took place between around 1 pm and 5 pm because past research showed an influence of chronobiologic rhythms on stress, for example, a circadian rhythm of cortisol levels and heart rate (Bhake et al., 2019; Sammito et al., 2016).

Body temperature was measured twice due to the covid-19 pandemic, to make sure it was not elevated. Also, the temperature of the instructor, the person in charge of the TEWL measurement, and the committee of the TSST was measured twice. Furthermore, a covid-interview was conducted. Everyone involved in the experimental session completed it.

Once consent was granted, the music or audiobook was chosen by the participant. She filled out multiple questionnaires for the first time. Measures of subjective stress and positive affect are of particular interest for the current investigation. Next, the participants were brought to a second testing room, got the instruction for the TSST, and filled out the questionnaires for the second time. Subsequently, they underwent the TSST. After the stress induction, they completed the questionnaires for the third time.

They then were led back to the initial testing room. A TEWL measure was taken before the skin disruption. Afterward, the skin barrier was disrupted with the tape stripping procedure and the baseline TEWL measure was taken. Eventually, they listened to music, an audiobook, or nothing for 30 minutes, depending on the group they were randomly assigned prior to the experimental session. During the listening, they wore headphones and lay down in a deckchair with an optional blanket. The instructor advised them to try to stay awake, switched off the light, and left the room. After 30 minutes she came back into the testing room and switched on the light.

55 Minutes after the skin impairment the first post-disruption TEWL measure was taken, and the questionnaires were filled out again. There were three more TEWL measures and questionnaires within the next few hours. They were each 30 minutes apart. In the meantime, the participants were allowed to read magazines and were alone in the testing room. In total, subjective stress level and relaxed positive affect were assessed eight times throughout the experimental session.

At the end of the experimental session, the participants got a debriefing. The instructor informed them about the purpose of the study. Furthermore, that the interview situation was fake, that they were not video recorded, and that the jury was not trained in behavioral analysis. The participant also had the opportunity to ask questions.

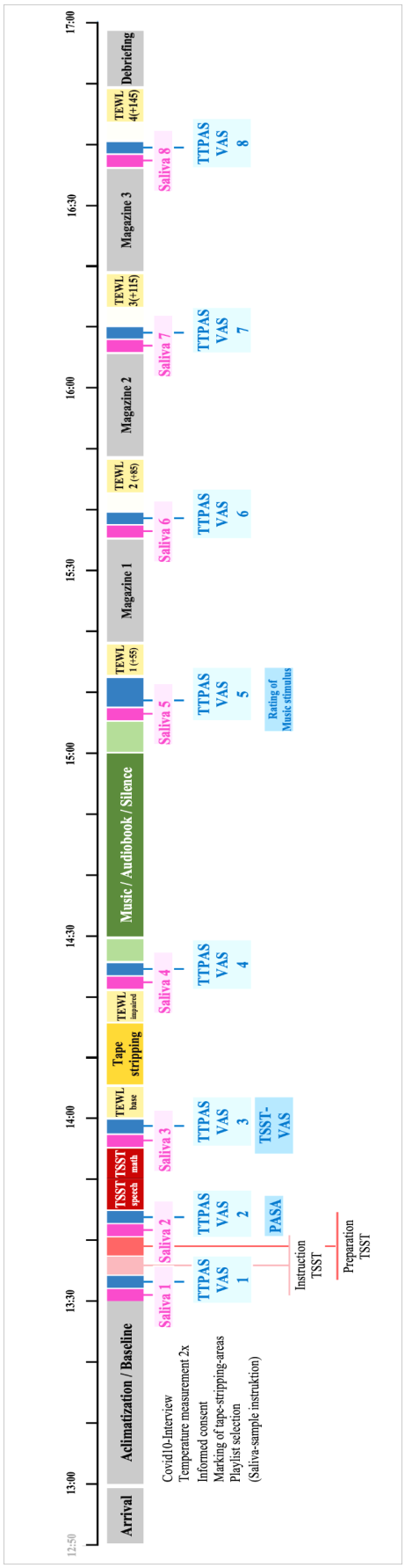

Figure 4. Study timeline

Analysis

Initially, it was planned to perform a mediation analysis with the Process Macro from Andrew F. Hayes (Hayes, 2017) in SPSS statistics for the first set of hypotheses (H1a: Neuroticism has a reinforcing effect on subjective stress., H1b: Neuroticism has a negative effect on wound healing., H1c: Stress mediates the effect from Neuroticism on wound healing.). For the second hypothesis (H2: Neuroticism enhances the effect of listening to music (versus listening to an audiobook or silence)) the intention was to perform a moderation analysis with the same Process Macro.

Due to the small sample size, the originally planned mediation and moderation analysis could not be executed. It was replaced by a single case / extreme case analysis.

To answer the first research question, multiple line charts were created to visualize the data characteristics and results. Moreover, a scatter plot and a correlation analysis were used to investigate the relationship between subjective stress and SBR. For the second hypothesis, line charts were created.

The results will be presented in the following sections.

Results

The participants ($N = 15$) were distributed between the experimental group, that listened to music and the control groups, that either listened to an audiobook or were in silence in the following way:

Seven participants were in the music group ($N_{Music} = 7$), three participants were in the audiobook group ($N_{Audiobook} = 3$) and five participants were in the silence group ($N_{Silence} = 5$). Thus, eight participants in total were in the control group ($N_{control} = 8$).

First, the results for the first research question (*Is neuroticism related to slower skin barrier recovery? And does stress mediate this effect?*) will be shown. Different subsamples were used to assess the hypotheses.

Stress and Neuroticism

The neuroticism scores of the 15 participants are displayed in Table 1. Six participants show neuroticism scores that are above the average for the population ($M = 1.99$, $SD = .69$) (Borkenau & Ostendorf, 2008). As of now, they are referred to as the *high neuroticism group* (HN).

The two participants with the lowest scores are still within average, with values of 1.33 and 1.5, but far apart from the rest, which are all above 2.0. Therefore, they were summed up as the *low neuroticism group* (LN).

The remaining seven participants have average neuroticism scores (*mean neuroticism group*, MN).

For reasons of clearness and simplification I grouped them into three groups, namely high neuroticism (HN, N = 6), low neuroticism (LN, N = 2), and mean Neuroticism (MN, N = 7). In the analysis, I mainly focused on the extreme cases, namely the two groups (HN, LN) with the most distinct neuroticism scores.

Table 1

Neuroticism scores from NEO-FFI

Participant	Neuroticism Score	Group
1	2.00	MN
2	3.92	HN
3	1.33	LN
4	2.08	MN
5	2.00	MN
6	2.75	HN
7	2.25	MN
8	2.42	MN
9	3.33	HN
10	3.33	HN
11	2.33	MN
12	1.50	LN
13	3.92	HN
14	3.42	HN
15	2.42	MN

Note. Average neuroticism score in population: $M = 1.99$, ($SD = .69$);

Eight (N = 8) participants in total were included in the analysis of the relationship between stress and neuroticism. The course of the mean subjective stress levels of HN and LN are displayed in Figure 5. Standard errors are marked.

The results described in the following reflect the visual inspection of the graphs. The participants do not feel stressed at the beginning. Subjective stress rises before the TSST (time point two) and the curve shows a peak at time-point three, which is directly after the TSST. After that, it declines rapidly to the baseline level after time point four. Subjective stress stays low until the end of the experimental session (time point eight).

The HN group reports slightly higher stress levels directly before and after the stress intervention than the LN group. The peak is at 61 out of 100 right after undergoing the TSST (time point three). The peak of LN is at 57. The stress level of group HN at the peak is 4 points higher than that of group LN. The difference between mean baseline stress levels and peak stress for HN is 47.5 points. For LN this difference is 44.5 respectively. The HN group shows a slightly higher increase in subjective stress after the stressor of 3 points.

After that, both curves decline and after time point five the HN group reports slightly lower stress levels than the LN group.

The curves only partly support the previous assumptions. The two curves are very similar, and the stress course does not differ substantially between HN and LN. Thus, the subjective stress levels of the two extreme groups regarding neuroticism do not differ extensively.

These results do not fully support the first hypothesis (H1a: Neuroticism has a reinforcing effect on subjective stress.). The pattern in the graphs shows the expected direction, but that the standard deviation is rather high. Thus, it is not possible to make definite claims about an effect.

Figure 6 shows a comparison between the separate subjective stress levels of the participants in group HN and LN to illustrate the interindividual differences ($N_{HN} = 6$, $N_{LN} = 2$).

The two LN participants show quite distinct stress courses and so do the HN participants. One LN participant, who scored lowest on neuroticism, shows the third-highest stress level directly after the TSST with a score of 75 out of 100. Two HN participants report the highest subjective stress at that time point, with scores of 99 and 90. All the other participants report lower subjective stress. The second low neurotic person shows a peak in stress directly before the TSST. The stress level afterward is higher than for the first LN person and shows a minor increase towards the end of the experimental session. The first LN person exhibits a rapid decline after the peak to zero for the rest of the experimental session. For the HN participants, there is no common course visible respectively.

This illustrates, that the individual stress levels of either HN or LN participants do not show a common tendency in their course throughout the experimental session. Moreover, no major difference between the two groups is visible.

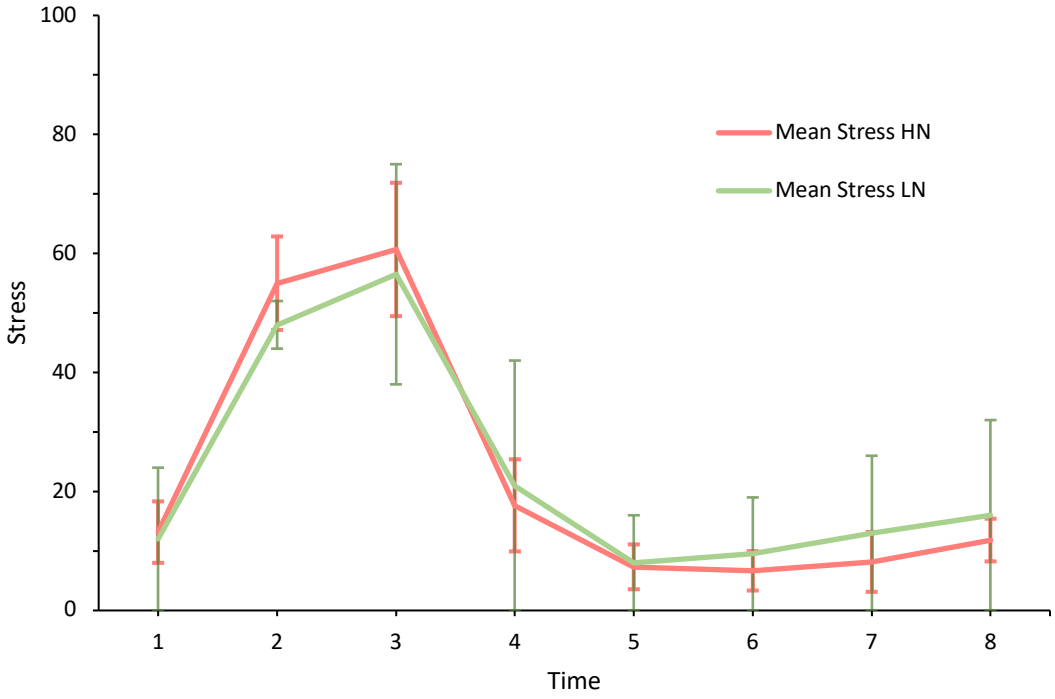

Figure 5. Mean Subjective Stress-levels across Time from visual analogue scale (VAS)

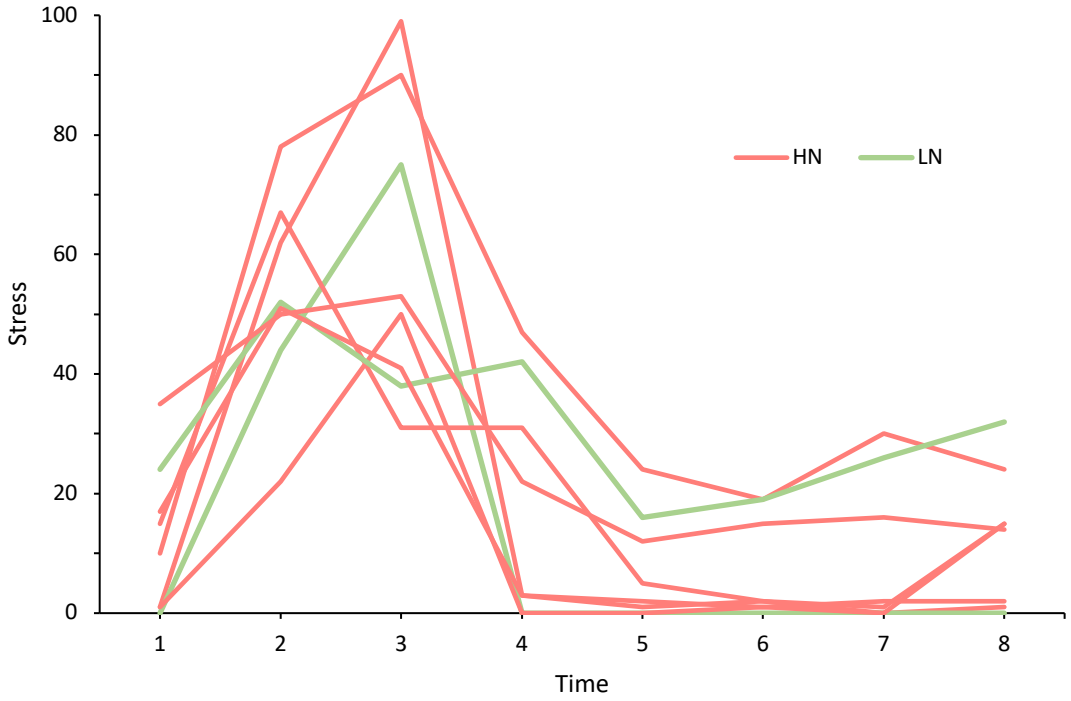

Figure 6. Separate Subjective Stress-levels across Time from VAS

Neuroticism and Skin Barrier Recovery.

The sample size for analyzing SBR is N = 9. The TEWL values of the remaining six participants were flawed and had therefore been excluded. In the high neuroticism group, there are four participants with viable TEWL values, in the low neuroticism group there is only one participant. The remaining four people are in the MN group.

Figure 7 displays the mean SBR values of all nine participants. Within the first hour after skin disruption major changes in SBR are visible. 55 minutes after skin impairment the mean SBR reaches 26.8% (Time point 2). After that point, the increase becomes less steep, and the curve shows a plateau during the next two time points, after which the increase again becomes slightly steeper. The mean SBR curve follows the expected direction.

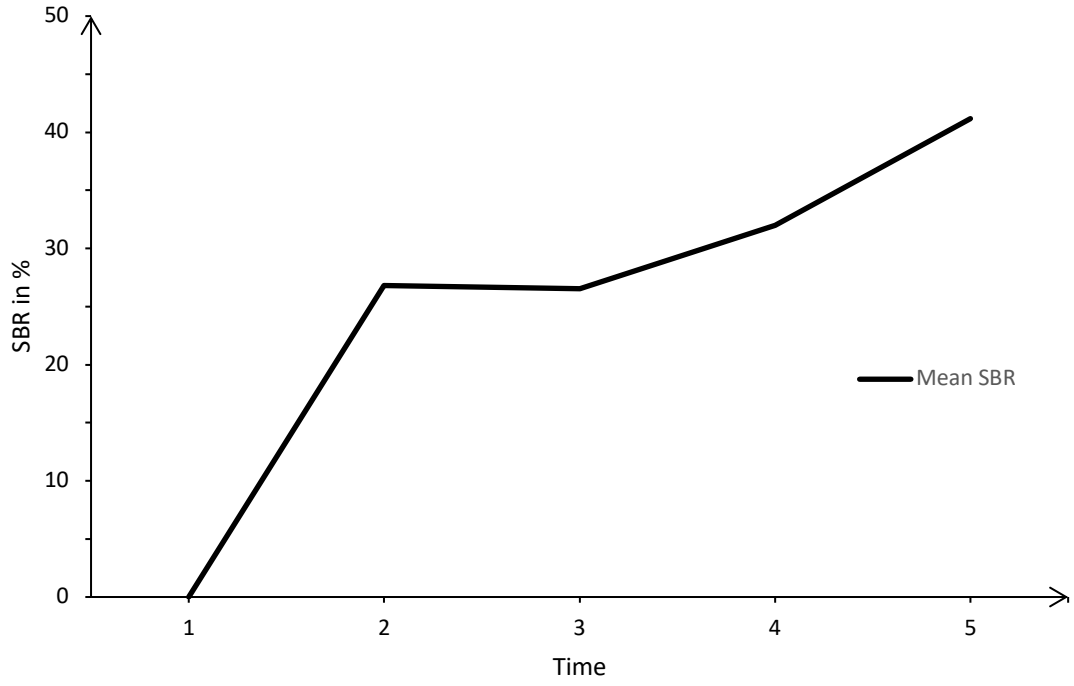

Figure 7. Mean Skin Barrier Recovery across Time

Figure 8 presents the mean SBR of the highly neurotic participants, the separate SBR of the highly neurotic participants, and the low neurotic participant over time (N = 5).

The pattern shows the predicted direction. Group HN displays a lower mean SBR (SBR = 21.8%) than person LN (SBR = 45.2%) one hour after skin disruption. These differences stay equal until TEWL 4 (145 minutes after disruption), where the two values reach the same level. For the low neurotic person, the SBR declines to 33.9% and then increases to 37.9% and 36.2%. After the first hour after skin impairment, the SBR shows a plateau. In the high neuroticism group, the mean SBR does not change between the first and second hour after skin impairment. In the next two hours, it increases to 33.7% and 38.4%.

When looking at the separate HN SBR values one hour after skin impairment, it is clear, that all of them are lower than the SBR of person LN at this timepoint.

The SBR values show fluctuations, especially for person LN and one HN person. For example, person LN´s SBR at TEWL2 is lower than at TEWL1. These fluctuations and decline in SBR values are not visible in the mean SBR across all participants.

The described results provide some initial support for the second hypothesis (H1b: Neuroticism has a negative effect on skin barrier recovery.) The highly neurotic participants show poorer skin barrier recovery than the low neurotic person one hour after skin disruption.

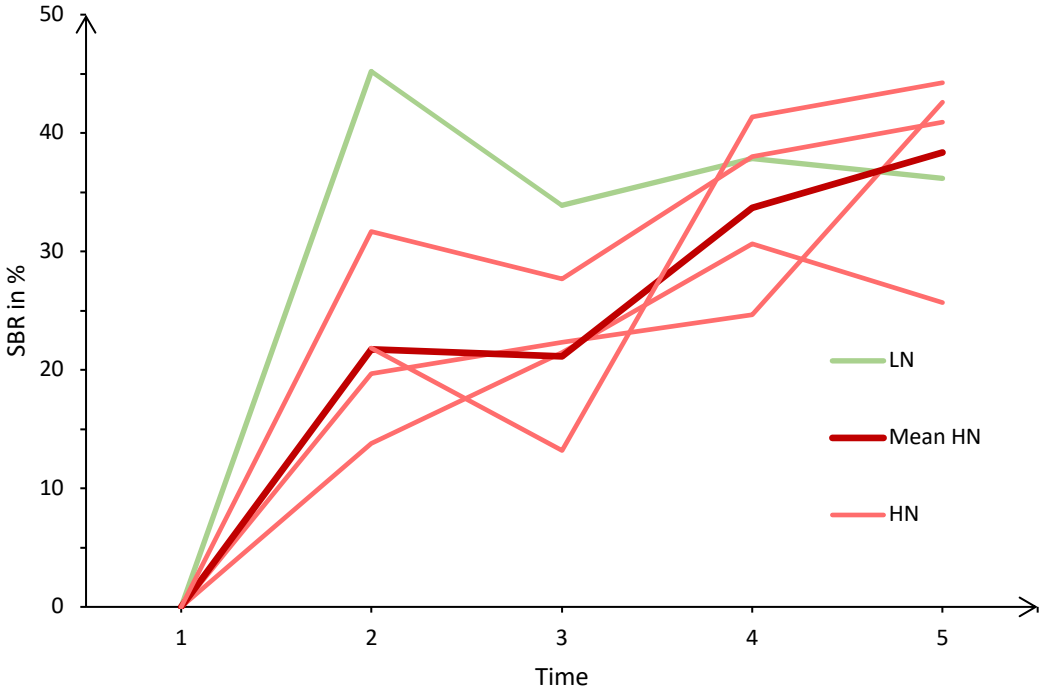

Figure 8. Separate Skin Barrier Recovery across Time

Stress and SBR

The scatterplot in Figure 9 illustrates the relationship between SBR and subjective stress. Baseline corrected subjective stress values were used, to show the increase after the stress intervention. There is a negative correlation between subjective stress and SBR. This moderate negative correlation did not reach significance, r = -.253, p = .551.

The person who exhibits the highest SBR of 45.2% reports a high increase in subjective stress at the same time. This point is an aberration from the remaining values.

For increases in subjective stress under 45 points, the SBR values range between 21.8% and 36.2% and tend to be higher than the SBR values from participants who exhibited an increase in subjective stress over 45. Those SBR scores range from 13.8% to 19.7%. The two participants with the highest increase in subjective stress (95, 98) present with low SBR respectively (14.4%, 19.7%).

The assumption that higher levels of stress would be associated with lower SBR does not hold true.

The mediation analysis could not be performed due to the small sample size. Thus, based on the current data, the third hypothesis (H1c: Stress mediates the effect from neuroticism on skin barrier recovery.) cannot be accepted.

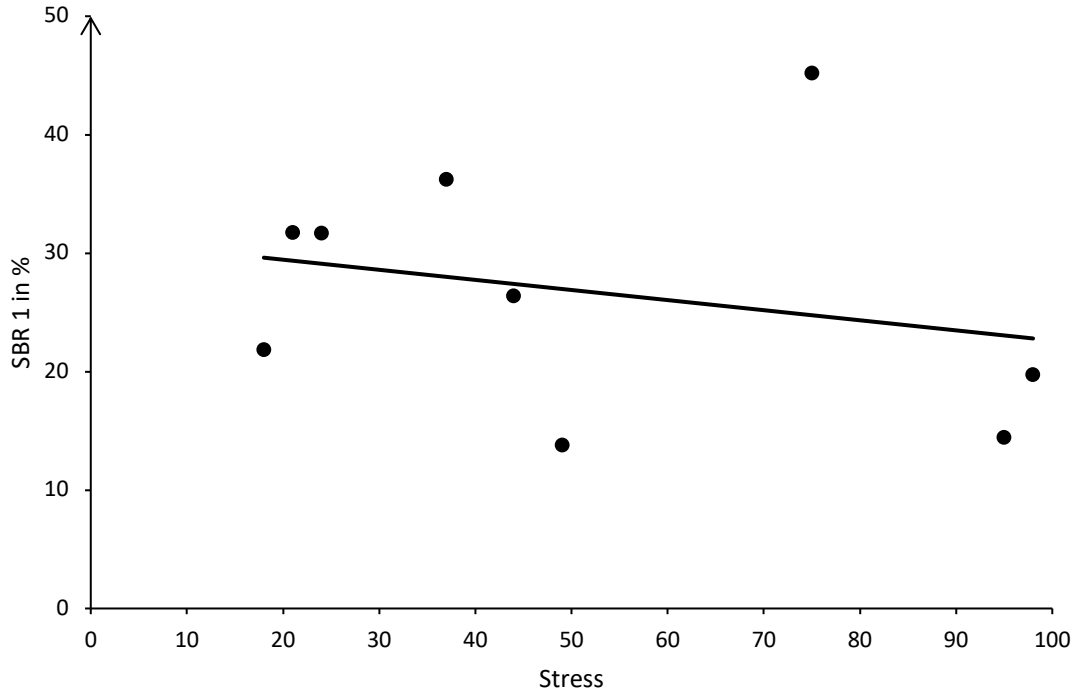

Figure 9. Correlation of maximum stress values and SBR values one hour after impairment

Music and Stress moderated by Neuroticism

Now I present the results of the second research question (*Is the relation between music listening and stress moderated by neuroticism?*)

The moderating mechanism could not be investigated in the current sample, because the sample size was not large enough to calculate a moderation analysis. Thus, I compared the subjective stress levels of group HN and LN in the music and control condition before and after the intervention. In the LN music and control groups, there was one person respectively. In the HN music group, there were four participants and in the HN control group, there were two. The scores were baseline corrected. Figure 10 shows the difference in subjective stress before and after the intervention for the HN and LN group.

The HN group in the music condition shows a stress reduction of 12.5, whereas the HN group in the control condition shows an increase of 0.5. The highly neurotic participants

in the music condition experience a greater subjective stress reduction compared to the control condition, which report a minor increase.

In the LN group, there is no change in subjective stress during the music intervention, therefore no difference can be reported here. The highest reduction in subjective stress, with a value of 26 is exhibited by the LN group in the control condition.

It is not possible to draw a conclusion about the moderating role of neuroticism in the relationship between music and subjective stress from this data.

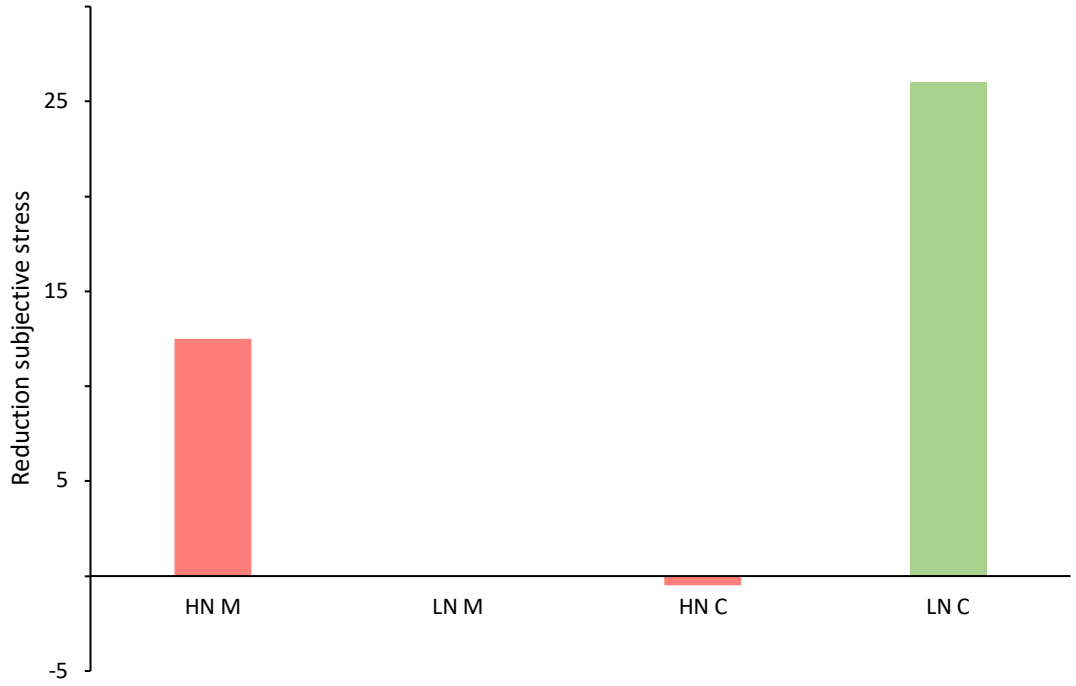

Figure 10. Difference in Subjective stress before and after the intervention

Exploration

Due to the previous results regarding subjective stress, that did not make precise conclusions possible, I looked at another variable that correlates negatively with stress (Gilbert et al., 2008; Lindahl & Archer, 2013). The reason was to see if here conclusions could be drawn more easily and potential inferences about subjective stress could be made. The variable is positive affect, which was measured with the *relaxed positive affect* dimension of the TTPAS. Figure 11 illustrates the course of relaxed positive affect during the experimental session. Relaxed PA starts high from values around four at the beginning of the experimental session. Before TSST the scores decline, and the minimum is at time point 3 directly after the TSST. It

increases substantially for all participants after the TSST (from time point three onwards). The listening intervention takes place between time point four and five.

The measures reach almost baseline values between approximately four and five at time point five after the music listening or silence intervention. After that the curves show a plateau.

Group HN displays the lowest score at time point three. The highly neurotic participants experience the least relaxed positive affect after the stressor, compared to the average and low neurotic participants, which is in line with theory.

The differences before and after the intervention regarding neuroticism and the music and control condition are illustrated in Figure 12. Group HN in the music condition shows an increase of 0.55. Person LN in the music condition shows an increase of 2. In the control conditions, group HN shows an increase of 0.67 and there is no difference for Person LN. Group HN that listened to music reported less increase in relaxed positive affect than the control group.

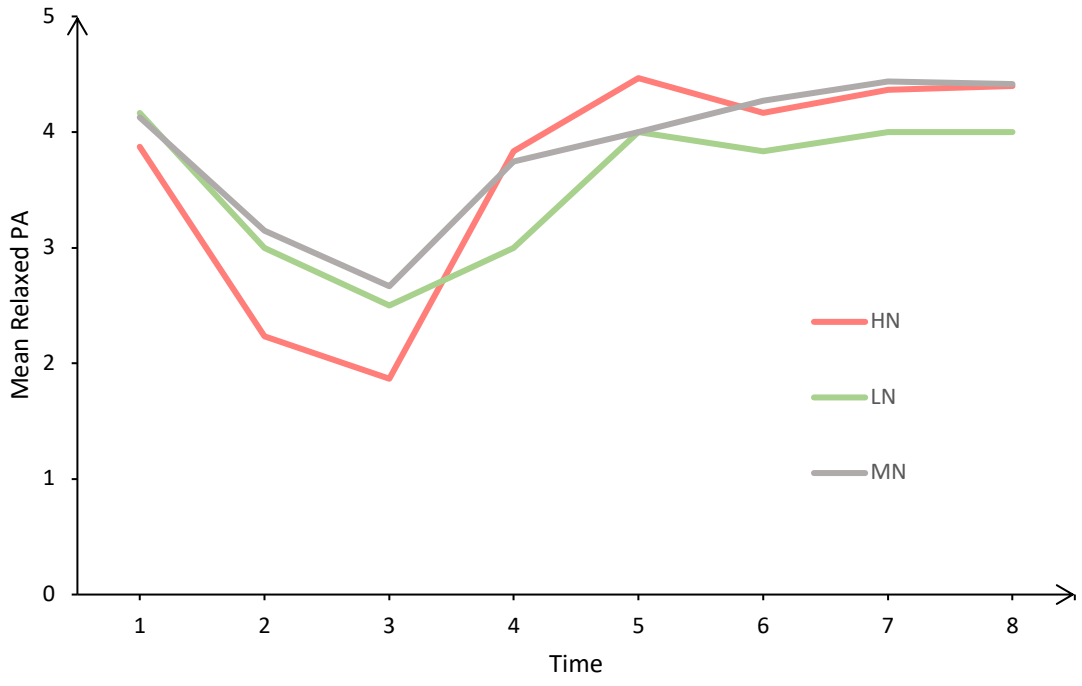

Figure 11. Relaxed Positive Affect over Time

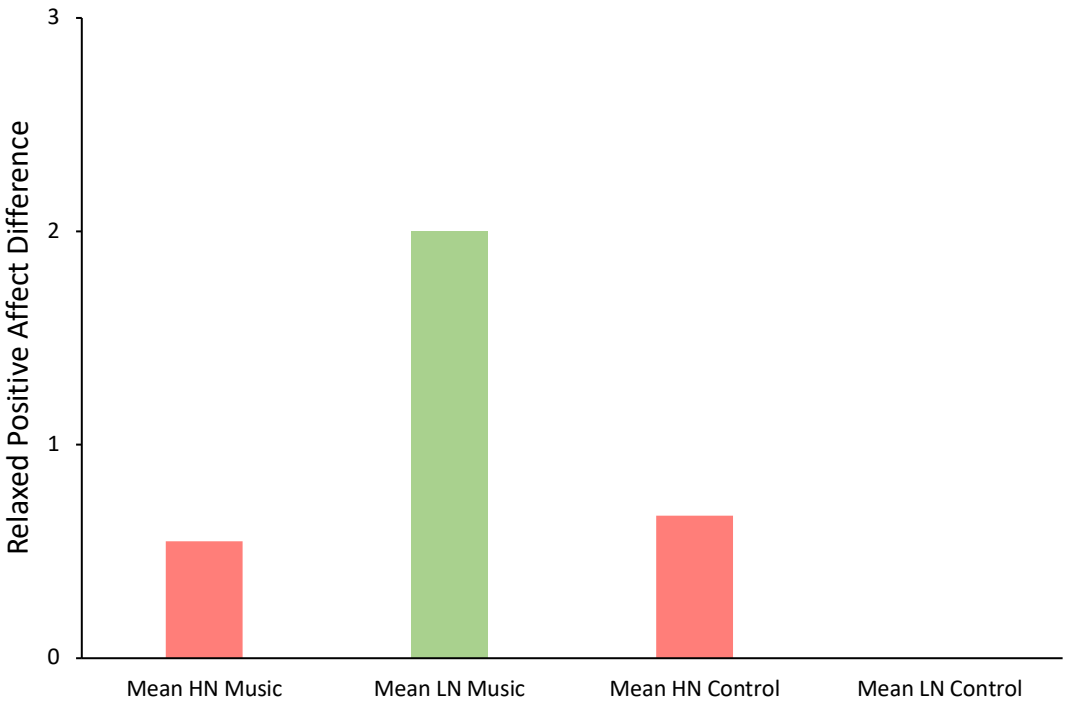

Figure 12. Difference in Relaxed Positive Affect before and after listening intervention

Discussion

In my thesis, I examine the role of neuroticism in the relationship between stress, music listening, and skin barrier recovery. The positive effect of listening to music as a stress-reduction technique on skin barrier recovery is investigated. Stress, as previously mentioned, negatively affects skin barrier recovery. As music can reduce stress, it should promote recovery of the skin barrier. Considering that people high in neuroticism are more prone to experiencing stress and show greater stress responses after a stressful experience their skin barrier recovery might be slower. At the same time, as they are very sensitive to the effects of music and typically use it for emotion regulation, they should benefit a lot from music as a means of stress reduction. In the following, the results will be discussed.

Stress and Neuroticism

Hypothesis H1a postulates a reinforcing effect of neuroticism on subjective stress. (H1a: Neuroticism has a reinforcing effect on subjective stress.) The data does not support this hypothesis. Even if the patterns indicate the expected direction strong claims are not possible.

Stress was relatively low at the beginning of the experimental session for all participants. It then increased and reached its peak after the TSST. This shows that the stress induction is working, and that subjective stress increases during and after this stress test.

In line with previous research, the mean subjective stress level in the HN group before and directly after the TSST was higher than in the LN group. However, the difference was not large. After that point, the curves are very similar and after time point 5 the HN group reports even lower subjective stress than group LN, which would not have been expected.

To get a clearer impression, I also looked at the separate subjective stress levels. In agreement with the theory, two HN participants reached the highest subjective stress level. As expected, the person with the highest neuroticism scores in the sample also reported the highest subjective stress. Counter these findings, the person with the lowest neuroticism scores reported the third-highest subjective stress. This result is not line with what was expected.

Previous studies found that high neuroticism is related to more experience of subjective stress (Lahey, 2009; McCrae, 1990; Vollrath, 2001). The current results are partly in line with these findings, as the person with the highest neuroticism scores also reported the highest subjective stress level. In addition, another HN person displayed the second-highest stress scores.

Conversely, the person with the lowest neuroticism scores reported very high subjective stress as well. Possible reasons for that might be interindividual differences in general, for example in coping styles, earlier experiences or further personal characteristics that could influence stress experience apart from personality traits such as neuroticism. Additionally, with the small sample size, these differences do not even out. Even if there would have been an effect, it would have been almost impossible to detect it given the small sample. These circumstances make it extremely difficult to generalize findings over the population.

Moreover, some studies about the relationship between neuroticism and stress have looked at chronic stress. One study, in which neuroticism was strongly related to perceived stress used Cohen's perceived stress scale (PSS-10) that assessed stress over the last month (Ebstrup et al., 2011). Gunthert et al. (1999) assessed subjective stress in daily life over 14 consecutive days.

People high in trait neuroticism might not show a significantly larger stress reaction to a brief laboratory stressor, such as the TSST, compared to people with lower trait neuroticism, as also found by Puig-Perez et al. (2016). One study found no significant difference in saliva

cortisol levels between personality measures after the TSST, which suggests that there was no unique stress response from neurotic individuals (Kirschbaum et al., 1992). The tendency to experience more stress and react stronger could be more pronounced for daily life stressors and events, as in this context also maladaptive coping strategies might play a role (Gunthert et al., 1999; McCrae, 1990; Shewchuk et al., 1999; Vollrath, 2001; Watson & Hubbard, 1996). Only one brief laboratory stressor might not have been sufficient or suitable to evoke distinct stress responses.

Neuroticism and Skin Barrier Recovery

Hypothesis H1b assumes, that there is a negative effect of neuroticism on SBR (H1b: Neuroticism has a negative effect on skin barrier recovery). In general, the mean SBR of all participants with viable TEWL values in this sample followed the same curve as proposed in the literature. The biggest changes happened within the first hour. After that the SBR showed a plateau (Robles, 2007).

The negative effect of neuroticism was visible in the data. The low neurotic participant showed a substantially higher SBR than the highly neurotic participants one hour after skin impairment. Hence these results provide some initial support for this hypothesis. In accordance with previous assumptions, the low neurotic person shows the greatest recovery with 45.2% one hour after skin impairment.

Neuroticism is related to altered functioning of the immune system (Bouhuys et al., 2004). The immune system is important for SBR (Smith et al., 2015). As emotional stability was also found to be linked for example to faster wound healing (Maple et al., 2015), it seems reasonable that person LN showed the fastest recovery within the first hour.

The finding, that person HN shows a very low recovery rate at time point one fits the assumptions, that high neuroticism should be linked to slower SBR.

However, the results must be interpreted with caution. It is important to state that the results show only an association between the variables and no effect. Conclusions can only be drawn under the caveat of the small sample size.

Especially for this part of the research question, the distribution of the participants in the two groups, namely HN and LN was far from equal, with only one low neurotic person. For profound interpretation, more participants in the low neuroticism group would have been needed and a larger sample in general for both groups.

Moreover, as explained in the introduction, the research results regarding the physiological correlates and consequences related to neuroticism are ambiguous. More research is needed to shed light on these complex processes.

Mediation of Stress in the relationship of Neuroticism and Skin Barrier Recovery

Next, I was interested, if stress acts as a mediator in the relationship between Neuroticism and SBR. Hypothesis H1c states that stress mediates the effect from neuroticism on skin barrier recovery (H1c: Stress mediates the effect from neuroticism on skin barrier recovery.).

Stress should have a negative effect on SBR. Due to the small sample size, only a correlation analysis could be calculated. Additionally, a scatter plot was created to illustrate the findings. The results showed a moderate negative correlation between stress and SBR. Hence, the correlation followed the expected direction. However, it was not significant and therefore has no explanatory power. These results do not confirm the assumption, that stress should lead to impaired SBR.

The hypothesis H1c (*Stress mediates the effect from neuroticism on skin barrier recovery*) cannot be accepted, because no mediation analysis was performed due to the small sample. A significant negative effect from stress on SBR cannot be found and the analysis was only correlational. Moreover, there was also no association between neuroticism and stress.

When looking at the single curves, the two participants who reported the highest increase in subjective stress levels exhibited very low SBR values, which is in line with previous findings. Prior studies have found this negative effect from high stress on SBR (Altemus et al., 2001; Robles, 2007). Participants who reported lower subjective stress levels tend to exhibit higher SBR.

The person with the highest SBR reported the third-highest subjective stress increase, which does not fit the theory. The physiological effects and correlates of stress are very complex and not fully understood yet. Especially short-term stress was found to enhance certain immune parameters, whereas chronic stress leads to impairment (Altemus et al., 2001).

Consequently, the results were mixed. The expectations were only met for very high subjective stress. Again, the small sample limits interpretation and generalization possibilities.

High neuroticism was weakly associated with lower SBR and low neuroticism with higher SBR. High stress was not clearly associated with lower SBR. The mechanism behind

the association of neuroticism, SBR, and subjective stress, and whether there is a mediation or not, remains unclear.

The associations between the variables were not consistent and did not fit the empirical background very well. This means a bigger sample would be needed in order to shed light on the mechanism and clarify the relationship between neuroticism, stress, and SBR.

Music, Stress, and Neuroticism

The second research question involves the relationship between neuroticism, music, and stress. Hypothesis 2 assumed, that neuroticism enhances the effect of music listening on stress compared to listening to an audiobook or silence (H2: Neuroticism enhances the effect of listening to music (versus listening to an audiobook or silence) on stress). The positive effect of music listening (versus listening to an audiobook, or silence) on stress should be higher for participants high in trait neuroticism than for participants low in trait neuroticism.

The initially planned moderation analysis could not be performed, as previously mentioned. Thus, the subjective stress levels before and after the intervention from the HN and LN groups were compared in an extreme group analysis.

The subjective stress reduction of participants in the HN group, that listened to music was considerably higher than stress reduction in the HN control group, that either listened to an audiobook or silence. Those even experienced a slight increase. These results seem to support the assumption, that neurotic individuals would profit a lot from music listening. As neurotic individuals are very sensitive to the effects of music and use music commonly as means of emotion regulation, these results make sense. (Chamorro-Premuzic & Furnham, 2007; Vella & Mills, 2017).

The low neurotic group in the music condition did not show a difference between subjective stress levels before and after the music intervention. The stress level before was already very low and could therefore not decrease any further. In this case, there might be a floor effect. This result makes a comparison of subjective stress decrease between the HN and LN group in the music condition hard.

In contrast to the music condition, the LN group in the control condition displayed the greatest decrease in subjective stress. The reduction was almost twice as high as the reduction in the HN music group. Nevertheless, there was only one person in the LN group in each condition, which makes the interpretation and especially the generalization of the results rather difficult. The person in the music condition reported very low subjective stress already

before the intervention and thus no further reduction was possible. The LN person in the control condition reports higher subjective stress before the intervention and there is room for reduction. These circumstances highlight the importance of a large enough sample. Even if there were effects, it is not possible to detect them in the current small sample.

Exploration

An explorative analysis regarding the development of relaxed positive affect scores of the participants over time during the experimental session was performed. Relaxed positive affect was therefore assessed multiple times. The reason for further exploration were floor effects of stress in the analysis of the second hypothesis. Stress was already almost at its lowest possible level for all participants before the listening intervention even started. With positive affect, a measure that correlates negatively with stress was chosen (Lindahl & Archer, 2013). Results show that this is also the case in the current sample.

Relaxed positive affect starts at a high point for all participants. It then declines and reaches the lowest values directly after the stress test. Group HN shows the lowest scores, which is in line with previous theory, that people high in neuroticism tend to experience more negative and less positive affect than people low in neuroticism (McNiel & Fleeson, 2006; Rusting & Larsen, 1997; Schneider et al., 2012).

The increase in relaxed positive affect after the intervention is almost the same for the HN groups in the music and control condition. The highly neurotic participants do not report a higher increase in relaxed positive affect after listening to music than the control group. One must mention here that the relaxed positive affect values, like the subjective stress values, were already quite high directly before the intervention.

The LN music group shows the highest increase in relaxed positive affect after music listening. Here the scores were lower before the intervention though and the range for increase was bigger. In the LN control group, no difference can be found. Like for the subjective stress measure, it could be the case, that low neurotic individuals recover faster than high neurotic individuals regardless of the intervention. It might be solely based on their predisposition to experience more positive affect as mentioned above.

Contradicting to these findings is, that person LN shows second-lowest relaxed positive affect values after having been stressed. It would have been expected that this person would exhibit the highest relaxed positive affect values because of the very low neuroticism scores. Thus, the explorative results are only partly in agreement with existing empirical findings.

Limitations and Future Research

The current study has a few limitations that I will address in the next paragraphs. Foremost, one major limitation of the current study is the small sample size at the point of the data analysis. The analysis consequently was an extreme cases analysis. That can be mostly attributed to the lockdown situation during the covid-19 pandemic. Testing in the laboratory was limited during that time because of government restrictions and social distancing. Moreover, some participants had to be excluded due to flawed TEWL measurements. Also, the strict inclusion and exclusion criteria and the limited time frame for testing in the monthly cycle of the participants contributed to this.

The majority of the sample had neuroticism values within an average range. Either very high or low neuroticism scores would have contributed more to the analysis of the hypotheses and research questions. The general aim of the study was not related to neuroticism and therefore, not particularly many highly neurotic individuals were recruited. It was embedded in a bigger research project. In addition, neuroticism is related to a wide range of psychological and health problems (Lahey, 2009) and those were an exclusion criterion. If this would have been an individual study, above and below average neuroticism scores would have been included as an additional criterion in the recruiting process.

Due to the lack of inferential statistics and the difficulty to generalize given the small sample, the results should be interpreted with caution. Future studies should aim for a larger and more representative sample to be able to perform inferential statistical analysis and to generate more generalizable findings.

The present study was only conducted for females between 18 and 35 years. This is of course a limited partition of the population. While this was necessary to make the experiment feasible, future studies should include a more representative sample of a wider age range and all genders.

In the context of sample size, it is also essential to have enough people in every experimental and control condition and that they are equally distributed. This would make it possible to compare the different groups and people with different features (for example high and low neuroticism).

The current study is a laboratory experiment. This brings with it, that the external validity and generalizability are lower than in a field experiment. Many studies on the topic of music and stress reduction take place in everyday life of the participants. The artificial setting might have had an influence on stress reaction and recovery. Nevertheless, the standardized

conditions in the laboratory have many advantages and make conclusions from the independent variable on the dependent possible.

Another caveat that I briefly mentioned is the fluctuation in TEWL after the first hour after skin impairment. One explanation for this noise in data might be the increased sweating of the participants. This could be corrected by lowering the room temperature and keeping it at a constant level. Moreover, the TEWL measurement devices are very sensitive to external changes in temperature, humidity, and air draft, for example from breathing or speaking. Such disturbances could also be responsible for distorted results. In future SBR measurements, it should be made a priority to limit movement and speaking/ breathing of the participants and the testing person in the direction of the measurement device. Because of the covid-19 pandemic, we installed a dividing wall out of plexiglass between the participant and the testing person at some point. This appliance could also improve the accuracy of measurement because air draught will be diminished and might be a useful tool for future studies in general.

Another influencing variable on fluctuation in SBR is the degree of skin impairment. It is important that the skin is disrupted "severe enough" to obtain accurate results. The TEWL should therefore be at least 15g/hr/m^2 above baseline measures. This was not the case for all the measurements. As the SBR is the percentage of recovery, minor fluctuations preponderate more when the skin barrier disruption is smaller. Being very thorough in the process of skin disruption and TEWL measuring will help alleviate fluctuations in SBR.

A further point is, that the fluctuations are only visible in the single cases, whereas this is not the case for mean SBR values. The noise might be equated if more participants would be included in the analysis. This again underlines the importance of a larger sample size in the several experimental groups.

Regarding the listening intervention, it would be interesting for future research to pay closer attention to the genre of music that the participants of the study choose. The type of music might play a role in the context of stress reduction. Classical music was shown to facilitate cardiovascular recovery after a stressor while this was not the case for jazz for example (Chafin et al., 2004). This factor could be taken into consideration when investigating the relationship between music, stress, and health.

Conclusion

This research gives insight into the relationship between stress, music, health, and the role of personality in this association. Neuroticism did not show a reinforcing effect on subjective stress in the current sample. Nevertheless, there was some initial support for the

negative effect of neuroticism on SBR. The mediating role of stress in the relationship between neuroticism and SBR could not be investigated due to the small sample. The same applies to the moderating role of neuroticism in the relationship between music and subjective stress. The explorative analysis of the variable relaxed positive affect showed mixed results and does not allow definite claims.

With music being a cost-effective and widely available stress reduction tool, it is worth continuing the research, especially in the context of wound healing and SBR. It could be useful notably in clinical settings, for example in hospitals, as well as in the daily life of people.

One major advantage of music is that it is independent of culture and language. Thus, it is applicable for a wide range of individuals with minor boundaries regarding diversity. Another area of application could be in training and research in self-regulation, emotion regulation, and coping strategies for neurotic individuals.

The negative impact of stress on well-being and health in our society is an important topic. The current study contributes to the research field of music and health. However, the generalizability of the present results is limited due to the small sample size. Notwithstanding, the present study can serve as a starting point for future research and a bigger sample will be collected.

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List of Abbreviations

HN	*High neuroticism*
HPA	*Hypothalamic-pituitary-adrenal axis*
LN	*Low neuroticism*
MN	*Mean Neuroticism*
NEO-FFI	*NEO-Fünf-Faktoren-Inventar*
NK	*Natural killer*
PMBC	*Peripheral blood mononuclear cells*
PSS	*Perceived stress scale*
RST	*Restraint stress*
SBR	*Skin barrier recovery*
SNS	*Sympathetic nervous system*
TEWL	*Trans-epidermal water loss*
TSST	*Trier social stress test*
TTPAS	*Types of positive affect scale*
VAS	*Visual analog scale*

Appendix A. Abstract

Background: Stress is a major factor that compromises physiological and psychological well-being. It was found to negatively impact skin barrier recovery (SBR). Neuroticism is a personality trait, that is especially linked to heightened stress experience and to the use of music for emotion regulation. Music is already known as an effective and feasible stress reduction technique. In the current research the relationship between stress, music, and SBR as well as the role of neuroticism is investigated. *Methods:* The study was a randomized controlled trial with three groups (music, audiobook, silence). The participants, 15 healthy women between 18 and 35 years whose neuroticism scores were measured before the experiment, underwent a stress induction test, and part of their skin was disrupted with the tape stripping technique. Afterwards the impact of stress on SBR was assessed. Therefore, SBR and subjective stress were measured multiple times. *Results:* After the stress induction all participants reported increased subjective stress and there was no difference between high and low neurotic individuals. One individual with low neuroticism scores showed a faster SBR one hour after skin impairment than the highly neurotic participants. There was no correlation between subjective stress and SBR. Finally, there was also no influence of neuroticism in the relationship between music listening and stress found. *Conclusion:* Due to the small sample size the results should not be overrated. Nevertheless, this work contributes to the research field of stress music and health and shows possible future directions.

Keywords: stress, neuroticism, music, skin barrier recovery, health

Appendix B. Zusammenfassung

Hintergrund: Stress ist einer der Hauptfaktoren, die das physiologische und psychologische Wohlbefinden beeinträchtigen. Es wurde festgestellt, dass er sich negativ auf die Hautbarrieren Regeneration (SBR) auswirkt. Neurotizismus ist ein Persönlichkeitsmerkmal, das besonders mit erhöhtem Stresserleben sowie mit der Verwendung von Musik zur Emotionsregulation zusammenhängt. Musik ist bereits als wirksame und praktikable Technik zur Stressreduzierung bekannt. In der aktuellen Studie wird der Zusammenhang zwischen Stress, Musik und SBR sowie die Rolle von Neurotizismus untersucht. *Methoden:* Die Studie war eine randomisiert-kontrollierte Studie mit drei Gruppen (Musik, Hörbuch, Stille). Die Teilnehmerinnen waren 15 gesunde Frauen zwischen 18 und 35 Jahren, deren Neurotizismus Werte vor dem Experiment erhoben wurden. Nach einem Stressinduktionstest wurde ein kleiner Bereich ihrer Haut durch die Tape-Stripping-Technik geschädigt. Anschließend wurde die Auswirkung von Stress auf SBR untersucht. SBR und subjektiver Stress wurden folglich mehrfach gemessen. *Ergebnisse:* Nach der Stressinduktion berichteten alle Teilnehmerinnen erhöhten subjektiven Stress, wobei es keinen Unterschied zwischen Personen mit hohen und niedrigen Neurotizismus Werten gab. Eine Person mit niedrigen Neurotizismus Werten zeigte eine Stunde nach der Hautschädigung eine schnellere SBR als die hoch neurotischen Teilnehmerinnen. Es gab keine Korrelation zwischen subjektivem Stress und SBR. Schließlich wurde auch kein Einfluss von Neurotizismus auf die Beziehung zwischen Musikhören und Stress festgestellt. *Schlussfolgerung*: Aufgrund der geringen Stichprobengröße sollten die Ergebnisse nicht überbewertet werden. Gleichwohl leistet diese Arbeit einen Beitrag zum Forschungsfeld von Stress, Musik und Gesundheit und zeigt mögliche zukünftige Forschungsansätze auf.

Schlagwörter: Stress, Neurotizismus, Musik, Hautbarrieren Regeneration, Gesundheit

Appendix C. NEO-FFI Subscale Neuroticism

Lesen Sie bitte jede dieser Aussagen aufmerksam durch und überlegen Sie, ob diese Aussage auf Sie persönlich zutrifft oder nicht. Zur Bewertung jeder der 60 (Neurotizismus 12) Aussagen steht Ihnen eine fünffach abgestufte Skala zur Verfügung. Kreuzen Sie bitte an:

SA (**starke Ablehnung**), wenn Sie dieser Aussage auf keinen Fall zustimmen oder sie für völlig unzutreffend halten

A (**Ablehnung**), wenn Sie der Aussage eher nicht zustimmen oder sie für unzutreffend halten.

N (**neutral**), wenn die Aussage weder richtig noch falsch, also weder zutreffend noch unzutreffend ist

Z (**Zustimmung**), wenn Sie der Aussage zustimmen oder sie für zutreffend halten

SZ (**starke Zustimmung**), wenn Sie der Aussage nachdrücklich zustimmen oder sie für völlig zutreffend halten

Es gibt bei diesem Fragebogen keine „richtigen“ oder „falschen“ Antworten und Sie müssen kein Experte/keine Expertin sein, um den Fragebogen angemessen beatworten zu können. Sie erfüllen den Zweck der Befragung am besten, wenn Sie die Fragen so wahrheitsgemäß wie möglich beantworten.

Bitte lesen Sie jede Aussage genau durch und kreuzen Sie als Antwort die Kategorie an, die Ihre Sichtweise am besten ausdrückt. Falls Sie Ihre Meinung nach dem Ankreuzen einmal ändern sollten, streichen Sie Ihre erste Antwort bitte deutlich durch. Bitte beantworten Sie die 60 Aussagen zügig, aber sorgfältig. **Lassen Sie keine Aussage aus.** Auch wenn Ihnen einmal die Entscheidung schwerfallen sollte, kreuzen Sie trotzdem immer eine Antwort an, und zwar die, welche noch am ehesten auf Sie zutrifft. Beginnen Sie bitte jetzt mit der Beantwortung!

1. Ich bin nicht leicht beunruhigt.
2. Ich fühle mich anderen oft unterlegen.
3. Wenn ich unter starkem Stress stehe, fühle ich mich manchmal, als ob ich zusammenbräche.
4. Ich fühle mich selten einsam oder traurig.
5. Ich fühle mich oft angespannt und nervös.
6. Manchmal fühle ich mich völlig wertlos.
7. Ich empfinde selten Furcht oder Angst.
8. Ich ärgere mich oft darüber, wie andere Leute mich behandeln.
9. Zu häufig bin ich entmutigt und will aufgeben, wenn etwas schiefgeht.
10. Ich bin selten traurig oder deprimiert.
11. Ich fühle mich oft hilflos und wünsche mir eine Person, die meine Probleme löst.
12. Manchmal war mir etwas so peinlich, dass ich mich am liebsten versteckt hätte.

Appendix D. Visual Analogue Scale

universität wien
Fakultät für Psychologie

Datum ☐☐ / ☐☐ / ☐☐ (Tag / Monat / Jahr)
VP-Code: | | | | |

VAS

Bitte zeichnen Sie bei den folgenden Fragen an der Stelle auf der Linie ein Kreuz ein, die Ihrer **persönlichen Einschätzung** am meisten entspricht. Die Wertung 0 bedeutet, dass die Aussage überhaupt nicht auf Sie zutrifft und die Wertung 100, dass die Aussage voll und ganz zutrifft.

Ich fühle mich gestresst

0 ——————————————————— 100

Appendix E. TTPAS

Subscale *Relaxed Positve Affect:*

Im Moment fühle ich mich...

gar nicht	**1**	**2**	**3**	**4**	**5**	**sehr**
entspannt	○	○	○	○	○	
ruhig	○	○	○	○	○	
friedlich	○	○	○	○	○	
gelassen	○	○	○	○	○	
locker	○	○	○	○	○	
unbeschwert	○	○	○	○	○	

Appendix F. Study Flyer

universität wien

Music & Health Lab

Studienteilnehmerinnen gesucht

Stress und Musik- und Hörbuchhören

45 €
Aufwands-entschädigung

Für eine psychologische Stress-Studie suchen wir gesunde, weibliche Teilnehmerinnen. Die Studie untersucht verschiedene Einflussfaktoren auf die Wirkung von Stress.

Um an der Studie teilnehmen zu können, sollten folgende Kriterien auf Sie zutreffen:

- ✓ weiblich, 18–35 Jahre
- ✓ keine hormonelle Verhütung, regelmäßiger Zyklus
- ✓ kein regelmäßiger Nikotinkonsum
- ✓ kein Unter- oder Übergewicht, keine körperlichen und psychischen Erkrankungen
- ✓ Deutsche Muttersprache oder fließende Deutschkenntnisse

Aufwand und Aufwandentschädigung

- ✓ Online-Fragebogen (Dauer: ca. 60 Minuten)
- ✓ Termin an der Fakultät für Psychologie (Dauer: ca. 4 Stunden)
- ✓ Ausfüllen von Fragenbögen zu Stress und Befinden
- ✓ Abgabe von Speichelproben für Messung von Stressmarkern
- ✓ Messungen an der Haut
- ✓ Aufwandsentschädigung von 45 €

Sollten Sie Interesse haben, senden Sie bitte eine E-Mail mit dem Betreff *„Stress und Musik- oder Hörbuchhören“* an:

muskiba.klinische-gesundheit-psy@univie.ac.at

Sie bekommen dann weitere Informationen per E-Mail zugesendet.