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„Visual art and stress: Does viewing movingly beautiful art regulate acute stress responses?"

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Visual art and stress: Does viewing movingly beautiful art regulate acute stress responses?

Visual art is everywhere. Not only do we encounter it when visiting museums, but also when walking in city-centres, attending churches, spending time in our homes or navigating through the web. These and many more occasions of everyday life allow us to deeply engage with art, which can affect us in a profound emotional way: it can make us smile, fill us with joy, give us chills or even bring us to tears (Pelowski et al., 2017). It thus comes as no surprise that philosophers, psychologists and art critics have for decades been interested in the pleasing emotional impact of visual art on its viewers (e.g., Robinson, 2004). Accordingly, past theories in psychology and aesthetics (Bell, 1914; Berlyne, 1974; James, 1890/1950) focused on positive emotional responses that arise from the appreciation of visual art as movingly beautiful (Robinson, 2004). Although visual art permeates several aspects of our daily life and has historically been associated with pleasure and positive emotions, research regarding its effects on psychological and physiological health remains scarce. Only recently results emerged hinting at possible health-benefiting effects of viewing aesthetically pleasing artworks. For example, de Tommaso et al. (2008) found that paintings rated as beautiful provide positive distractions and, therefore, lead to a decrease of pain perception. Moreover, Martínez-Martí et al. (2018) revealed that the appreciation of beauty in visual art improves mood and decreases subjective anxiety. Still, only little is known about the effects of visual art on essential health parameters, such as copying with daily stress. Hence, the question arises if viewing movingly beautiful visual art serves as strategy to regulate stress responses and, thus, promotes individual health.

In today's technological society, stress occurs as an omnipresent part of everyday life with potentially severe consequences on mental and physical health (McEwen, 2008). Accordingly, the World Health Organization (WHO; 2010) considers stress as a determinant factor in health outcomes. Moreover, recent findings hint that subjective levels of stress in everyday life have increased during the current Covid-19 pandemic (De Quervain, et al., 2020) Thus, it seems that worrying over the coronavirus and growing feelings of isolation and loneliness due to public health actions, such as social distancing, lead to more stress and anxiety. Therefore, providing a broad range of efficient strategies aiding individuals in their management of stressful experiences in daily life becomes more and more important. For its pleasing and positive emotional qualities, I expect viewing visual art to emerge as one stress-regulating strategy. This notion is based on research in music psychology, which revealed that

listening to music regulates psychological and physiological stress (de Witte et al. 2018), with several researchers attributing these effects to the experience of pleasure and positive emotions (Taruffi & Koelsch, 2014; Sakka & Juslin, 2018). For instance, Sakka and Juslin (2018) suggest that positive emotions evoked by music help us regulating negative affect and mood, thereby reducing stress. In the same vein, the present study examined if visual art considered as movingly beautiful increases positive affect and mood; consequently, decreases subjective levels of stress, anxiety and negative affect. The study focused on psychological affect and stress through self-report. This can be seen as important starting point for future studies on the effects of visual art in terms of psychophysiological measures of stress and emotion (e.g., levels of cortisol, levels of alpha amylase, heart rate, skin conductance).

The introduction first provides an overview on stress, its common definitions, its physiological correlates, and its effects on health. Subsequently, appreciating art as potential strategy to reduce stress is discussed. Thereby, a more detailed look on past research about the effects of music listening on subjective and physiological well-being is provided, with a special emphasis on the experience of positive emotions as potential underlying mechanism. Based on research in music psychology, it is then outlined how engaging with visual art might act as a similar stress-regulating strategy, with distinct focus on the health-benefitting effects of pleasure and positive emotions as response to art. Moreover, it is shortly discussed how stress might change the way we experience visual art. Lastly, an empirical study examining the effects of viewing movingly beautiful visual art on psychological components of stress is presented.

Daily stress puts your health at risk

When experienced on a regular basis, stress has the potential to be a major health threat facilitating the development of disease and illness (McEwen, 2008). In the following section, common conceptualizations of stress are discussed thoroughly with a special emphasis on the process of allostasis. Thereby, the health risks of daily stress are covered more extensively. A closer look on the bodily correlates of stress is then provided, focusing on two common physiological stress pathways. Eventually, frequent ways of measuring subjective levels of stress are outlined.

Conceptualizing stress

Stress is commonly defined as a physiological process resulting from the evaluation of a situation as challenging (= stressor) with the person appraising her or his coping strategies as insufficient (Lazarus & Folkman, 1984). Moreover, these physiological reactions elicited by stressors are associated with the maintenance of homeostasis as they aim to optimize the person's adjustment to its environment and to restore the loss of homeostatic equilibrium (McEwen, 2000). The reactions usually fade out in a few minutes, bouncing back to baseline levels (Chida & Hamer, 2008; Kirschbaum et al., 1993). This entire process is typically referred to as allostasis (McEwen, 2000).

Allostatic systems enable an organism to respond to its physical state and to cope with aversive, environmental stimuli (McEwen, 2000). The allostatic regulation differentiates between copying with acute stressors and copying with chronic stressors. When copying with acute stressors, allostatic adaptation processes are activated, maintaining homeostasis through the production of mediators such as adrenalin or cortisol. These mediators of stress responses promote adaptation in the aftermath of intense challenges while increasing immune function and generating hazard-related memory content. When being exposed to stressors regularly, the bodily responses remain recurrent over time and repeatedly encourage the organism to react against daily situations as to those that would be stressful (Smyth et al., 2013). This persistently activates the immune system and, subsequently, leads to chronic alterations in physiological processes that are maladaptive in daily contexts. Consequently, repeated stress exposure is associated with a wide range of diseases and mortality, as studies have found an increased risk of conditions like obesity, heart disease, Alzheimer's disease, diabetes, and asthma (Chida & Hamer, 2008; Chida & Steptoe, 2010). Moreover, daily stress may impair cognitive functioning and provoke mental disorders (Chida et al., 2008; Oei et al, 2006). In the following, the two main bodily reactions as part of the allostatic regulation (and stress response, respectively) are covered more comprehensively.

Physiology of stress

At a physiological level, two primary stress responses are distinguished: the hypothalamus–pituitary–adrenal (HPA) axis and the sympathetic nervous system (SNS). With the HPA-axis, the perception of stress evokes activation in the hypothalamus leading to the release of corticotrophin-releasing hormones. These hormones make the anterior pituitary to secrete adrenocorticotropic hormones, which stimulate the adrenal cortex to secrete

glucocorticoids, including cortisol. Cortisol is involved in several vital functions (e.g., modulating central nervous system and immune function, supporting vascular responsiveness, maintaining glucose production from protein). However, chronically elevated cortisol levels can be harmful as they may result in immunosuppression, muscle atrophy, decreased sensitivity to insulin, and hypertension (Smyth et al., 1997). In stress research, cortisol has become the "gold standard" biomarker by which to evaluate systemic fluctuations of the HPA axis, mainly because it is easily and reliably measured from saliva (Ali & Nater, 2020). Studies have shown that salivary cortisol increases in response to laboratory stressors, stressful jobs, stressful activities, and daily hassles (e.g., Hellhammer et al., 2009). Another well-known stress-sensitive system in the body is represented by the SNS, which activation leads to the release of catecholamines such as epinephrine. This initiates several physiological changes like elevations in blood pressure and heart rate, increased sweat production and higher adrenaline and noradrenaline concentrations (Al'Absi et al., 2002; Bolli et al., 1981). When recurrently exposed to stress, however, the heart-derived functioning is hindered in returning to baseline-levels and, thus, impairing cardiovascular recovery (Chatkoff et al., 2010; Pieper & Brosschot, 2005). Hence, daily stress is associated with myocardial infarction (heart attack), heart failure, abnormal heart rhythms, and stroke (Gallo et al., 2014; Kivimäki et al., 2004; Vitalino et al., 2002).

Operationalizing subjective stress responses

In order to measure the above-mentioned activity of stress-sensitive systems, a variety of self-report measures has been used in research. Two commonly applied subjective measures are discussed shortly.

One of the most prominent ways in operationalizing subjective stress is asking participants to rate their experienced levels of stress on a Visual Analog Scale (VAS; Folstein & Luria, 1973). Generally, the VAS consists of a straight horizontal line of 100 mm. The ends are defined as no stress (left) and very intense stress (right). The participants are asked to rate their current stress levels by indicating a position along the respective line. The VAS is well suited for the clinical assessment of stress as studies found it to be a reliable, valid, and sensitive self-report measure of subjective phenomena (Gift, 1989). In addition, experimental studies have pointed to a good sensitivity for acutely distressing events (Lesage et al., 2011), and found significant relationships with cardiovascular parameters such as heart rate and blood (Hulsman et al., 2010) and salivary cortisol levels (Bement et al., 2010).

Since anxiety can be defined as an emotional response to an individual's perception of a stressful experience (e.g., Fuermetz et al., 2011; Hook et al., 2008; Zhang et al., 2014), researchers commonly operationalize stress-related outcomes with state anxiety (Fuermetz et al., 2011; Lazarus, 1966). Frequently, the State Trait Anxiety Inventory State (STAI-S; Spielberger et al., 1983) has been used to measure state anxiety in stress research. Findings showed that the inventory is a highly reliable measure (Cronbach's Alpha = 0.90) that can discriminate between high- and low-stress situations (Metzger, 1976).

Appreciating art as means of stress reduction

To manage the stress of everyday life, people frequently use tranquilizing medication, which is linked to multiple adverse effects (e.g., Bandelow et al., 2015; Olfson et al., 2015; Puetz et al., 2015). Reducing stress without any professional support appears as rather difficult and the demand for non-pharmacological stress reduction interventions keeps on growing. Hence, finding economical, non-medicinal interventions for stress reduction emerges as crucial (Casey, 2017; Holahan et al., 2005; McEwen & Gianaros, 2010; WHO, 2010). Appreciating art may appear as a particularly promising means of symptom reduction and health promotion as it is popular, cost-effective, and easily accessible (Kreutz et al., 2004). Accordingly, engaging with auditory forms of art already operates as efficient stress-management strategy as several studies found that listening to preferred music reduces physiological and subjective stress (e.g., de Witte et al., 2018). Due to its positive emotional effects, appreciating visual art may serve as another stress-regulation strategy that does not only effectively decrease different parameters of stress but is also easy-accessible and low in cost. Particularly in times of increased loneliness and isolation during the Covid-19 pandemic, visual art may help individuals to cope with frequently experienced stress and anxiety. However, only a few studies explored the effects of visual art on different parameters of stress (Clow & Fredhoi, 2006; Grossi et al., 2019; Mastandrea et al., 2018). Thus, more research is needed to examine whether viewing visual art may operate as effective way to regulate everyday stress. Hence, in the following paragraphs research about the effects of art appreciation on stress is summarized and, subsequently, outlined how visual art may regulate different correlates of stress.

First, the main findings about the physiological and subjective effects of listening to music on stress regulation are evaluated in depth. Thereby, a distinct focus is set on the role of individual preferences and positive emotions within the health-benefitting effects of music

listening. Afterwards, it is delineated how viewing visual art may lead to similar stress-regulating effects as listening to music. There, the findings on the effects of art gallery and museum visits on individual stress are discussed. Consequently, the potential mechanisms on how visual art may regulate stress are outlined with special emphasis on whether experiencing positive emotions while viewing art may improve mood and decrease stress and anxiety. Eventually, a short look at the effects of stress on visual art perception is provided.

Listening to music as efficient strategy to regulate stress

In recent decades, researchers have started to gather evidence of the physiological and subjective effects of listening to music on stress regulation (de Witte et al., 2018). At a physiological level, being exposed to music appears to reduce stress as evidenced by a decrease in its biomarkers (Yehuda, 2011). Specifically, prior studies found that music listening reduces HPA axis activity, as reflected by lower levels of cortisol, and down-regulates SNS activity, as mirrored in both lower blood pressure and lower heart rate (Chanda & Levitin, 2013; Fancourt et al., 2014; Kreutz et al., 2012). At a subjective level, people report that music has a relaxing effect, increases mood, and relieves them from anxiety and negative affect (Miranda & Claes, 2009; North et al., 2000). The recent meta-study by de Witte et al. (2020) revealed a small-to-medium effect of music listening on physiological correlates of stress (d = .380) and a medium effect of music listening on subjective correlates of stress (d = .545). De Witte et al. (2020) thus concluded that listening to music appears as an effective strategy to reduce physiological and subjective stress-related symptoms. These results are consistent with findings of previous meta-analyses on the effects of music on stress (Bradt & Dileo, 2014; Bradt et al., 2011; Bradt et al., 2013; Gillen et al., 2008; Kim et al., 2015). Noteworthy, the meta-analysis by de Witte et al. (2020) points at inconsistencies in some of the findings, which the authors assume to be due to methodological issues, such as different music styles and preferences. Hence, the effects of various context factors need to be taken into account when investigating the stress-reducing effects of music listening. Below, self-selected music and stress intensity as important context factors are discussed in depth.

Self-selected music and stress intensity. Firstly, stress-reducing effects of music may vary as a function of stressor intensity. Several findings suggest that listening to music may effectively reduce stress only in the context of a mild stressor compared to a strong stressor (Pelletier, 2004). In this vein, the study by Thoma et al. (2013) revealed that listening to music prior to a strong social stressor did not effectively regulate stress-related outcomes. Secondly, self-selected music seems to exert the greatest stress-reducing effects, hinting at the importance of individual preferences (Chanda & Levitin, 2013). For instance, Allen and Blascovic (1994) found that slow and relaxing music as well as fast-tempo music reduce stress, as long as the music style characterizes the individual's preferred taste. These effects might be due to an increase in one's perceived control as research in health psychology found perceived control to play an important role in stress reduction (Brannon & Feist, 1992). Hence, Labbé, et al. (2007) argue that music selected by the participants is more effective in regulating stress as opposed to music chosen by the experimenter since it increases participant's control over the situation. In line with this, Helsing et al. (2016) found that perceived stress decreases when listening to own chosen compared to experimenter chosen music and, furthermore, that levels of subjective stress correlate negatively with the amount of perceived control during the music listening sessions.

The role of positive emotions via listening to music in stress reduction. Numerous authors attribute the beneficial effects of music listening on health to the experience of positive emotions (Koelsch, 2014; Sachs et al., 2015; Sakka & Juslin, 2018; Yehuda, 2011). This notion is in line with the model by Fredrickson (2001), which proposes that positive emotions are fundamental for improving both psychological and physiological aspects of well-being. Specifically, Sakka and Juslin (2018) argue that listeners use music to enhance positive emotions and regulate negative emotions, or simply to regulate levels of arousal. For instance, when comparing depressed and non-depressed individuals regarding their use of music for emotion regulation, the authors found that the most frequent regulation goal in both groups was to enhance positive emotions.

Positive emotions evoked by music may also directly intervene the physiological stress response, as suggested by Koelsch (2014). His model proposes that the stress regulating effects of listening to music may be due to music especially influencing activity in the hippocampal formation, which affects the activity of the HPA-axis and, subsequently, decreases concentrations of cortisol. Accordingly, research found that self-selected music intensifies the experience of positive emotions and reduces self-reported overall stress,

arousal, and levels of cortisol (Helsing et al., 2016). In a similar fashion, the review by Sachs et al. (2015) posits that pleasure as response to aesthetically pleasing music restores homeostatic equilibrium, which promotes optimal functioning. More precisely, it suggests that individuals seek out the feelings of pleasure provided by music to correct a homeostatic imbalance and, thus, increase mood and well-being.

Viewing visual art as (potential) strategy to regulate stress

Similar to music, visual art has the potential to elicit profound positive-emotional responses through aesthetic experiences (Pelowski et al., 2017). Thus, viewing visual art may also lead to health-benefitting effects in form of reducing stress and negative emotions. Next, findings about the effects of visiting art galleries and museums on stress are summarized. Subsequently, it is outlined how the experience of positive emotions when viewing visual art may improve mood and positive affect and, therefore, regulate stress and anxiety.

Empirical studies showed that visits to art museums decrease subjective and physiological levels of stress (Clow & Fredhoi, 2006; Grossi et al., 2019; Mastandrea et al., 2018;). Clow and Fredhoi (2006) found that visiting the Guildhall Art Gallery of London led to lower concentrations of cortisol and to lower subjective levels of stress in healthy young people. Similarly, the study by Grossi et al. (2019) revealed that visiting the vault of the Sanctuary of Vicoforte in Italy increases subjective well-being and reduces levels of cortisol. Lastly, Mastandrea et al. (2018) found that exposure to figurative art lowers systolic blood pressure (SBP), which promote relaxing effects. The authors suggest that the decreased levels of ambiguity that characterizes unambiguous figurative arts may explain potential relaxing effects on the physiological states. This explanation would be in line with the fluency theory (Reber et al., 2004), which posits that processing ease increases positive emotional response to artworks. However, it remains important to note that participants in the study by Mastandrea et al. (2018) were not asked to rate the comprehensibility of artworks. Thence, it does not allow drawing firm conclusions about the effects of figurative art on health and well-being.

Several studies also showed benefits of art museums as settings for therapy (Chatterjee & Vartanian, 2014; Treadon et al., 2006). These benefits include improvement of memory and social inclusion as well as lower stress levels. Regarding the elements of the museum setting responsible for facilitating treatment goals, Biasi and Carrus (2016) argue that the museum environment offers an extraordinary aesthetic experience, which allows the recollection of

positive memories, therefore affects health positively. Accordingly, studies revealed that reminiscing activities in art contexts affects mood, self-worth, and a general sense of well-being (Eekelaar et al., 2012; O'Rourke et al., 2011).

In sum, these findings hint at the importance past experiences might have regarding the health benefitting effects of visual art, either through easing the cognitive mastering of an artwork or through evoking positive memories and emotions. Below, these potential underlying processes are discussed in more detail.

The role of positive emotions via visual art viewing in stress reduction. When it comes to the underlying mechanisms responsible for potential effects of art on health, Mastandrea et al. (2019) assessed the idea that the positive-emotional output elicited from aesthetic experiences, such as pleasure and aesthetic emotions, may affect mood, and indirectly promote health and well-being. This idea is in accordance with common explanations of stress-relieving effects of music listening discussed in the section before (Koelsch, 2014; Sachs et al., 2015; Sakka & Juslin, 2018; Yehuda, 2011). Moreover, Mastandrea et al. (2019) reviewed some evidence detailing the psychophysiological mechanisms of the relationship between aesthetic experiences and the activation of emotional states, thus, providing a more comprehensive understanding of how aesthetic experiences provoke pleasure and aesthetic emotions. Subsequently, these mechanisms are discussed in more depth. Afterwards, it is outlined how pleasure and aesthetic emotions elicited by visual art may reduce symptoms of stress and promote well-being and health.

Art viewing elicits positive affect. The cognitive processing of visual art may produce positive-affective and aesthetically pleasing experiences. As stated by the information-processing stage model by Leder et al. (2004), the experience of pleasure and positive affect depends on a satisfactory cognitive mastering of the artwork. Thus, a better understanding of the artwork leads to a reduction of ambiguity and, consequently, to a higher probability of experiencing pleasure and positive affect. Consistently, neurophysiological studies found that context information facilitates the processing of an artwork and, thus, increases positive affect (Gerger & Leder, 2015; Mastandrea, 2015; Mastandrea & Umiltà, 2016). This is accompanied by greater neural activity in regions strongly associated with the experience of reward and emotion processing (Kawabata & Zeki, 2004; Kirk et al., 2009).

Alternatively, experiencing positive affect may not only depend on the level of perceived ambiguity but also be the outcome of a special empathetic state provoked by the

artwork itself (Leder et al., 2004; Leder & Nadal, 2014). In this view, the aesthetic emotion reflects an art-specific emotional response evolved from basic biologic emotions. Pelowski et al. (2017) propose that profound aesthetic emotional experiences may be evoked when an artwork is experienced as high schema-congruent and high self-relevant. Thereby, something about the artwork resonates with a viewer's identity, which potentially ushers in intense emotional reactions such as the feeling of being moved or chills. These reactions are associated with higher arousal and the activation of positive emotions such as joy or wonder (Menninghaus et al., 2017). Support for this notion was found by the study of Gerger et al. (2018), in which individuals rated representational and abstract paintings, showing positive correlation between the perceived feeling of being moved and positive affect. In line with this finding, Ishizu and Zeki (2017) showed that the experience of beauty when viewing aesthetic images modulated activity in brain areas that have been found to be involved in positive emotional states. Moreover, Brielmann and Pelli (2017) revealed that feelings of beauty elicited by visual art are closely related to pleasure. Eventually, Menninghaus et al. (2017) suggest that the aesthetic emotional experience of art is a pleasurable activity, irrespective of the emotional content of the artwork. Accordingly, Gerger et al. (2014) showed that art contexts heighten positive responses toward images depicting negative emotions.

In conclusion, past research suggests that visual art may be perceived as movingly beautiful regardless of whether it depicts positive or negative content (Menninghaus et al., 2017), and that art context as well as experienced schema-congruency and self-relevancy may play a major part when it comes to positive-affective and pleasurable responses to visual art (Pelowski et al, 2017).

Art evoked positive affect reduces stress. The stress-buffering hypothesis states that experiencing positive emotions reduces the health harming effects of daily stress (Pressman & Cohen, 2005). Accordingly, research found a correlation between positive emotions and longevity (Chida & Steptoe, 2008; Howell, 2007; Zhang & Han, 2016). Regarding positive emotions as response to art, the models by Koelsch (2014) and Sachs et al. (2015) propose that pleasure and positive affect evoked by music listening reduce physiological stress responses and aid us in achieving homeostatic balance. In the same vein, Mastandrea et al. (2019) suggest that pleasure and positive emotional responses while experiencing visual art may activate specific brain areas (e.g., amygdala, hippocampal formation, and reward-related brain circuitry) which, subsequently, lead to a decrease of physiological and subjective levels of stress.

Presently, only few studies explored the effects of aesthetically pleasing visual art on different correlates of well-being. For instance, the study by Mastandrea (2019) tested how art images can affect people's emotional state depending on the content (disturbing, neutral or serene) depicted by the images. Findings revealed that evaluating serene images decreased post-anxiety scores significantly with the author concluding that the simple vision of pictures with this content can produce a perception of well-being. Moreover, the study by Totterdell and Poerio (2020) revealed that individuals' variety of encounters with visual art in daily life are associated with well-being. Specifically, visual art was found to be positively correlated with greater meaning in life. Elsewhere, de Tommaso et al. (2008) found that paintings rated as beautiful provide positive distractions and, thus, lead to a decrease of pain perception. Still, only little is known about the aesthetically pleasing and positive emotional responses evoked by visual art and its relation to essential health parameters. As consequence, our study emerges as a first approach in shedding light on respective relationship while testing how movingly beautiful visual artworks impact subjective levels of stress, negative affect, and anxiety.

Does stress influence visual art perception?

In the present study, the focus does not only lie on the potential effects of visual art on subjective stress but also on whether stress might change the way we perceive art. Currently, I am not aware of any research investigating effects of stress on visual art perception. However, research regarding the effects of stress and arousing on the perception of internal and external stimuli hints at an altered perception of visual aesthetics during stress. First, the negative

affect and arousal we experience during stress might be misinterpreted as an increase in perceived negative emotion depicted by visual art. In this line, Dutton and Aron (1974) revealed that arousal can be misattributed to incorrect stimuli. Specifically, they found that experimentally induced fear led male participants wrongly believe that they were feeling sexual arousal at the sight of women. Second, stress might impair the cognitive processing of visual artworks which, according to the fluency theory (Reber et al., 2004), can increase perceived negative emotion. In this vein, the study by Paul et al. (2016) tested how stress effects the perception of scenes and faces revealing that acute stress impedes the discrimination of spatial information, especially when the perception is characterized by high complexity. Third, the experienced anxiety associated with stress might lead to a more positive perception of visual art, as Eskine et al. (2012) showed that fear, not happiness or arousal, inspires positive aesthetic judgments with making participants rate art as more sublime.

To throw light on potential effects of stress on visual art perception, I examined in an exploratory fashion if mild stress leads to a change in perceived visual aesthetics. Specifically, I focused on differences in the perceived aesthetic and emotional experiences when viewing artworks during stress.

Present study: Research question

This master's thesis addresses whether and how movingly beautiful visual art can modify different subjective correlates of stressful experiences. The theoretical framework by Mastandrea et al. (2019) suggests that emotional output elicited from aesthetic experiences when viewing artworks positively affects mood, reduces stress, and indirectly promotes health. However, proposed effects of visual art on health have not been tested empirically yet. Thus, the study aimed to investigate (1) whether aesthetically pleasing visual art (beautiful artworks in comparison to non-beautiful ones) could lead to improved positive affect and mood and therefore (2) reduces stress, negative affect and anxiety. Furthermore (3), I investigated exploratively how stress could influence the perception of visual artworks.

Present study: Hypotheses

Corresponding to the research questions, I investigated following confirmatory hypotheses. First (1), I supposed that viewing self-selected movingly beautiful visual art leads to increased mood, calmness, wakefulness and positive affect compared to viewing self-

selected non-beautiful visual art. For this reason, I supposed that (2) levels of subjective stress, negative affect and anxiety are reduced when viewing self-selected movingly beautiful visual art compared to viewing self-selected non-beautiful visual art after inducing mild stress.

Present study: Exploratory analysis

Furthermore (3), I investigated in an exploratory fashion if acute stress influences the way we perceive artworks. Specifically, I tested if inducing mild stress leads to changes in perceived movingly beautifulness, aesthetic experiences, positive emotion, and negative emotion when viewing artworks.

Method

Ethics statement

The study was conducted with prior approval of the ethic commission for research of the University of Vienna. The respective approval can be found in Appendix A. The anonymized participant data are stored on servers of the University of Vienna.

Participants

In their meta-study, de Witte et al. (2020) found a medium effect size (d = .545) of music listening on subjective stress-related outcomes. Similarly, Clow and Fredhoi (2006) found a small-to-medium effect of museum visits on self-reports of stress. Considering these results, I conducted an a-priori sample size calculation using G*Power (version 3.1.9.4; Faul et al., 2007) with linear mixed models (LMMs) as planned statistical test and assuming a medium effect size, f = 0.23, probability of type I error = .05, power = .90, number of groups = 2, number of measurements = 2. Results suggested a total sample size of 52 participants.

Seventy-nine Psychology students were recruited via the recruitment system of the University of Vienna. Sample recruitment focused on women and men between the age of 18 and 35 with normal weight (Body Mass Index (BMI) from 18.5 to 25), sufficient knowledge of German and regular menstruation (for women). Exclusion criteria were colour blindness, inappropriate visual acuity, hearing problems, art/music-related profession/art/music-related studies, mental disorders (queried via a structured clinical interview according to Diagnostic and Statistical Manual of Mental Disorders (DSM)-criteria), cardiovascular diseases, arterial

occlusive diseases, very high or very low blood pressure, chronic pain, diabetes, Raynaud's syndrome, epilepsy, recent serious injury, regular intake of pain-reducing medication, more than five cigarettes per week and current drug consumption. Women with momentary pregnancy or breastfeeding, premenstrual syndrome and intake of hormonal contraceptive were also excluded. After an online pre-screening, 26 students had to be excluded for not fulfilling the participation criteria. This resulted in a total sample size of 53 (35 female, Mage = 22.15 years, SDage = 2.92 years). The students received course credit for their participation.

The participants were treated in accordance with standards of the Declaration of Helsinki: First, they were precisely instructed about the procedure and informed about the method used in the study to induce stress. They then gave written consent. During the experiment, participants were repeatedly monitored to ensure their well-being. After the experiment, participants were informed about the theoretical background, study design, and hypotheses of the study in oral form.

Measures and materials

Design

The experiment used a 2x2 repeated measures design with time (*pre* vs. *post*) and condition (*beautiful* vs. *non-beautiful*) as within-subject factors. In the *beautiful* condition, the participants viewed the movingly beautiful artwork and in the *non-beautiful* condition, they viewed the non-beautiful artwork. *Pre* refers to measuring the dependent variables before stress induction, *post* refers to measuring them after stress induction. The repeated measures design reduces the effect of variability since the same subjects are used throughout the experiment. Regarding the use of stressful stimuli, this design has been considered most suitable due to the significant individual differences that exist in stress responses (Minkley et al., 2014). The participants were assigned in counterbalanced order to the respective conditions.

Stimuli

Participants were asked to provide one visual artwork (e.g., a painting, picture, or photograph) that they consider as movingly beautiful as well as one visual artwork (e.g., a painting, picture, or photograph) that they do not find beautiful at all. They were instructed to send a digital version of the artworks with a minimum resolution of 720×576 pixels via mail

to the experimenter 24 hours prior to the testing day. If the participants did not provide the respective artworks before testing, they were asked to select two digital artworks out of artwork-pools in the laboratory on testing day. One pool consisted of 90 pre-rated highly liked and beautiful visual artworks, the other pool consisted of 90 pre-rated not liked and not beautiful visual artworks. Artworks in the pools are taken from the JenAesthetic dataset (Amirshahi et al., 2013; Amirshahi et al., 2014) and the Vienna Art Picture System (VAPS). Again, the participants were asked to select one artwork they consider as movingly beautiful as well as one artwork they do not find beautiful at all. The exact instruction for the artwork selection as well as a list of all the artworks from the pools can be found in Appendix B.

In the study, 36% of the participants (n = 19) provided both artworks, one considered as movingly beautiful and one as not beautiful, 49 % of the participants (n = 26) chose both artworks from preselection pools and 15 % of the participants (n = 8) provided a movingly beautiful artwork only and chose the non-beautiful artwork from the preselection pool. Figure 1 compares distributions of movingly beautiful ratings for the artworks brought by the participants and for the artworks selected in the laboratory by the participants. Figure 2 shows examples for a movingly beautiful artwork and a non-beautiful artwork chosen from the respective pools as well as for a movingly beautiful artwork and a non-beautiful artwork brought by the participants.

Figure 1

Movingly beautifulness ratings for brought and selected artworks

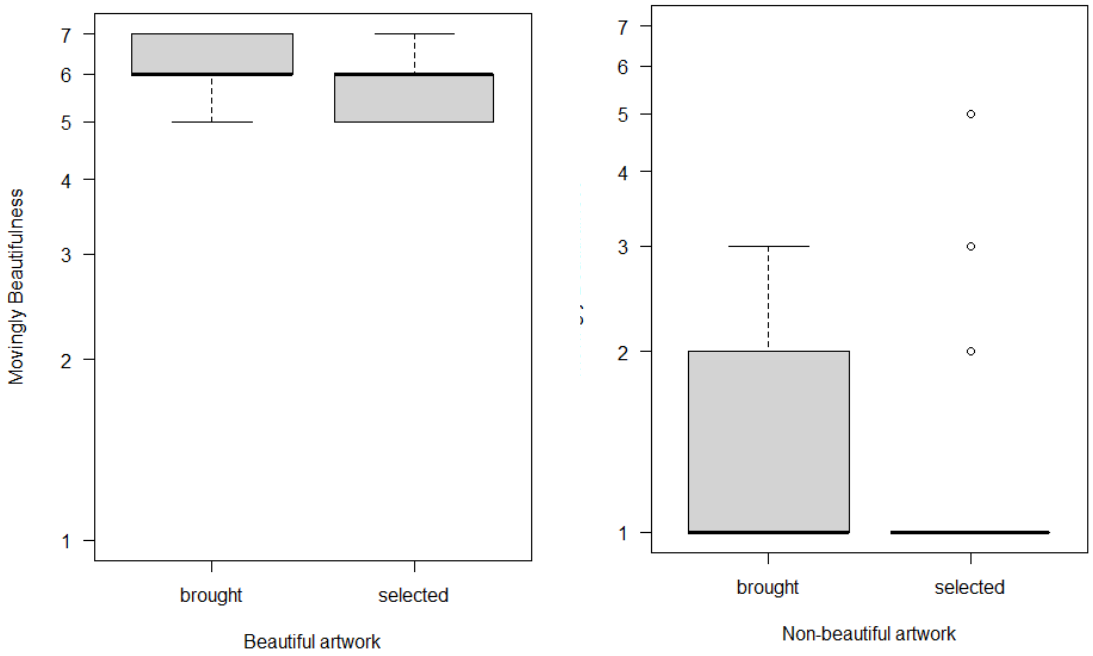
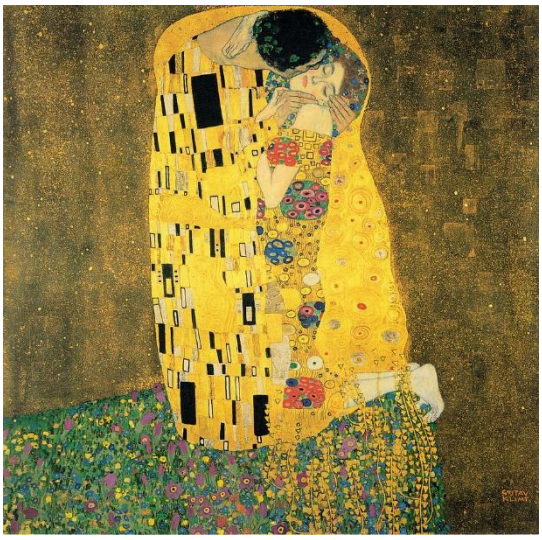


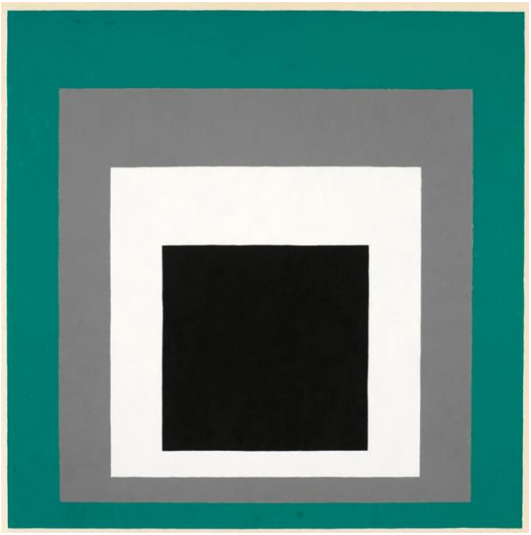
Figure 2

Four examples of the presented stimuli

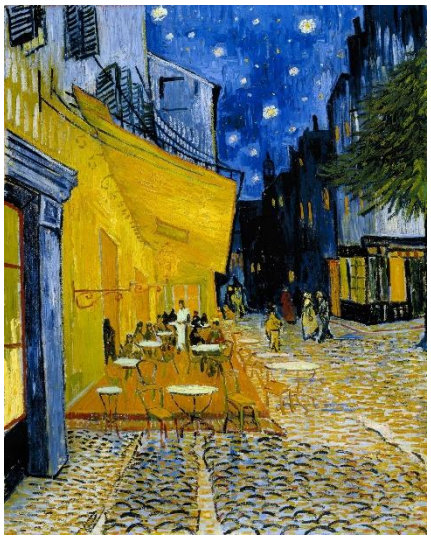
a)



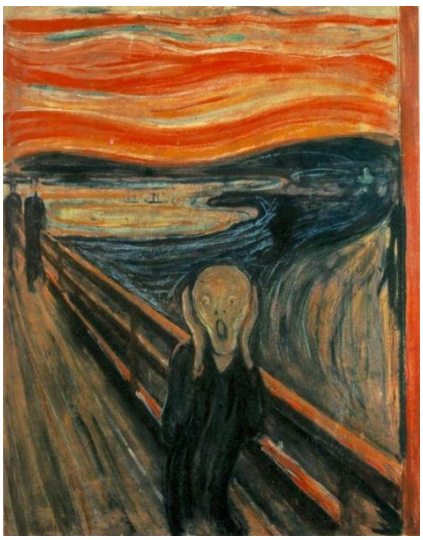
b)



c)



d)



Note. A) shows a movingly beautiful artwork from the preselection pool (Klimt, G., 1908, The Kiss); b) shows a non-beautiful artwork from the preselection pool (Albers, J., 1951, Homage to the Square, Decided); c) shows a movingly beautiful artwork brought by participants (van Gogh, V., 1888, Café Terrace at Night); and d) shows a non-beautiful artwork brought by participants (Munch, E., 1893, The Scream). All images above are retrieved from the Vienna Art Picture System (VAPS).

Stress induction

In the study, mild stress was induced with the cold pressor test (CPT). The CPT is a commonly used technique to rapidly elicit a stress reaction in which the participant's hand is immersed in ice-cold water for a short time. This physiological stressor leads to stress responses mirrored in increased HPA and SNS activity (Al'Absi et al., 2002; Robertson et al., 1979). As CPT, I used a C40 'frost-box' and a submersion pump (Reich, 10 L/min, 0.5 bar) running of a 12v battery for circulating the water to avoid laminar warming around the submerged hand. The box was filled-up with crushed ice up to 40 cm from top corners and with cold water up to 5 cm from top corners. Before and during the experiment, the water temperature was repeatedly measured to ensure that it does not increase beyond 1.5° Celsius or decrease below 0.5° Celsius. In cases when the water was too warm or too cold, crushed ice or warm water was added, respectively.

Mood states and positive affect

Mood states were assessed with the short version of the Multidimensional Mood State Questionnaire (MDBF; Steyer et al., 1997) which consists of six questions to be answered on 7-point Likert scales (from "definitely not" to "very much") and yields scores on the scales bad-good mood (mood), sleepy-awake (wakefulness), and restless-calm (calmness). The internal consistency (Cronbach's Alpha) of the scales lies between r= 0.73 and r= 0.89.

The subscale positive affect of the Positive Affect Negative Affect Scale (PANAS; Krohne et al., 1996) was used to measure participants' positive affect. Past research revealed that PANAS is a valid and reliable measure for assessing positive and negative affect (Crawford & Henry, 2004). Positive affect refers to the propensity to experience positive emotions such as joy, cheerfulness or contentment and describes the extent to which a person feels enthusiastic, active, and alert (Magyar-Moe, 2009). The subscale consists of 10 items asking participants to rate how they feel in the current moment on a 5-point Likert scale (from "not at all" to "extremely").

Negative affect, subjective stress, and anxiety

In this study, I measured perceived negative affect with the subscale negative affect of the PANAS (Krohne, et al., 1996). Negative affect refers to the amount of distress and negative emotions a person experiences, including anger and fear (Watson et al., 1988). The

subscale consists of 10 items asking participants to rate how they feel in the current moment on a 5-point Likert scale (from “not at all” to “extremely”).

Subjective levels of stress were operationalized with a VAS (Folstein & Luria, 1973) which consists of a single item asking participants to rate their subjective stress on a 100-mm horizontal line. The ends of the lines are labelled ‘‘not at all’’ (0 mm, on the left) and ‘‘extremely’’ (100 mm, on the right).

Subjective feelings of anxiety were assessed with the STAI-S (Spielberger et al., 1983). STAI-S scale consists of six items asking participants to rate how anxious they feel at a particular moment in time on a 4-point scale (1 = not at all, 2 = somewhat, 3 = moderately, 4 = very much). Findings show that the inventory is a highly reliable measure (Cronbach’s Alpha = 0.90; Spielberg et al., 1983).

Art perception

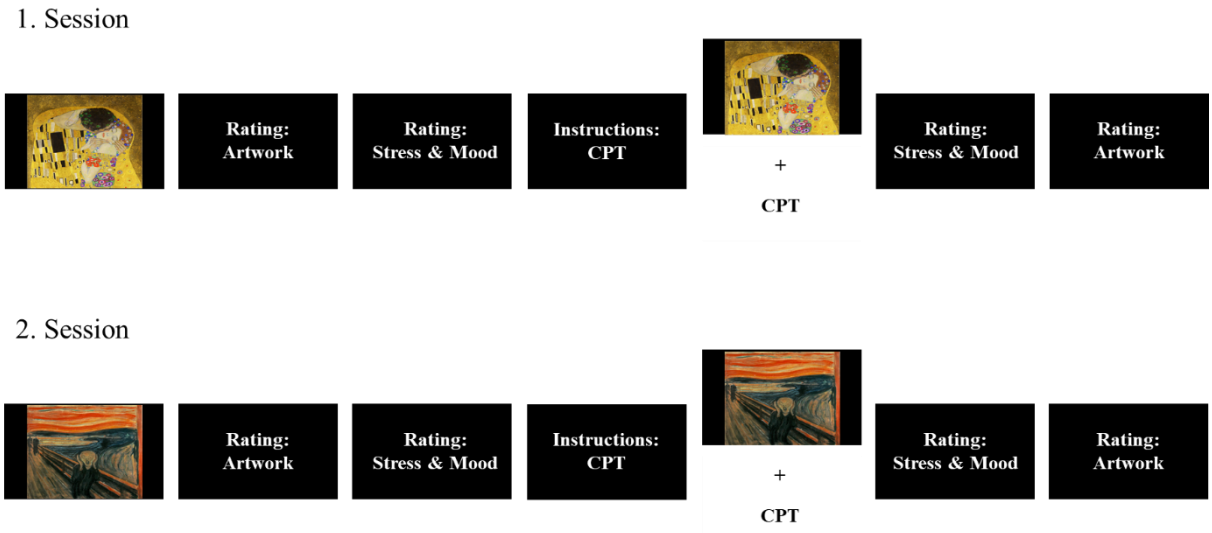
The individual perception of the self-selected artworks was assessed with four questions to be answered on 7-point Likert scales (from “not at all” to “extremely”). The questions were: “How much did you find the selected artworks movingly beautiful in this laboratory environment?”, “Did you have any aesthetic experiences when being exposed to the artwork?”, “Did you experience positive emotions when viewing the artwork?” and “Did you experience negative emotions when viewing the artwork?”.

Procedure

The experiment consisted of two testing sessions with one session per condition *(beautiful* vs. *non-beautiful)*. The testing sessions took place on the same day with 30 minutes in between. In each session, the participants were exposed to their self-selected artworks during stress induction. The participants were tested twice per testing session, once before (*pre*) and once after (*post*) stress induction. To eliminate order effects, I used counterbalanced conditions. Thus, the participant sample was divided in half, with one half completing the two conditions in one order (first viewing the beautiful artwork and then the non-beautiful one) and the other half completing the conditions in the reverse order (first viewing the non-beautiful artwork and then the beautiful one). In the following paragraphs, the experimental procedure is detailed. Figure 3 shows the representation of the experimental procedure.

Figure 3

Representation of the experimental procedure



Note. Here, with the self-selected movingly beautiful artwork presented in the first session and the self-selected non-beautiful artwork presented in the second session. From left to right: (1) Participants viewed their self-selected artwork of one condition and answered items regarding the perception of the presented artworks. (2) Then, they rated mood, positive and negative affect and subjective stress. (3) Afterwards, the cold pressor test (CPT) was applied during which participants viewed their self-selected artwork. (4) After stress induction, participants rated again mood, positive and negative affect. subjective stress as well as anxiety. (5) Eventually, they answered items regarding the perception of the presented artworks during stress induction. The entire procedure was repeated in a second session, that time with the artwork from the other condition presented. Through counterbalanced conditions, the participants viewed either the beautiful artwork in the first session and the non-beautiful artwork in the second session or vice versa. All images above are retrieved from the Vienna Art Picture System (VAPS).

All participants were tested individually in a laboratory of the EVAlab (Research focus Empirical Visual Aesthetics) at the Faculty of Psychology in Vienna, Liebiggasse 5. Three days before the participants were tested, I asked them to provide an artwork they consider as movingly beautiful as well as an artwork they do not find beautiful at all. Additionally, I sent them a mail with COVID-19 safety guidelines for the University of Vienna and asked them to follow these guidelines strictly during the whole period of testing. Therefore, the participants were wearing oronasal masks and repeatedly disinfecting their hands during the entire experiment. Moreover, a minimal distance of 1.5m between participant and experimenter was kept throughout testing. On the testing day, participants were welcomed outside the faculty building and accompanied to the laboratory. There, they were asked to carefully read and sign the informed consent. Before starting the experiment,

participants who did not send me the required artworks were asked to select one artwork they consider as movingly beautiful as well as one artwork they do not find beautiful from the preselection pools. Afterwards, the experiment started.

The experiment was programmed and executed in PsychoPy (version 2020.1.1) running on a desktop computer with Windows 10 Professional (Microsoft, Inc.). Visual artworks and rating scales were presented in front of a black background on a 39.5-inch monitor (LG 34WL500-B; resolution 3,840 x 2,160 pixels). The participants responded by clicking with a standard mouse. Additionally, headphones with noise-cancelling (BOSE QuietComfort 25) were provided to reduce ambient noises during stress induction. See Figure 4 for images of the experimental setting.

At the beginning of the first session, participants were instructed to view the self-selected artwork of one condition and to answer the art perception items. Then, they received the written instruction for the MDBF. They were asked to rate to which extent the following adjectives correspond with their current mood via clicking with the right mouse button on the respective spot of the 7-point Likert scale (1 = definitely not, 7 = very much; see Appendix B for the German instructions). After rating their current mood, the written instruction for the PANAS followed. They were asked to judge to which extent the following words describe emotions and sensations in respect to their current affective state. Again, they should use the right mouse button to click on the respective spot of the 5-point Likert scale (1 = not at all, 5 = extremely; see Appendix B for the German instructions). After answering the items of the PANAS, the written instruction for the VAS was presented asking them to rate their currently subjective levels of stress via clicking with the right mouse button on the corresponding point of a 100-mm horizontal line, with the ends labelled as ‘‘not at all’’ (0 mm, on the left) and ‘‘extremely’’ (100 mm, on the right; see Appendix B for the German instructions).

Then, the instruction for the CPT followed. Participants were asked to immerse their right hand in a circulating water bath with temperatures between 0.5 °C and 1.5 °C, and keep it submerged until it is too uncomfortable to continue. Specifically, they were instructed to immerse the hand until the wrist with released fingers, and to avoid touching the container with the palm of their hands. Moreover, they were asked to put on the provided headphones to reduce ambient noise during the CPT. They were then instructed to look at the artwork of one condition which would appear on the screen as soon as their hand was submerged. During the whole procedure, the experimenter was standing behind the participants and watched their

hand immersing in water. He pressed the space bar of his keyboard as soon as the participants had immersed their hands in order to present the self-selected artwork on the screen. In the moment the participants pulled out their hands, the experimenter pressed the space bar again and the artwork disappeared from the screen. If the participants kept their hand in water for three minutes, the artwork would disappear from the screen automatically with the instruction followed to pull out their hands. The participants were provided a towel to dry their hands and, subsequently, were asked to answer the items on the screen again. See Figure 4 for images of the CPT as stress-inducing tool.

Figure 4

Images of the experimental setting

Note. The upper picture shows a participant seated in front of the screen with the movingly beautiful artwork presented. To induce mild stress reactions, a cold pressor test (CPT) is applied in which the participant's right hand is immersed in ice-cold water. The lower picture provides a closer look of the hand immersed in ice-cold water.

Immediately after the CPT, participants were again instructed to rate their currently subjective levels of stress on a VAS. They then received the written instruction for the STAI-S. They were asked to rate to which extent the following statements correspond with their current emotional state. They should use the right mouse button to select the corresponding spot of the 4-point Likert scale (1 = not at all and 4 = very much; see Appendix B for the German instructions). Subsequently, the instructions and items for the PANAS, MDBF and art perception were presented in the same way as before the CPT. After answering the items regarding art perception, participants were told that the first session had now ended and that the second session would start in 30 minutes. Until the second session, they could leave the building or stay and read magazines I provided for them.

The second session followed the same procedure as the first one with the difference that the self-selected artwork of the other condition was presented. After completing the second session, participants were thanked for participating and orally debriefed about aim and hypotheses of the study. Eventually, I provided them the opportunity to give me their e-mail address in order to send them information about the outcomes of the study.

Statistical analysis

All statistical analysis were conducted using R Studio 3.5.1 (R Core Team, 2020) with the following packages: data.table (Version 1.12.8: Dowle et al., 2020), lme4 (Version 1.1–1.23; Bates et al., 2020), emmeans (Version 1.4.7; Lenth, 2020), ggplot (Version 3.3.0; Wickham, 2016) and rmcorr (Version 0.4.1; Bakdash & Marusich, 2017).

Regarding levels of mood, calmness, wakefulness, positive affect, negative affect, and subjective stress, differences in behavioural responses were analysed using a LMM for each dependent variable with the fixed factors condition (*beautiful* vs. *non-beautiful*) and time (*pre* vs. *post*) and the per-participant intercept as random factor. LMMs are a frequently used method for analysing data that are non-independent or multilevel/hierarchical. In contrast to other methods for analysing hierarchical data (like repeated measure analyse of variances), LMMs are very robust to violations of distributional assumptions and can accommodate missing data (Schielzeth et al., 2020). Moreover, the structural models are based on the population, not on data from any particular participant, thus allowing for sparse sampling.

Additionally, paired t-tests were performed using the Bonferroni correction to reveal contrasts within significant main effects. Furthermore, a paired t-test was conducted to find

significant differences in subjective feelings of anxiety between the conditions after stress induction.

In the exploratory analysis, perceived differences in movingly beautifulness, aesthetic experience, positive emotion, and negative emotion were examined using a LMM with the fixed factors condition (*beautiful* vs. *non-beautiful*) and time (*pre* vs. *post*) and the per-participant intercept as random factor. Again, paired t-tests were performed using the Bonferroni correction as post-hoc tests to reveal contrasts within significant main effects.

Additionally, I tested in an exploratory fashion for group differences in ratings of mood, positive and negative affect, stress, anxiety and art perception between participants who brought the artworks (beautiful and non-beautiful) and participants who selected them in the laboratory. Due to violations to distribution assumptions (see *Test assumptions* below), I performed Mann Whitney U Tests (Wilcoxon Rank Sum Tests) to test for respective differences.

Results

Test assumptions

Prior to statistical analysis, each LMM was tested for linearity, homogeneity of variances and normal distribution. For linearity, the model residuals were plotted against the predictors. While observing the respective plots for every model, the predictors correlated linearly with the residuals hinting that the assumption is not violated (see Appendix B for respective plots). For testing equal variances of the residuals across individuals, Levene's tests were conducted for each model. Results indicated homogeneous variances in each test (ps > .05). Normal distributed residuals were tested with QQ plots which give an estimation of where the standardized residuals lie with regard to normal quantiles. Strong deviation from the respective line suggests that the residuals are not normally distributed. There are smaller deviations from the expected normal line towards the tails (see Appendix B for respective plots). However, since LMMs are very robust to violations of distributional assumptions (Schielzeth et al., 2020), the observed smaller deviations can be ignored.

As for the dependent t-tests, a Shapiro-Wilk test was conducted to check if the differences between each pair of value were normal distributed. Results revealed a violation of this assumption in the anxiety ratings. Hence, a Wilcoxon-Signed-Rank test was performed

to test for significant differences in subjective feelings of anxiety between the respective conditions.

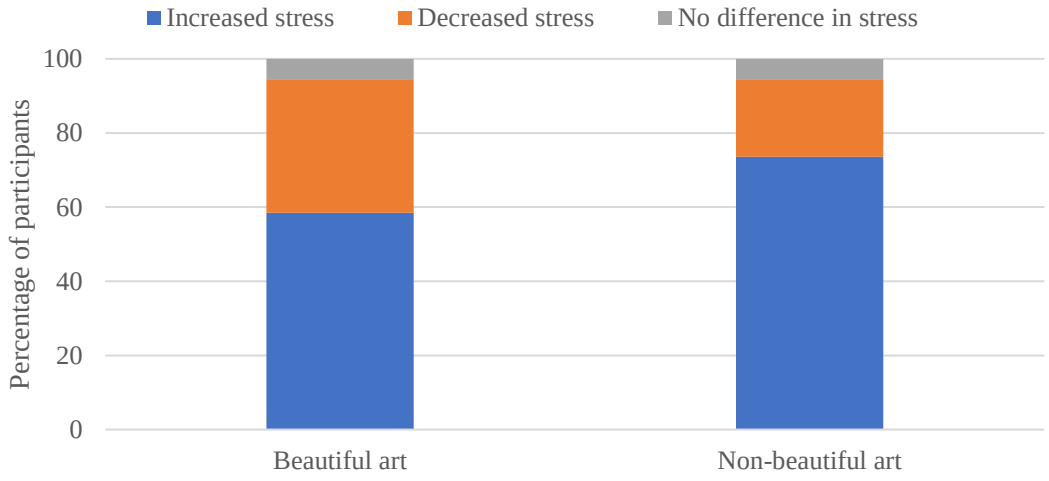
Regarding differences in ratings between groups (*brought* vs. *selected artworks*), results of Levene's tests indicated heterogeneous variances in the data (*p*s < .05). Moreover, QQ plots indicated non-normal distributed data. Thus, Mann Whitney U Tests were used for statistical analysis.

Manipulation check

Participants rated subjective feelings of stress in both conditions significant higher after compared to before the CPT (see Fig. 7 for mean ratings of subjective stress). Moreover, descriptive data revealed that 59 percent of participants (n = 31) in the beautiful condition and 79 percent of participants (n = 39) in the non-beautiful condition reported higher subjective levels of stress after compared to before stress induction. See Fig. 5 for percentage of participants who reported an increase, a decrease or no difference in stress after the CPT.

Figure 5

Changes in subjective levels of stress after stress induction



Note. Percentage of participants who reported an increase, a decrease or no difference in levels of subjective stress after the CPT when viewing beautiful art and when viewing non-beautiful art during stress induction.

Confirmatory data

To analyse whether being exposed to movingly beautiful visual art compared to being exposed to non-beautiful art during stress leads to increased levels of mood, calmness,

wakefulness and positive affect (hypothesis 1) and therefore decreased levels of subjective stress and negative affect (hypothesis 2), I conducted a LMM for each dependent variable. Additionally, I used a Wilcoxon-Signed-Rank test for examining whether perceived anxiety is lower when viewing movingly beautiful visual art compared to viewing non-beautiful visual art during stress. See Table 1 for descriptive statistics.

Table 1

Descriptive data of art viewing on mood, positive/negative affect and stress variables (N = 53)

Variable	Pre-stress		Post-stress	
	M	*SD*	*M*	*SD*
Beautiful artwork				
VAS: Subjective Stress	17.84	18.19	26.48	23.06
PANAS: Positive Affect	3.35	0.57	3.32	0.59
PANAS: Negative Affect	1.41	0.44	1.41	0.39
MDBF: Mood	5.71	0.90	5.42	1.03
MDBF: Wakefulness	4.81	1.09	4.97	1.27
MDBF: Calmness	5.53	0.97	5.18	1.17
STAI-S: Anxiety	-	-	1.83	0.50
Non-beautiful artwork				
VAS: Subjective Stress	18.54	16.66	27.98	19.73
PANAS: Positive Affect	3.05	0.59	2.98	0.67
PANAS: Negative Affect	1.49	0.45	1.51	0.44
MDBF: Mood	5.43	1.05	5.00	1.08
MDBF: Wakefulness	4.48	1.12	4.70	1.19
MDBF: Calmness	5.30	1.11	4.88	1.22
STAI-S: Anxiety	-	-	2.02	0.48

Note. VAS = Visual Analogue Scale; PANAS = Positive Affect Negative Affect Scale; MDBF = Mehrdimensionaler Befindlichkeitsfragebogen; STAI-S = State Trait Anxiety Inventory (State Anxiety).

Mood and positive affect

Regarding **mood**, there was a significant main effect of condition ($\chi^2(1) = 16.39$, $p < .001$) and time ($\chi^2(1) = 15.58$, $p < .001$) but no interaction between condition and time ($\chi^2(1) = 0.77$, $p = .381$). This indicated an improved mood in the beautiful compared to the non-beautiful condition as well as an increased mood before compared to after stress induction (see Fig. 6 for mean mood ratings).

Regarding **calmness**, there was a significant main effect of condition ($\chi^2(1) = 9.12$, $p = .003$) and time ($\chi^2(1) = 4.32$, $p = .038$) but no interaction between condition and time ($\chi^2(1) = 0.09$, $p = .765$). This suggested an increase in calmness in the beautiful compared to the non-beautiful condition and before compared to after stress induction (see Fig. 6 for mean calmness ratings).

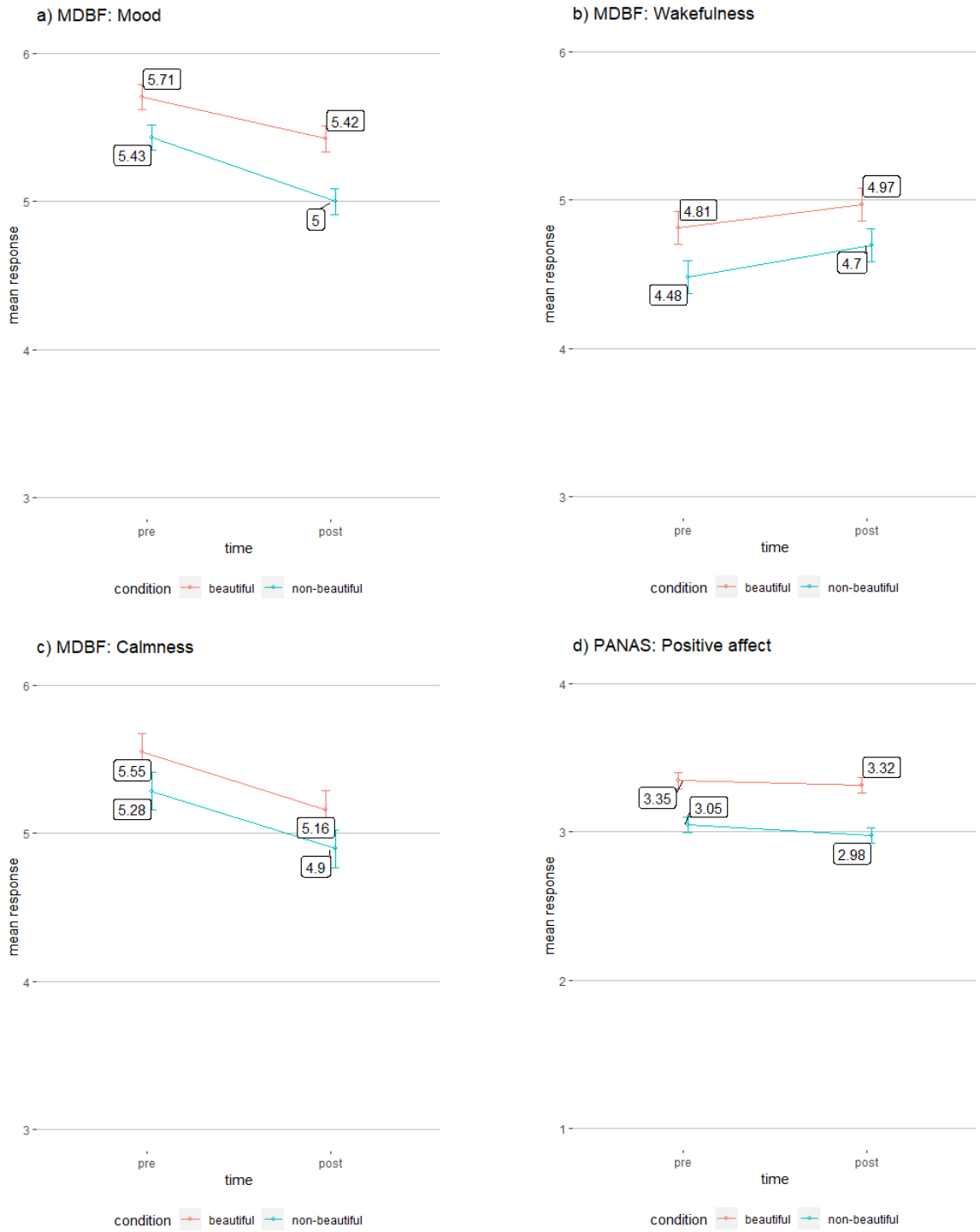
Regarding **wakefulness**, I observed a significant main effect of condition ($\chi^2(1) = 7.23$, $p = .007$) but no main effect of time ($\chi^2(1) = 2.79$, $p = .095$) and no interaction of condition and time ($\chi^2(1) = 0.07$, $p = .79$). This finding indicated an increased wakefulness in the beautiful compared to the non-beautiful condition at both times (see Fig. 6 for mean wakefulness ratings).

On the **positive affect** scale, I found a significant main effect of condition ($\chi^2(1) = 30.69$, $p < .001$) but no main effect of time ($\chi^2(1) = 0.71$, $p = .398$) and no interaction of condition and time ($\chi^2(1) = 0.14$, $p = .70$). This indicated an increase in positive affect in the beautiful compared to the non-beautiful condition at both times (see Fig. 6 for mean positive affect ratings).

Table 2 shows the results of pairwise comparisons between levels of condition (*beautiful vs. non-beautiful*) and time *(pre vs. post)* for each dependent variable. Specifically, I used Bonferroni corrected paired t-tests to test for differences in mean ratings of mood, calmness, wakefulness, and positive affect between the beautiful and non-beautiful condition and between before and after stress induction.

Figure 6

Means of mood, wakefulness, calmness and positive affect



Note. Means of mood, wakefulness, calmness, and positive affect in the beautiful and non-beautiful condition before (pre) and after (post) stress induction. Error bars represent confidence intervals. a) shows the mood scale of the MDBF, b) the wakefulness scale of the MDBF, c) the calmness scale of the MDBF and d) the positive affect scale of the PANAS.

Table 2

Results of Bonferroni corrected paired t-tests for differences of means between levels of condition (beautiful vs. non-beautiful) and time (pre vs. post) for each dependent variable

Variable and main effects	*β*	*SE*	*t*	*df*	*d*	*d* 95% CI
MDBF: Mood						
Condition	0.35	0.09	4.02***	105	0.55	[0.27,0.83]
Time	0.36	0.09	4.13***	105	0.57	[0.29, 0.85]
MDBF: Wakefulness						
Condition	0.30	0.11	2.71**	105	0.37	[0.09, 0.65]
Time	–0.19	0.11	–1.67	105	–0.23	[–0.50, 0.04]
MDBF: Calmness						
Condition	0.26	0.13	2.08*	105	0.29	[0.01, 0.56]
Time	0.39	0.13	3.05**	105	0.42	[0.14, 0.69]
PANAS: Positive Affect						
Condition	0.32	0.06	5.80***	105	0.79	[0.51, 1.08]
Time	0.05	0.06	0.84	105	0.12	[–0.16, 0.39]
VAS: Subjective Stress						
Condition	–1.10	2.23	–0.49	105	–0.07	[–0.35, 0.21]
Time	–9.04	2.10	5.80***	105	–0.61	[–0.89, –0.32]
PANAS: Negative Affect						
Condition	–0.09	0.03	–2.87**	105	–0.40	[–0.68, –0.12]
Time	–0.01	0.03	–0.41	105	–0.06	[–0.33, 0.22]

Note. CI = confidence interval; VAS = Visual Analogue Scale; PANAS = Positive Affect Negative Affect Scale; MDBF = Mehrdimensionaler Befindlichkeitsfragebogen; STAI-S = State Trait Anxiety Inventory (State Anxiety). *p < .05. **p < .01. ***p < .001.

Negative affect, subjective stress and anxiety

On the **negative affect** scale, a significant main effect of condition *($\chi^2(1) = 8.08$, $p = .005$)* but no main effect of time *($\chi^2(1) = 0.17$, $p = .68$)* and no interaction of condition and time *($\chi^2(1) = 0.13$, $p = .72$)* were found. This suggested higher subjective levels of negative affect in the non-beautiful compared to the beautiful condition at both times (see Fig. 7 for mean negative affect ratings).

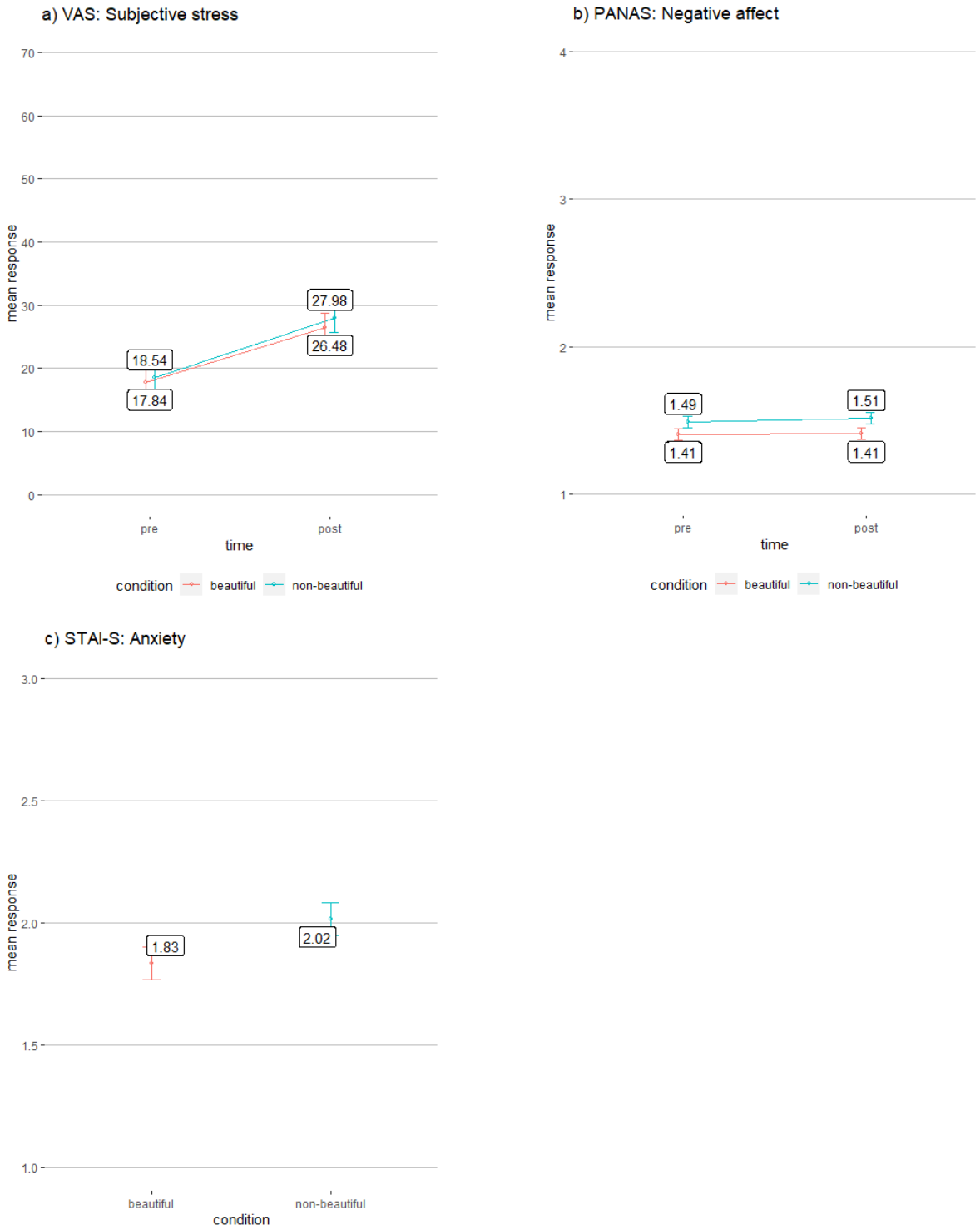
On the **subjective stress** scale, I observed a significant main effect of time *($\chi^2(1) = 17.53$, $p < .001$)* but no main effect of condition *($\chi^2(1) = 0.25$, $p = .62$)* and no interaction of condition and time *($\chi^2(1) = 0.04$, $p = 0.85$)*. This finding indicated an increase in subjective stress after compared to before the stress induction in both conditions but no significant difference between the conditions at both times (see Fig. 7 for mean subjective stress ratings).

Regarding **subjective feelings of anxiety** after stress induction, I found a significant difference ($V = 201.5$, $p < .001$, $r = .49$) in anxiety ratings between the beautiful and non-beautiful condition with higher levels of reported anxiety in the non-beautiful as opposed to the beautiful condition (see Fig. 7 for mean anxiety ratings).

Table 2 shows the results of pairwise comparisons of mean negative affect ratings and mean stress ratings between levels of condition (*beautiful vs. non-beautiful*) and time *(pre vs. post)* using Bonferroni corrected paired t-tests.

Figure 7

Means of subjective stress, negative affect, and anxiety



Note. Means of subjective stress, negative affect, and anxiety in the beautiful and non-beautiful condition. Error bars represent confidence intervals. a) shows the perceived stress scale of the VAS before and after stress induction, b) the negative affect scale of the PANAS before (pre) and after (post) stress induction and c) the anxiety scale of the STAI-S only after the stress induction.

Exploratory data

Art perception

Corresponding to the third goal (3), I investigated in an exploratory fashion if acute stress influences the way we perceive artworks. To examine whether the experience of stress influences the way we perceive art, I performed LMMs for the four art perception scales (see Table 3 for descriptive statistics).

Table 3

Descriptive data of art viewing on perceived movingly beautifulness, aesthetic experience and positive/negative emotion (N = 53)

Variable	Pre-stress		Post-stress	
	M	*SD*	*M*	*SD*
Beautiful artwork				
Movingly Beautifulness	6.04	0.73	5.51	1.03
Aesthetic Experience	5.68	0.94	5.21	1.13
Positive Emotions	5.91	1.13	5.77	1.05
Negative Emotions	1.72	1.05	1.83	1.12
Non-beautiful artwork				
Movingly Beautifulness	1.36	0.65	1.36	0.74
Aesthetic Experience	2.17	1.27	1.79	1.17
Positive Emotions	1.57	1.05	1.43	1.01
Negative Emotions	5.04	1.80	4.47	1.98

On the **movingly beautifulness** scale, a significant interaction of condition and time ($\chi^2(1) = 6.24$, $p = .013$) was observed. The interaction is driven by significantly higher ratings in the beautiful compared to the non-beautiful condition at both times and by a significant decrease in perceived movingly beautifulness after stress induction only in the beautiful condition (see Fig. 8 for mean movingly beautifulness ratings).

On the **aesthetic experience** scale, I observed a significant main effect of time ($\chi^2(1) = 8.98$, $p = .003$) and condition ($\chi^2(1) = 266.87$, $p < .001$) but no interaction of condition and time ($\chi^2(1) = 0.04$, $p = .85$), indicating on the one hand higher ratings of perceived aesthetic experience in the beautiful compared to the non-beautiful condition at both times. On the other hand, the findings suggest lower levels of perceived aesthetic experience after inducing stress in both conditions (see Fig. 8 for mean aesthetic experience ratings).

On the **positive emotion** scale, a significant main effect of condition ($\chi^2(1) = 359.27$, $p < 0.001$) but no main effect of time ($\chi^2(1) = 0.16$, $p = .69$) and no interaction of condition and time ($\chi^2(1) = 614.59$, $p = .90$) were found. This suggested higher ratings of perceived positive emotion in the beautiful compared to the non-beautiful condition at both times. (see Fig. 8 for mean positive emotion ratings).

On the **negative emotion** scale, I found a significant main effect of condition ($\chi^2(1) = 154.02$, $p < .001$) but no main effect of time ($\chi^2(1) = 0.59$, $p = .44$) and no interaction of condition and time ($\chi^2(1) = 3.42$, $p = .06$). Contrary to the positive emotion ratings, participants perceived higher negative emotions in the non-beautiful compared to the beautiful condition at both times (see Fig. 8 for mean negative emotion ratings).

Table 4 shows the results of pairwise comparisons using Bonferroni corrected paired t-tests examining differences in mean ratings of aesthetic experience, movingly beautifulness, positive and negative emotion between levels of condition (*beautiful vs. non-beautiful*) and time (*pre vs. post*).

Table 4

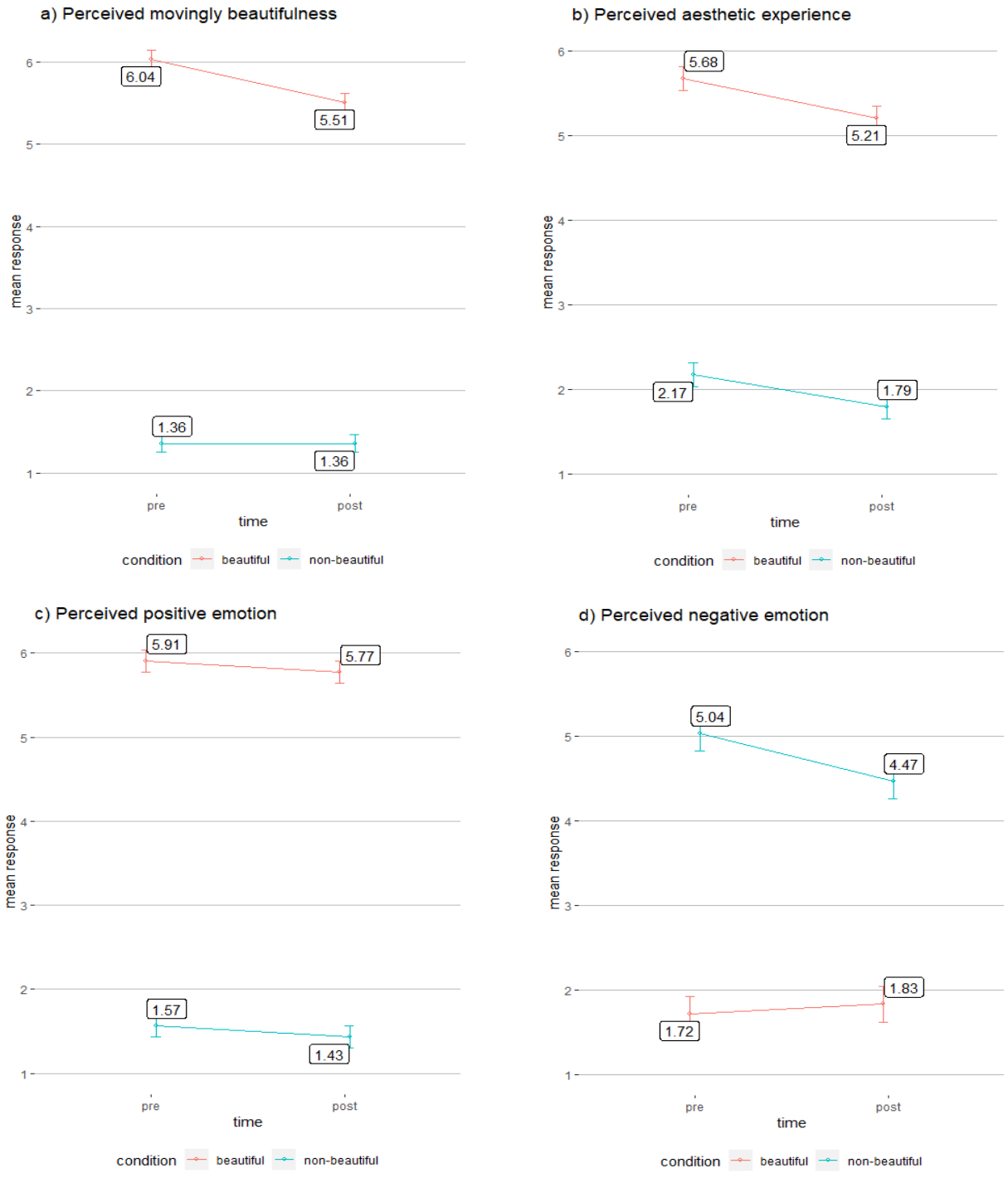
Results of paired t-tests for differences in means between levels of condition (beautiful vs. non-beautiful) and time (pre vs. post) for each dependent variable

Variable and main effects	*β*	*SE*	*t*	*df*	*d*	*d* 95% CI
Aesthetic experience						
Condition	3.46	0.14	24.63***	105	3.38	[2.92, 3.85]
Time	0.43	0.14	4.13**	105	0.42	[0.14, 0.69]
Positive Emotion						
Condition	4.34	0.13	32.82***	105	4.51	[3.94, 5.08]
Time	0.13	0.33	0.40	105	0.06	[–0.22, 0.33]
Negative Emotion						
Condition	–2.98	0.19	–16.02***	105	–2.20	[–2.57, –1.83]
Time	0.23	0.30	0.77	105	0.11	[–0.17, 0.38]

Note. CI = confidence interval. **p < .01. ***p < .001.

Figure 8

Means of movingly beautifulness, aesthetic experience, positive emotion and negative emotion



Note. Means of perceived movingly beautifulness, aesthetic experience, positive emotion, and negative emotion in the beautiful and non-beautiful condition before (pre) and after (post) stress induction. Error bars represent confidence intervals. Each variable was measured with a single 7-point Likert scale. a) shows the perceived movingly beautifulness scale, b) the aesthetic emotion scale, c) the positive emotion scale and d) the negative emotion scale.

Post-hoc comparisons of ratings between brought and selected artworks

To examine if ratings of mood, positive and negative effect, stress, anxiety and art perception differed between participants who brought the beautiful and non-beautiful artwork and those who selected them in the laboratory, I performed Bonferroni corrected Mann Whitney U Tests.

Table 5 shows results of the Bonferroni corrected Mann Whitney U Tests **in the beautiful condition,** before and after stress induction. The results reveal that ratings did neither differ significantly between the groups (*brought vs. selected artworks*) before stress induction nor afterwards.

Table 6 shows results of the Bonferroni corrected Mann Whitney U Tests **in the non-beautiful condition,** before and after stress induction. Again, results indicate no significant differences in any of the ratings between the groups (*brought vs. selected artworks*), neither before nor after stress induction.

Additionally, I calculated post-hoc power for each effect with G*Power (version 3.1.9.4; Faul et al., 2007), using Mann Whitney U Tests (two groups) as statistical test with the found effect sizes (see *Cohen's d* in Table 5 and 6), probability of type I error = .05, sample size group 1 = 27 (and 19, respectively), sample size group 2 = 26 (and 34, respectively). Results are shown in Table 5 and 6, respectively.

Table 5

Results of Bonferroni corrected Mann Whitney U Tests for group differences (brought vs. selected artworks) regarding ratings in the beautiful condition

Beautiful artwork	Brought (n = 27)		Selected (n = 26)		*W*	*p*	*d*	*Power*
	M	*SD*	*M*	*SD*				
Pre-stress ratings								
Positive Affect	3.44	0.53	3.24	0.60	426.5	.181	0.38	0.26
Mood	5.81	0.83	5.60	0.97	385	.533	0.17	0.09
Calmness	5.56	0.99	5.50	0.97	363	.830	0.06	0.06
Wakefulness	5.07	1.05	4.54	1.09	451.5	.072	0.51	0.43
Stress	19.56	19.93	17.35	18.97	399.5	.393	0.24	0.13
Negative Affect	1.44	0.38	1.40	0.52	433.5	.141	0.41	0.30
Movingly Beautifulness	6.26	0.66	5.81	0.75	430	.092	0.39	0.27
Aesthetic Experience	5.93	0.73	5.42	1.07	451	.062	0.50	0.41
Positive Emotions	6.22	0.85	5.58	1.30	448	.078	0.49	0.40
Negative Emotions	1.70	1.03	1.73	1.08	351.5	.987	0.01	0.05
Post-stress ratings								
Positive Affect	3.39	0.57	3.23	0.61	417	.242	0.33	0.21
Mood	5.44	1.15	5.40	0.92	377	.645	0.13	0.07
Calmness	5.30	1.08	5.06	1.27	376	.658	0.12	0.07
Wakefulness	5.28	1.16	4.65	1.32	444	.097	0.47	0.37
Stress	29.19	25.05	27.27	23.97	366	.796	0.07	0.06
Negative Affect	1.40	0.41	1.45	0.38	383	.572	0.16	0.09
Anxiety	1.86	0.51	1.80	0.49	382.5	.579	0.15	0.08
Movingly Beautifulness	5.67	1.07	5.35	0.98	425	.171	0.37	0.25

Table 5

(continued)

Beautiful artwork	Brought (n = 27)		Selected (n = 26)		*W*	*p*	*d*	*Power*
	M	*SD*	*M*	*SD*				
Post-stress ratings								
Aesthetic Experience	5.25	1.01	4.85	1.16	451	.061	0.50	0.41
Positive Emotion	6.04	0.98	5.70	1.07	434.5	.123	0.42	0.31
Negative Emotion	1.85	1.10	1.81	1.67	364	.809	0.06	0.06

Table 6

Results of Bonferroni corrected Mann Whitney U Tests for group differences (brought vs. selected artworks) regarding ratings in the non-beautiful condition

Non-beautiful artwork	Brought (n = 19)		Selected (n = 34)		*W*	*p*	*d*	*Power*
	M	*SD*	*M*	*SD*				
Pre-stress ratings								
Positive Affect	3.13	0.52	2.96	0.66	413	.273	0.31	0.19
Mood	5.59	0.96	5.27	1.06	420	.210	0.34	0.22
Calmness	5.44	1.18	5.15	1.03	416	.239	0.32	0.20
Wakefulness	4.61	0.99	4.35	1.25	319.5	.473	0.15	0.08
Stress	22.78	20.19	18.89	19.39	398.5	.402	0.23	0.13
Negative Affect	1.53	0.43	1.53	0.56	383.5	.567	0.16	0.09
Movingly Beautifulness	1.41	0.64	1.31	0.68	387.5	.416	0.18	0.10
Aesthetic Experience	2.30	1.30	2.04	1.25	396.5	.400	0.22	0.12
Positive Emotions	1.59	0.97	1.54	1.14	383	.450	0.16	0.09
Negative Emotions	5.30	1.51	4.77	2.05	390	.478	0.19	0.10
Post-stress ratings								
Positive Affect	3.07	0.57	2.87	0.76	402.5	.360	0.25	0.14
Mood	5.19	0.97	4.81	1.17	414.5	.255	0.31	0.19
Calmness	4.63	1.19	5.14	1.21	256	.089	0.48	0.39
Wakefulness	4.89	1.23	4.50	1.13	427	.174	0.39	0.27
Stress	32.37	21.60	29.62	25.15	396	.428	0.22	0.12
Negative Affect	1.58	0.47	1.54	0.55	394.5	.44	0.21	0.11
Anxiety	2.07	0.51	1.96	0.45	419.5	.225	0.34	0.22
Movingly Beautifulness	1.37	0.57	1.35	0.89	393.5	.332	0.21	0.11

Table 6

(continued)

Non-beautiful artwork	Brought (n = 19)		Selected (n = 34)		*W*	*p*	*d*	*Power*
	M	*SD*	*M*	*SD*				
Post-stress ratings								
Aesthetic Experience	1.70	1.03	1.89	1.31	342.5	.874	0.04	0.05
Positive Emotion	1.37	0.74	1.50	1.24	358	.878	0.03	0.05
Negative Emotion	4.85	1.85	4.08	2.06	424	.191	0.36	0.24

Discussion

Stress seems to be an integral part of modern life. Repeated stressor exposure, however, can affect mental and physical health severely (McEwen, 2008). Since tranquilizing medication is associated with various negative side effects (e.g., Bandelow et al., 2015; Olfson et al., 2015; Puetz et al., 2015), non-pharmacological strategies are needed that help dealing with daily stress. Listening to music already appears as an easy-accessible and cost-effective way to reduce the physiological and subjective correlates of stress (de Witte et al., 2018). These stress-regulating effects are frequently attributed to the experience of positive emotions during music listening (e.g., Koelsch, 2014). For eliciting similar positive-emotional states as music (Pelowski et al., 2017), viewing visual art may also efficiently regulate stress and, thus, extend the set of non-pharmacological stress-relieving tools. However, research about the effects of visual art on stress remains scarce. Hence, the present study examined whether viewing art considered as movingly beautiful positively effects stress regulation. Specifically, it was hypothesized that after inducing mild stress (1) viewing movingly beautiful art, as opposed to viewing non-beautiful art, leads to higher levels of positive affect, mood, wakefulness and calmness and, therefore, (2) to lower levels of subjective stress, anxiety, and negative affect. Results showed that participants reported significant higher levels of positive affect, mood, wakefulness, and calmness when viewing beautiful art after and before stress induction compared to viewing non-beautiful art. Moreover, participants reported significant lower levels of subjective negative affect and anxiety when being exposed to beautiful art during stress induction. Contrarily to the expectations, no significant differences were observed in levels of subjective stress between the conditions.

In an exploratory fashion, it was investigated whether stress changes the way we perceive art. Results indicate that beautiful art is perceived as less movingly beautiful and less aesthetical after inducing mild stress, whereas non-beautiful art is perceived as less aesthetical and less negative emotional. Furthermore, I explored via post-hoc analysis if participants who brought the beautiful and non-beautiful artworks differed in effects compared to participants who selected the respective artworks in the laboratory. Results did not show any meaningful differences in ratings between the groups (*brought vs. selected artworks*), neither before nor after stress induction. Subsequently, the results are discussed in more depth.

Viewing visual art increases perceived positive affect and improves mood

Mastandrea et al. (2019) assessed the idea that the positive emotional output elicited from aesthetic experiences, such as being moved from viewing art, may affect mood and indirectly promote health and well-being. Furthermore, Brielmann and Pelli (2017) revealed that feelings of beauty and pleasure are reliably elicited by art considered as movingly beautiful. In line with this notion, the results suggest that viewing art considered as movingly beautiful successfully increases subjective levels of positive affect and mood, calmness, and wakefulness. These effects remain stable even after inducing mild stress, indicating that pleasure and positive affect derived from visual aesthetics superimpose the negative effects of stress. Additionally, the observed medium-to-large effects of visual art on positive affect and mood are comparable to those found when investigating the effects of preferred music on positive emotions and mood (Helsing et al. 2016).

A possible explanation for the increase of positive affect, mood, wakefulness, and calmness when viewing beautiful visual art is provided by the information-processing stage model of aesthetic processing (Leder et al., 2004; Leder & Nadal, 2014). The stage model suggests that a better grasp of an artwork's content and style may evoke feelings of pleasure and positive affect. Accordingly, numerous studies found a positive correlation between ease of processing and pleasure evoked by art (Gerger & Leder, 2015; Mastandrea, 2015; Mastandrea & Umiltà, 2016). Alternatively, experiencing positive emotions may also be the outcome of a special empathetic state provoked by the artwork itself (Leder & Nadal, 2014). Specifically, the model by Pelowski et al. (2017) posits that an art-specific emotional response may be evoked when an artwork is experienced as high schema-congruent and high self-relevant. Artworks that highly resonate with our identity may thus lead to an intense feeling of beauty, which studies found to be correlated with everyday positive emotions like joy and wonder (Menninghaus et al, 2017) as well as with positive affect (Gerger et al., 2018). Nevertheless, our results do not allow drawing firm conclusions regarding the mechanisms responsible for visual art evoking positive-emotional response since we did neither control for perceived degree of ambiguity nor for perceived degree of schema-congruency and self-relevancy within the artworks.

Viewing visual art decreases perceived anxiety and negative affect, but not stress

The models by Koelsch (2014) and Sachs et al. (2015) posit that pleasure and positive emotions evoked by music listening reduce bodily stress responses and aid us in achieving

homeostatic balance. Regarding visual art, Mastandrea et al. (2019) further suggest that pleasure and positive emotional responses while viewing visual art may activate specific brain areas (e.g., amygdala, hippocampal formation, and reward-related brain circuitry) which, subsequently, lead to a decrease of physiological and psychological levels of stress. Accordingly, prior research on the effects of appreciating visual art on parameters of stress found that visiting art museums and galleries reduces bodily and psychological correlates of stress (Clow & Feldhoi, 2006; Mastandrea et al., 2018; Grossi et al., 2019) and that being exposed to visual art with serene content reduces subjective levels of anxiety (Mastandrea et al., 2018). Hence, I hypothesized that viewing visual art considered as movingly beautiful reduces subjective levels of stress, anxiety, and negative effect.

The results regarding the effects of visual art on subjective correlates of stress were only partially in accordance with prior findings. On the one hand, I found that viewing art considered as movingly beautiful leads to lower subjective levels of anxiety and negative affect after inducing mild stress as opposed to viewing non-beautiful visual art. With the observed small-to-medium effect sizes, viewing beautiful visual art seems to exert comparable effects on anxiety and negative affect as listening to music (de Witte et al., 2020). I thus argue that aesthetically pleasing art may aid regulating negative-emotional experiences in a similar fashion as listening to music does (Sakka & Juslin, 2018). On the other hand, however, analyses did not reveal significant differences in mean ratings of subjective stress between the conditions. I assume that this lack of meaningful differences is mainly due to methodological issues since I only operationalized subjective levels of stress with a single VAS.

Although previous validity studies have highlighted its psychometric properties in stress assessment (Lesage et al., 2011; Hulsman et al., 2010; Bement et al., 2010), several empirical findings suggest that the VAS does not capture people's emotional states with sufficient accuracy. For instance, Vickers et al. (1999) found that the VAS is less specific and has worse precision than the Likert scale. Svensson (2000) even argues that a mark on the VAS has no interpretable meaning. Furthermore, in music research, studies reported inconsistent findings when comparing subjective measures of stress to physiological correlates of stress (DeMarco et al., 2012; Gerra et al., 1998; Thoma et al., 2013). Thus, an absence of significant differences in subjective levels of stress does not necessary mean that viewing art has no impact on other physiological parameters of stress (e.g., blood pressure, heart rate, skin conductance, levels of cortisol and alpha amylase). Consequently, future

studies should incorporate several different psychological and physiological measures of stress to get a clearer picture of the effects of visual art on stress regulation.

While I did not observe any significant differences in mean ratings of subjective levels of stress between the conditions, descriptive data showed some differences at interindividual level (see Figure 5). Specifically, more participants in the beautiful (n = 19) compared to the non-beautiful condition (n = 11) rated subjective levels of stress lower after stress induction. This hint that at least for some participants viewing visual art serves as strategy to reduce stress. Hence, future studies should focus on individual factors that might play an important role in potential stress-regulating effects of visual art. For instance, differences in personality and prior experiences with art might moderate respective effects. In this line, Silvia and Nusbaum (2011) found that people high in "openness to experience" as well as art expertise reported more pleasurable chills and feelings of being moved in daily life. Similarly, these individual factors might lead to a more pronounced positive-emotional response when viewing visual art, which eventually supports stress regulation (Mastandrea et al., 2019). However, since art students and professional artists were excluded from this study, art expertise does not hold as explanation for the differences observed in this study.

Stress influences the way we perceive art

In an exploratory fashion, it was investigated if acute stress influences the way people perceived visual art. Prior research regarding the effects of stress on the perception of internal and external stimuli hints at an altered perception of visual aesthetics during stress (Dutton & Aron, 1974; Eskine et al., 2012; Paul et al., 2016). For instance, stress might lead to an increase in perceived negative emotion either due to misinterpreting negative affect and arousal associated with stress as response to an artwork (Dutton & Aron, 1974) or due to stress impairing the cognitive processing of art and, consequently, increasing negative affect and arousal (Paul et al., 2016). Contrarily, stress and anxiety might also lead to a more positive perception of visual art, as Eskine et al. (2012) showed that fear, not happiness or arousal, made participants evaluate art as more sublime.

Results showed that, before inducing stress, beautiful art was rated as more movingly beautiful, more positive emotional and less negative emotional than non-beautiful art. Moreover, the beautiful artwork was associated with a more intense aesthetic experience compared to the non-beautiful artwork. These results are not surprising, since I asked the participants specifically to select one artwork which they consider as movingly beautiful and

one which they do not find beautiful at all. When inducing mild stress, however, the perception of the artworks changed: In both conditions, the participants reported fewer aesthetic experiences when viewing the artworks. Only in the beautiful condition, the artwork was perceived as less movingly beautiful during stress induction. Furthermore, only in the non-beautiful condition inducing stress led to a decrease in perceived negative emotions. Lastly, in both condition inducing stress did not change the perception of positive emotions when viewing the respective artworks.

Researchers have reached a consensus that negative emotions and acute stress are closely associated with each other. For instance, studies revealed that stress can positively predict anxiety symptoms (Fiedler et al., 2005) and anger (Aseltine et al, 2000). This relationship may be due to alterations in the amygdala elicited by stress, leading to an enhanced negative-emotional responding to environmental stimuli (Ferrara et al., 2020). Thus, experiencing stress might lead to an increase in perceived negative emotions in art. Contrary to this notion, however, the results suggest a less negative-emotional experience when viewing non-beautiful art during stress. This finding may be explained by stress reducing cognitive functioning and, thus, impairing the decoding of emotions in artworks. A few studies, for example, have looked at emotional facial recognition in stressed and non-stressed participants and found lower decoding of emotional facial expressions in stressed as opposed to non-stressed participants (Hänggi, 2004; Herridghe et al., 2004). Stress impairing cognitive processing may also serve as explanation for the lower reported movingly beautifulness and aesthetic experiences when viewing self-selected beautiful artworks during stress. Since a satisfactory processing of art leads to positive affect and pleasure (Leder et al., 2004), I suggest that stress hindering cognitive performance may diminish respective effects. Nevertheless, I refrain from making any firm conclusion based on these results. While only using four ratings scales for measuring perceived aesthetics, this exploratory attempt should moreover serve as an early-stage examination of the potential effects of stress on art perception. To provide a better understanding of whether and how stress impacts aesthetic perception, future studies should concentrate on the cognitive processing of artworks during stress, with special focus on perceived ambiguity and emotional content.

No differences in ratings between brought and selected artworks

When comparing ratings between participants who brought the beautiful and non-beautiful artwork to those who selected the respective artworks in the laboratory, no

significant differences were observed, neither before stress induction nor afterwards. This indicates that method of artwork selection did neither influence the effects of visual art on stress-regulation nor the effects of stress on art perception. However, it is important to note that post-hoc power analysis produced low power for the respective effects suggesting that the sample size was too small to find meaningful differences. This does not come as a surprise since power was originally calculated in regard to within-subject designs which require smaller sample sizes to detect statistically significant effects of certain size compared to between-subject designs. The observed results should thus be interpreted with caution.

Limitations and future research

Several limiting factors were present in the current study. Primary among them is the lack of a proper control condition, in which participants are exposed to a neutral stimulus (e.g., blank screen) during stress induction. Thus, the results only allow conclusions regarding differences in stress regulation when viewing art considered as movingly beautiful as opposed to viewing non-beautiful art. I decided not to include a third (control) condition to shorten the study duration and, subsequently, to test more people in less time. Since the testing phase coincided with the outbreak of the coronavirus, I wanted to ensure reaching the planned number of participants in this way. In fact, I was mainly interested in the part pleasure and positive affect plays in the stress-regulating effects of visual art. Thus, having one condition which reliably elicits positive affect, and one which does not, still allows me to meaningfully interpret the results.

As further limitation, I did not include a real baseline measure at which parameters of perceived mood and affect do not differ between the conditions. Specifically, in each condition participants viewed the respective artwork *before* rating mood and affect. Hence, it appears difficult to interpret that viewing movingly beautiful art *leads* to an increase in positive affect and mood. Moreover, the correct interpretation would be that subjective levels of stress, mood and affect differ after viewing movingly beautiful artwork as opposed to viewing non-beautiful visual art. Since prior research found that feelings of beauty and pleasure are reliably elicited by art considered as movingly beautiful (Brielmann & Pelli, 2017), it can still be argued that mood and positive affect increase due to viewing aesthetically pleasing art. The study, however, does not provide solid evidence for this argument. Therefore, future research should include a baseline measure to provide more solid interpretations about the effects of viewing art on mood and affect.

As previously stated, this study only used behavioural measures to capture participants' levels of stress, mood and affect. Moreover, I only used a single VAS to operationalize subjective stress. This sole focus on subjective measures of well-being comes with several downfalls. For instance, ratings scales are affected by numerous systematic biases in respect to psychological factors (Bertrand & Mullainathan, 2001), scale and order (Podsakoff et al., 2003) and others (see section above). To avoid these biases and to get a more extensive understanding of the relationship between the emotional responses to visual art and measures of stress, future studies should include physiological measures of stress, such as levels of cortisol and alpha-amylase, skin conductance, heart rate variability, or respiration rate.

Eventually, the study did not focus on the exact process how visual art elicits positive affect. Prior research suggest that pleasure and positive affect derived from visual artworks may be modulated by emotional responses of the beholder (Menninghaus et al., 2017), may be the result of a successful cognitive (Leder et al., 2004), or may be an outcome of a more complex model (Mastandrea et al., 2019). Hence, future research on the effects of visual art on stress should also explore the relationship between bottom-up stimulus properties and top-down cognitive appraisal on emotional experience during aesthetic appreciation. Thereby, a better insight would be provided on how visual art may serve as strategic tool for promoting well-being and health. As example, the more fluently processing of representational (or familiar) art may induce positive affect and aid in regulating negative emotions (Leder et al., 2004; Sakka & Juslin, 2018). In contrast, establishing a distant perspective when engaging with visual art, such as viewing modern abstract paintings in an art museum, may evoke profound emotional experiences, which restore homeostasis and promote individual well-being (Pelowski et al., 2017; Sachs et al., 2015).

Conclusion

Given the severe consequences of daily stress and its ubiquitous presence in everyday life, cost-effective and easily accessible interventions are needed that help reducing symptoms and promote well-being and health. Viewing aesthetically pleasing art may operate as said intervention as findings revealed significant lower subjective levels of negative affect and anxiety after inducing stress when viewing art considered as movingly beautiful compared to viewing non-beautiful visual art. While having the primary focus on subjective correlates of stress and affect, this study should serve as an important starting point for future research

shedding light on the effects of visual art on various parameters of psychological and physiological stress.

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List of Abbreviations

BMI	Body Mass Index
CI	Confidence interval
CPT	Cold Pressor Test
DSM	Diagnostic and Statistical Manual of Mental Disorders
HPA	Hypothalamus–pituitary–adrenal
LMM	Linear mixed effects model
MDBF	Multidimensional Mood State Questionnaire
PANAS	Positive Affect Negative Affect Scale
SBP	Systolic blood pressure
SNS	Sympathetic nervous system
STAI-S	State Trait Anxiety Inventory-State
VAPS	Vienna Art Picture System
VAS	Visual Analog Scale
WHO	World Health Organization

Appendix

Appendix A: Ethical approval

Acceptance of the study by the Ethics Committee of the University of Vienna

Beschluss der Ethikkommission Decision of the Ethics Committee	universität wien Ethikkommission

Antragsteller / Applicant: **Univ.-Prof. Dipl.-Psych. Dr. Helmut Leder**
Bearbeitungsnummer / Reference Number: **00506**
Projekttitel / Title of Project: **Physiological correlates of art modalities on pain and stress regulation**

Die Stellungnahme der Ethikkommission erfolgt aufgrund folgender eingereichter Unterlagen / The decision of the Ethics Committee is based on the following documents:

19.12.2019

- Antragsformular_Ethikkommission_Art_Music_Pain_Leder
- Questionnaires_Art_Music_Pain_Leder
- TeilnehmerInneninformation_und_Einverständniserklärung_dynamischeKunst_Musik_Stress_Schmerz_deutsch_FINAL
- TeilnehmerInneninformation_und_Einverständniserklärung_Kunstwerke-Schmerz_deutsch_FINAL

10.04.2020

- Antragsformular_Ethikkommission_Art_Music_Pain_Leder
- TeilnehmerInneninformation_und_Einverständniserklärung_dynamischeKunst_Musik_Stress_Schmerz_deutsch_FINAL
- TeilnehmerInneninformation_und_Einverständniserklärung_Kunstwerke-Schmerz_deutsch_FINAL

Die Kommission fasst folgenden Beschluss (mit X markiert) / The Ethics Committee has made the following decision (marked with an X):

☒ Zustimmung: Es besteht kein ethischer Einwand gegen die Durchführung der Studien. / Consent: There is no ethical objection to conduct the study as proposed.

☐ Negative Beurteilung: Der Antrag wird von der Ethikkommission abgelehnt. / Negative evaluation: The proposal is rejected by the Ethics Committee.

Inhaltliche Abänderungen müssen der Ethikkommission vorgelegt werden. / Amendments to the content must be presented to the Ethics Committee.

Unterschrift / Signature	Datum / Date
eigenhändig: Martin Voracek	*20.04.2020*

Vorsitzender der Ethikkommission / Chair of the Ethics Committee
Univ.-Prof. MMag. DDDr. Martin Voracek

Appendix B: Supplementary material

German instructions for artwork selection

Sehr geehrter Herr/Frau NACHNAME!

Vielen Dank für Ihre Teilnahme an unserer Studie **„Visuelle Kunst und Schmerzwahrnehmung“**!

In unserer Studie wollen wir subjektive, ästhetische Erfahrungen untersuchen. Da diese Erfahrung von Person zu Person durch unterschiedliche Reize hervorgerufen werden, möchten wir sicherstellen, dass Sie in unserem Labor ein schönes und ästhetisches Erlebnis erleben werden.

Deshalb bitten wir Sie, uns vorab Ihr **Lieblingskunstwerk** zukommen zulassen, eines, welches sie **bewegt** und ein **schönes Gefühl** in Ihnen auslöst. Hinzu bitten wir Sie, uns ein **weiteres Kunstwerk** zu senden, welches Sie als **nicht schön** beurteilen würden.

Nehmen Sie sich also bitte einen Moment Zeit und überlegen Sie, ob es ein Kunstwerk gibt, das Ihnen wirklich gefällt. Wenn Sie bereits ein Lieblingskunstwerk im Kopf haben sowie eine digitale Version davon auf Ihrem Computer, würden wir Sie bitten, uns dieses via Mail zu senden. Es ist ganz egal, um was für einen Stil oder um welches Motiv es sich handelt, wichtig ist, dass Sie persönlich finden, dass es sich um ein Kunstwerk handelt, das Ihnen gut gefällt, von dem Sie sagen würden, das es Sie wirklich bewegt, weil es schön oder ästhetisch ist.

Um sicherzustellen, dass Sie ein ästhetisches Erlebnis in unserem Setting vernehmen, sollten die Kunstwerke eine Auflösung von **mindestens 720×576 Pixel** besitzen, damit wir es in guter Qualität am Bildschirm zeigen können. Bitte senden Sie das Kunstwerk als *.jpg* oder *.png* Datei mindestens 12 Stunden vor der Testung an folgende Adresse***:*** ***maximilian.hirzer@univie.ac.at***

Sollten Sie keine passenden Kunstwerke finden, werden wir am Tag der Testung im Labor einen Pool an Kunstwerken zur Verfügung stellen. Aus diesem Pool bitten wir Sie, ein äußerst schönes Kunstwerk sowie ein Kunstwerk, das Sie für nicht schön beschreiben würden, auszuwählen.

Denken Sie daran, dass es keine schlechten Kunstwerke gibt. Wählen Sie jenes aus, welches ein besonders schönes Erlebnis vermittelt.

Für die komplette Teilnahme erhalten Sie eine Aufwandsentschädigung von **4 Lab-Credits**.

Sollten Sie noch weitere Fragen oder Anregungen haben, kontaktieren Sie uns einfach über diese Mail-Adresse.

Mit freundlichen Grüßen,

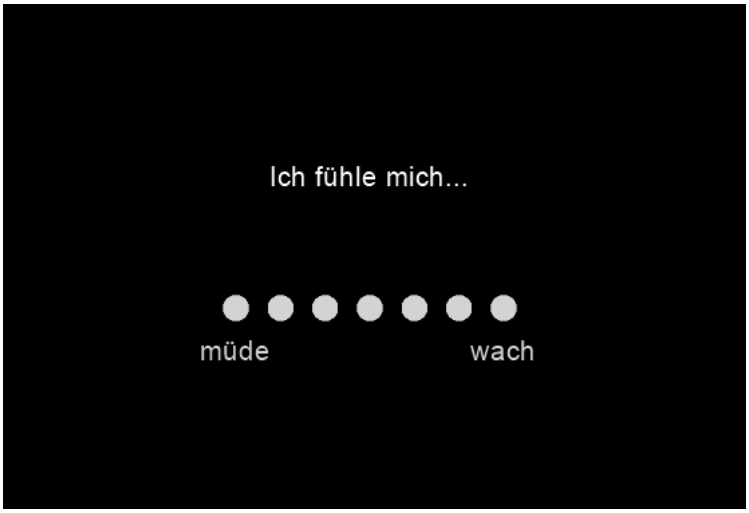
Ihr Studienteam

German instructions for rating scales

MDBF

„Bitte klicken Sie bei den folgenden Aussagen auf den Punkt, der Ihrer persönlichen Einschätzung, wie Sie sich momentan fühlen, am meisten entspricht.“

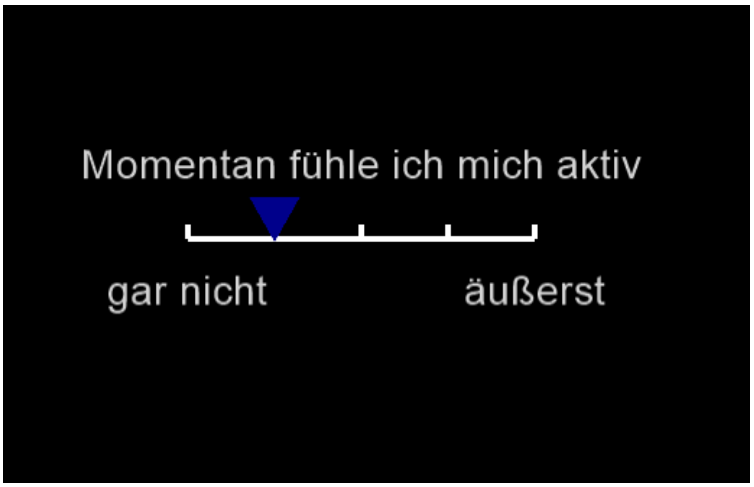
Example of the presentation for the different items



PANAS

“Bitte klicken Sie bei den folgenden Aussagen an der Stelle auf die Linie, die Ihrer persönlichen Einschätzung, wie Sie sich momentan fühlen, am meisten entspricht.“

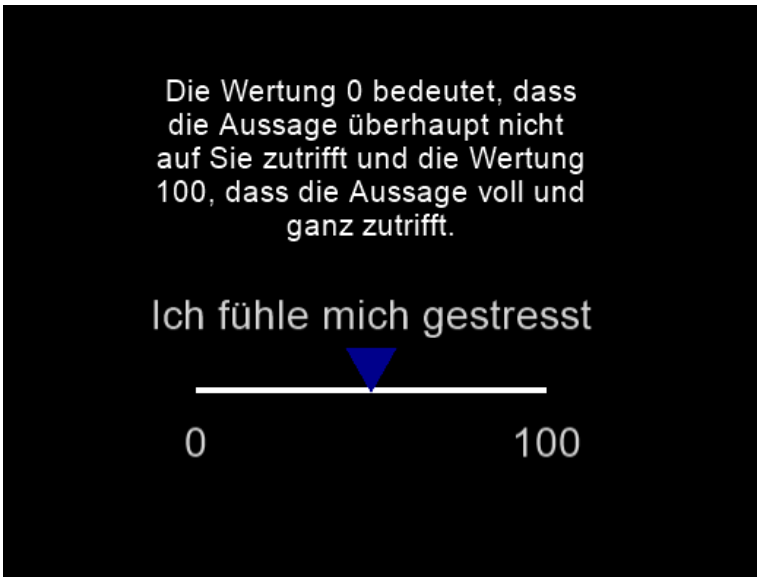
Example of the presentation for the different items



VAS Stress

„Bitte klicken Sie bei den folgenden Fragen an der Stelle auf die Linie, 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."

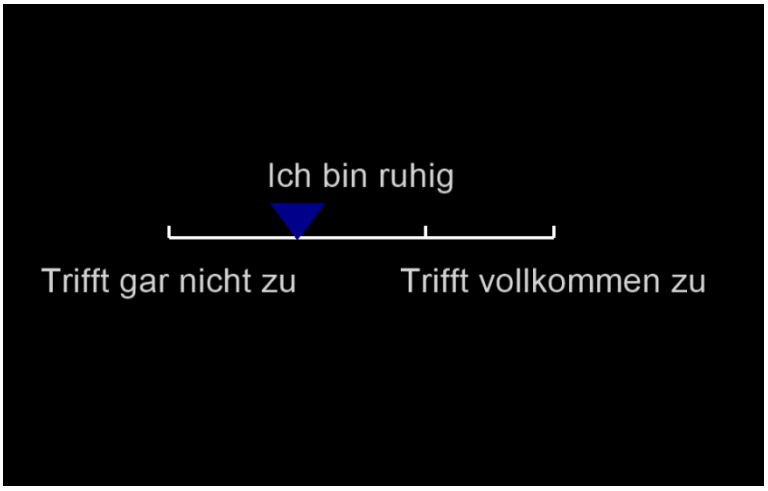
Example of the presentation for the different items



STAI-S

„Bitte beurteilen Sie bei den folgenden Aussagen, wie sehr diese momentan auf Sie zutreffen."

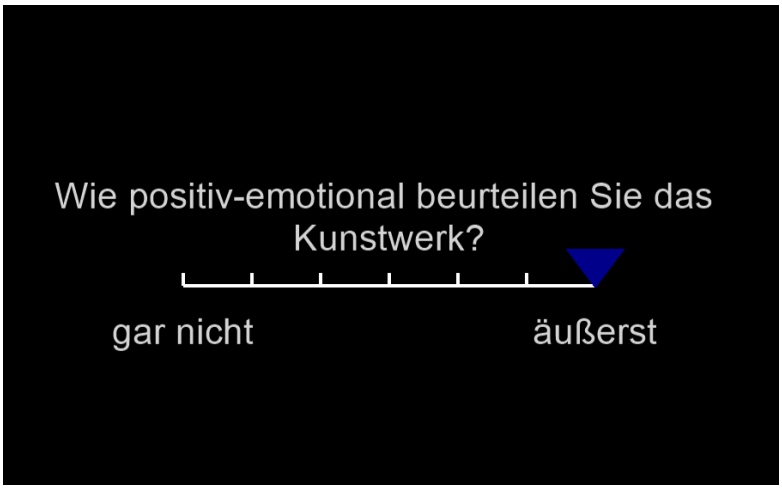
Example of the presentation for the different items



Art perception

„Nun folgen ein paar Fragen zu dem von Ihnen betrachteten Kunstwerk. Bitte klicken Sie bei jeder Frage an der Stelle auf die Linie, die Ihrer persönlichen Einschätzung am meisten entspricht. Denken Sie daran: Es gibt keine richtigen oder falschen Antworten, nur Ihre persönliche Einschätzung ist wichtig.“

Example of the presentation for the different items



German instructions for the CPT

“In diesem Teil des Experiments werden Sie eines der von Ihnen ausgewählten Kunstwerke betrachten. Bevor Sie das Kunstwerk betrachten, bitten wir Sie Ihre rechte Hand in den vorbereiteten Eimer mit kaltem Wasser einzutauchen. Tauchen Sie Ihre Hand bis etwas über das Handgelenk hinaus in das Wasser. Bitte bewegen Sie Ihre Hand während des ganzen Tests nicht und ballen Sie sie nicht zur Faust. Bitte entfernen Sie Ihre Hand aus dem Wasser, sobald die Schmerzen zu unangenehm sind.“

List of artworks from the pre-selection pools

Table 5

List of the artworks in the pre-selection pool selected from the Viennese Art Picture System (VAPS) based on high liking ratings

	***Title* Artist, year**	**Mean Liking Rating**		***Title* Artist, year**	**Mean Liking Rating**
1	*Nighthawks* Edward Hopper, 1942	*M* = 5.50	**8**	*The Calm Sea* Gustave Courbet, 1869	*M* = 5.80
2	*Selbstbildnis mit fiedelndem Tod* Arnold Böcklin, 1872	*M* = 5.40	**9**	*Harvest* Charles-François Daubigne, 1851	*M* = 5.45
3	*Man in a Bowler Hat (Man mit Melone)* René Magritte, 1964	*M* = 5.80	**10**	*Pradera* Alfred Sisley, 1875	*M* = 5.40
4	*River Landscape* Annibale Carracci, 1590	*M* = 5.45	**11**	*Café Terrace at Night (Place du Forum in Arles)* Vincent van Gogh, 1888	*M* = 5.75
5	*Landscape with Tobias and the Angel* Claude Lorrain, 1639	*M* = 5.60	**12**	*The Isle of the Dead (Toteninsel)* Arnold Böcklin, 1880	*M* = 5.40
6	*Landscape with the Ruins of the Palatine* Peter Paul Rubens, 1615	*M* = 5.55	**13**	*The Sacred Grove* Arnold Böcklin, 1882	*M* = 5.45
7	*Der Mönch am Meer* Caspar David Friedrich, 1808-10	*M* = 5.80	**14**	*Ruin by the Sea* Arnold Böcklin, 1881	*M* = 5.70

Table 5

(continued)

	***Title* Artist, year**	**Mean Liking Rating**		***Title* Artist, year**	**Mean Liking Rating**
15	*Tageszeitenzyklus - Der Morgen* Caspar David Friedrich, 1821-22	*M* = 5.90	**23**	*Stiller Tag am Meer III* Lyonel Feininger, 1929	*M* = 5.40
16	*Wanderer* Caspar David Friedrich, 1818	*M* = 5.80	**24**	*Rooms by the Sea* Edward Hopper, 1951	*M* = 5.50
17	*The Harbour of Dieppe* William Turner, 1826	*M* = 5.45	**25**	*The Empire of Light, II* René Magritte, 1950	*M* = 5.75
18	*The Fighting Téméraire tugged to her last Berth to be broken* William Turner, 1839	*M* = 5.60	**26**	*Blood with Tell (La voix du sang)* René Magritte, 1959	*M* = 5.80
19	*The Burning of the Houses of Lords and Commons* William Turner, 1834-35	*M* = 5.23	**27**	*Persistence of Time* Salvador Dalí, 1931	*M* = 5.60
20	*Der hohe Steinberg bei Berchtesgaden* Friedrich Gauermann, unknown	*M* = 5.40	**28**	*Grand Canal* Raphaella Spence, 2007	*M* = 6.00
21	*Memory of Mortefontaine* Camille Corot, 1864	*M* = 5.50	**29**	*Bianco e Negro* Raphaella Spence, 2012	*M* = 5.80
22	*Cliff at Etretat after a Thunderstorm* Courbet Gustav, 1870	*M* = 5.95	**30**	*View from the Artist's Window* Martinus Rørbye, 1825	*M* = 5.90

Table 6

List of the artworks in the pre-selection pool selected from the JenAesthetic dataset based on high beauty ratings

	***Title* Artist, year**	**Mean Beauty Rating**		**Title Artist, year**	**Mean Beauty Rating**
1	*Mother and Child in a Boat* Edmund Charles Tarbell, 1892	*M* = 95	**9**	*View of the Neumarkt in Dresden from the Jüdenhofe* Antonio Canaletto, 1749	*M* = 91
2	*Bacino di San Marco, Venice* Antonio Canaletto, 1783	*M* = 92	**10**	*The Interior of Saint Bavo, Haarlem* Pieter Jansz Saenredam, 1648	*M* = 89
3	*View of İstanbul* Félix Ziem, 1850	*M* = 91	**11**	*Mythological Scene* Dosso Dossi, 1524	*M* = 85
4	*The Quarters behind Alresford Hall* John Constable, 1816	*M* = 90.5	**12**	*Christ in the Desert* Ivan Kramskoi, 1872	*M* = 85
5	*Rye* Ivan Shishkin, 1878	*M* = 88	**13**	*The Indian's Vespers* Asher Brown Durand, 1847	*M* = 82
6	*The Mountain Torrent* Francis Danby, 1830	*M* = 87	**14**	*Woman with a Parasol - Madame Monet and Her Son* Monet, 1875	*M* = 82
7	*Der einsame Baum* Caspar David Friedrich, 1822	*M* = 86	**15**	*Orpheus Leading Eurydice from the Underworld* Jean-Baptiste-Camille Corot, 1861	*M* = 81
8	*Rainy Day, Boston* Childe Hassam, 1885	*M* = 86	**16**	*View on Monmartre* Johan Barthold Jongkind, 1850	*M* = 81

Table 6

(continued)

	***Title* Artist, year**	**Mean Beauty Rating**		**Title Artist, year**	**Mean Beauty Rating**
17	*View of Santa Teresa Convent from the Heights of Paula Matos* Henri Nicolas Vinet, 1863	*M* = 86	**25**	Dancing Fairies August Malmström, 1866	*M* = 81
18	*The Black Sea* Ivan Aivazovsky, 1881	*M* = 85	**26**	*A Dutch Road* Anton Mauve, 1880	*M* = 81
19	*Dream* Joan Brull, 1905	*M* = 85	**27**	*The Landing Stage* Santiago Rusiñol, 1911	*M* = 81
20	*View of Dresden by Moonlight* Johan Christian Dahl, 1839	*M* = 85	**28**	*Italian (active Venice, Rome, and England) - The Bucintoro at the Molo on Ascension Day* Antonio Canaletto, 1745	*M* = 80
21	*The Return of the Flock, Laren* Anton Mauve, 1887	*M* = 85	**29**	*El Archiduque Leopoldo Guillermo en su Galería de Bruselas* David Teniers the Younger, 1652	*M* = 80
22	*Poppy Field* Claude Monet, 1873	*M* = 85	**30**	*Italian Triumph of the Marine Venus* Sebastiano Ricci, 1713	*M* = 79.5
23	*Moscow Courtyard* Vasily Polenov, 1878	*M* = 85	**31**	*The Floor Planers* Gustave Caillebotte, 1875	*M* = 79
24	*The Mirror* Robert Reid, 1910	*M* = 84.5	**32**	*Autoportrait à vingt-quatre ans* Jean-Auguste-Dominique Ingres, 1804	*M* = 79

Table 6

(continued)

	***Title* Artist, year**	**Mean Beauty Rating**		**Title Artist, year**	**Mean Beauty Rating**
33	*Late Autumn Day in the Jægersborg Deer Park, North of Copenhagen* Theodor Philipsen, 1886	*M* = 84	**42**	*The Nurture of Jupiter* Nicolas Poussin, 1630	*M* = 79
34	*The Ninth Wave* Hovhannes Aivazovsky, 1850	*M* = 84	**43**	*The South Ledges, Appledore* Childe Hassam, 1913	*M* = 78.5
35	*Paris Street; Rainy Day* Gustave Caillebotte, 1877	*M* = 84	**44**	*The Fog Warning* Winslow Homer, 1885	*M* = 78
36	*The Rooks Have Come Back* Alexei Savrasov, 1871	*M* = 84	**45**	*Banks of the Loing - Autumn Effect* Alfred Sisley, 1881	*M* = 78
37	*Alyonushka* Viktor Vasnetsov, 1881	*M* = 83	**46**	*Young Girls by the Seaside* Pierre Puvis de Chavannes, 1879	*M* = 77.5
38	*The Entrance to the Grand Canal, Venice* Antonio Canaletto, 1730	*M* = 83	**47**	*Boat Building near Dinan, Brittany* Francis Danby, 1838	*M* = 77
39	*The Grove, or the Admiral's House in Hampstead* John Constable, 1822	*M* = 83	**48**	*The Repentant Magdalen* Georges de La Tour, 1640	*M* = 77
40	*The Spring* Jean Auguste Dominique Ingres, 1856	*M* = 83	**49**	*Flowers and Fruit* Henri Fantin-Latour, 1866	*M* = 77
41	*Landhaus in Rueil* Edouard Manet, 1882	*M* = 83	**50**	*Flora* Tiziano Vecelli, 1517	*M* = 77

Table 6

(continued)

	***Title* Artist, year**	**Mean Beauty Rating**		**Title Artist, year**	**Mean Beauty Rating**
51	*French Landscape with a Calm* Nicolas Poussin, 1651	*M* = 82	**56**	*River Landscape with Ferry* Salomon van Ruysdael, 1649	*M* = 77
52	*St. Paul's Cathedral* Antonio Canaletto, 1754	*M* = 82	**57**	*Indians Spear Fishing* Albert Bierstadt, 1862	*M* = 77
53	*Interesting Story* Laura Muntz Lyall, 1898	*M* = 82	**58**	*Winter Landscape near Vordingborg, Denmark* Johan Christian Dahl, 1829	*M* = 76
54	*Two Sisters (On the Terrace)* Pierre-Auguste Renoir, 1881	*M* = 81	**50**	*Charles-Alexandre de Calonne (1734-1802)* Élisabeth Vigée-Lebrun, 1784	*M* = 76.5
55	*A Calm at a Mediterranean Port* Claude-Joseph Vernet, 1770	*M* = 85	**60**	*A Beech Wood in May near Iselingen Manor, Zealand* P.C. Skovgaard, 1857	*M* = 76

Table 7

List of the artworks in the pre-selection pool selected from the Viennese Art Picture System (VAPS) based on low liking ratings

	***Title* Artist, year**	**Mean Liking Rating**		***Title* Artist, year**	**Mean Liking Rating**
1	*Praise I 1* Bridget Riley, unknown	*M* = 2.10	**9**	*Sitzende Alte* Otto Dix, 1930	*M* = 2.55
2	*Supremus Nr. 50* Kasimir Malewitsch, 1915	*M* = 2.15	**10**	*Three Ways of Being* Maria Lassnig, 2004	*M* = 2.55
3	*Sans Titre* Richard Mortensen, 1953	*M* = 2.20	**11**	*Room Space* Albert Eugene Gallatin, 1937-38	*M* = 2.55
4	*Blue Still Life (Nature morte bleue)* Henri Matisse, 1907	*M* = 2.25	**12**	*Homage to the Square, Decided* Josef Albers, 1951	*M* = 2.55
5	*Selbstbildnis* Lyonel Feininger, 1915	*M* = 2.30	**13**	*Still life mit Blumen und Orangen* Alexej von Jawlensky, 1909	*M* = 2.55
6	*Will to Power* Jean DuBuffet, 1946	*M* = 2.30	**14**	*Proun (Project for Progress)* Eliezer Lissitzky, before 1924	*M* = 2.55
7	*Ohne Titel (mit Reinhard Stangl)* A.R. Penck, 1981	*M* = 2.40	**15**	*Italian Comedians* Jean-Antoine Watteau, 1720	*M* = 2.60
8	*Prato in Maggiatal* Karl Schmidt-Rottluff, unknown	*M* = 2.40	**16**	*Portrait of a Woman* Lorenzo Lotto, 1505-06	*M* = 2.60

Table 7

(continued)

	***Title* Artist, year**	**Mean Liking Rating**		***Title* Artist, year**	**Mean Liking Rating**
17	*Composition* Nicolas de Staël, 1948	*M* = 2.40	**24**	*Italian Woman (Agostina Segatori)* Vincent van Gogh, 1887	*M* = 2.60
18	*Breton Women at a Wall* Émile Bernard, 1882	*M* = 2.40	**25**	*Untitled* Mark Rothko, 1969	*M* = 2.60
19	*Cliffs* Olivier Debré, 1955	*M* = 2.40	**26**	*A Man with a Quilted Sleeve* Tizian, 1511-12	*M* = 2.65
20	*Franz I.* Jean Clouet, 1530	*M* = 2.45	**27**	*Kontra-Komposition V* Theo van Doesburg, 1924	*M* = 2.65
21	*Painting* Arshile Gorky, 1938	*M* = 2.45	**28**	*Bread and Fruit Dish on a Table* Pablo Picasso, 1909	*M* = 2.65
22	*Paysage: Les genêts (Landscape: Broom)* Henri Matisse, 1906	*M* = 2.45	**29**	*Bathers of Beach Scenes* Mark Rothko, 1933-34	*M* = 2.65
23	*Still Life* Giorgio Morandi, 1938	*M* = 2.50	**30**	*Still Life with Grapes and Clarinet* Georges Braque, 1927	*M* = 2.68

Table 8

List of the artworks in the pre-selection pool selected from the JenAesthetic dataset based on low beauty ratings

	***Title* Artist, year**	**Mean Beauty Rating**		**Title Artist, year**	**Mean Beauty Rating**
1	*An Old Woman ('The Ugly Duchess')* Quinten Massys, 1513	*M* = 2	**11**	*The Bay of Marseilles, Seen from L'Estaque* Paul Cézanne, 1885	*M* = 37
2	*Fränzi vor geschnitztem Stuhl* Ernst Ludwig Kirchner, 1910	*M* = 10	**12**	*Lady in Pink* Édouard Manet, 1881	*M* = 37
3	*A l'Opéra [At the Opera]* Édouard Vuillard, 1900	*M* = 13	**13**	*War* Pierre Puvis de Chavannes, 1867	*M* = 37
4	*Still Life with Golden Bream* Francisco de Goya, 1812	*M* = 13	**14**	*Portrait of Pierre Loti* Henri Rousseau, 1891	*M* = 37
5	*Dedham Lock* John Constable, 1820	*M* = 15	**15**	*Girl* Jalmari Ruokokoski, 1913	*M* = 37
6	*Portrait of a white-haired man* Rembrandt Harmensz. van Rijn, 1667	*M* = 15	**16**	*The Bathers* Pierre Auguste Renoir, 1919	*M* = 36.5
7	*L'Après-midi à Naples [Afternoon in Naples]* Paul Cézanne, 1875	*M* = 16	**17**	*The Arlesienne* Vincent van Gogh, 1888	*M* = 36.5
8	*Woman with a Fan* Edouard Manet, 1862	*M* = 16.5	**18**	*The Lion Hunt* Eugène Delacroix, 1854	*M* = 36
9	*Two Girls/Naked GirlsTalking* Ernst Ludwig Kirchner, 1910	*M* = 18	**19**	*Nudes in Studio* Ernst Ludwig Kirchner, 1912	*M* = 36

Table 8

(continued)

	***Title* Artist, year**	**Mean Beauty Rating**		**Title Artist, year**	**Mean Beauty Rating**
10	*Czardas dancers* Ernst Ludwig Kirchner, 1920	*M* = 18	**20**	*Colors from a Distance* Paul Klee, 1932	*M* = 36
21	*Visit to a Museum* Edgar Degas, 1890	*M* = 18	**33**	*Woman in a gothic arcade: woman with flowers* Odilon Redon, 1905	*M* = 36
22	*Madame Cézanne in a Red Armchair* Paul Cézanne, 1877	*M* = 19	**34**	*The Three Marys at the Tomb* Hubert van Eyck or Jan van Eyck or both, 1435	*M* = 36
23	*A Dinner Conversation* Marcellus Laroon the Younger, 1740	*M* = 19.5	**35**	*The Abduction of Ganymede* Rembrandt, 1635	*M* = 35.5
24	*Fishes, wine, frui* Konstantin Korovin, 1916	*M* = 19.5	**36**	*Laocoön* El Greco, 1614	*M* = 35
25	*Self-portrait* Jalmari Ruokokoski, 1914	*M* = 20	**37**	*Sunflowers* Vincent Willem van Gogh, 1888	*M* = 35
26	*After the Bath* Edgar Degas, 1895	*M* = 20	**38**	*Knitting Woman in Pink Dress* Édouard Vuillard, 1905	*M* = 34.5
27	*Portrait of a Young Man* Vincenzo Catena, 1510	*M* = 21	**39**	*Portrait of Madame Cézanne* Paul Cézanne, 1892	*M* = 34
28	*Rembrandt and Saskia in the Scene of the Prodigal Son* Rembrandt, 1635	*M* = 21	**40**	*Rushes by a pool* John Constable, 1821	*M* = 34
29	*A View from Hampstead Heath* John Constable, 1825	*M* = 22	**41**	*Cloud Study* John Constable, 1821	*M* = 34

Table 8

(continued)

	***Title* Artist, year**	**Mean Beauty Rating**		**Title Artist, year**	**Mean Beauty Rating**
30	*Hardship* Isidre Nonell, 1904	*M* = 22	**42**	*Le Grand Baigneur* Paul Cézanne, 1885	*M* = 33
31	*Undergrowth* John Constable, 1821	*M* = 23	**43**	*Nature morte avec trois petits chiens* Paul Gauguin, 1888	*M* = 33
32	*Madonna and the Child [obverse]* Albrecht Dürer, 1499	*M* = 23	**44**	*Woman's face* Alexej von Jawlensky, 1911	*M* = 33
45	*At the factory* Alvar Cawén, 1919	*M* = 23	**53**	*A Centennial of Independence* Henri Rousseau, 1892	*M* = 33
46	*Colonel Alexander Popham, of Littlecote, Wiltshire* Abraham Staphorst, 1665	*M* = 23	**54**	Portrait of Vincenzo Morosini Jacopo Tintoretto, 1580	*M* = 33
47	Arlésiennes (Mistral) Paul Gauguin, 1888	*M* = 23	**55**	*Breton Women with Umbrellas* Emile Bernard, 1892	*M* = 32.5
48	*Still Life with Horse's Head* Paul Gauguin, 1886	*M* = 23	**56**	*Portrait of a Gentleman* Charles Mellin, 1630	*M* = 32
49	*With Red Swallow-Patterned Wallpaper, 1915* Alexei Jawlensky, 1915	*M* = 24	**57**	*Rouen Cathedral, West Façade* Claude Monet, 1894	*M* = 32

Table 8

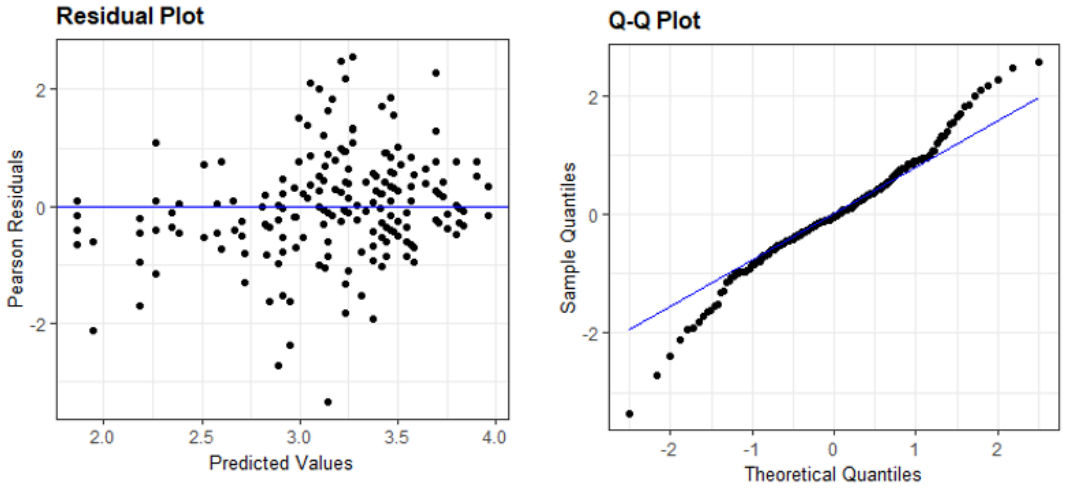
(continued)

	***Title* Artist, year**	**Mean Beauty Rating**		**Title Artist, year**	**Mean Beauty Rating**
50	*Portrait of Madame M* Henri Rousseau, known as le Douanier, 1897	*M* = 24	**58**	*Portrait of a Young Man* Willem Drost, 1654	*M* = 30.5
51	*Charles II* Claudio Coello, 1683	*M* = 24	**50**	*Tree-roots* Vincent van Gogh, 1890	*M* = 30
52	*Jean-Claude Richard, Abbot of Saint-Non, Dressed à l'Espagnole* Jean-Honoré Fragonard, 1769	*M* = 24	**60**	*Festival of Venice* Edmond Aman-Jean, 1923	*M* = 28.5

Linear Mixed-effects Models (LMM): Model diagnostics

Figure 9

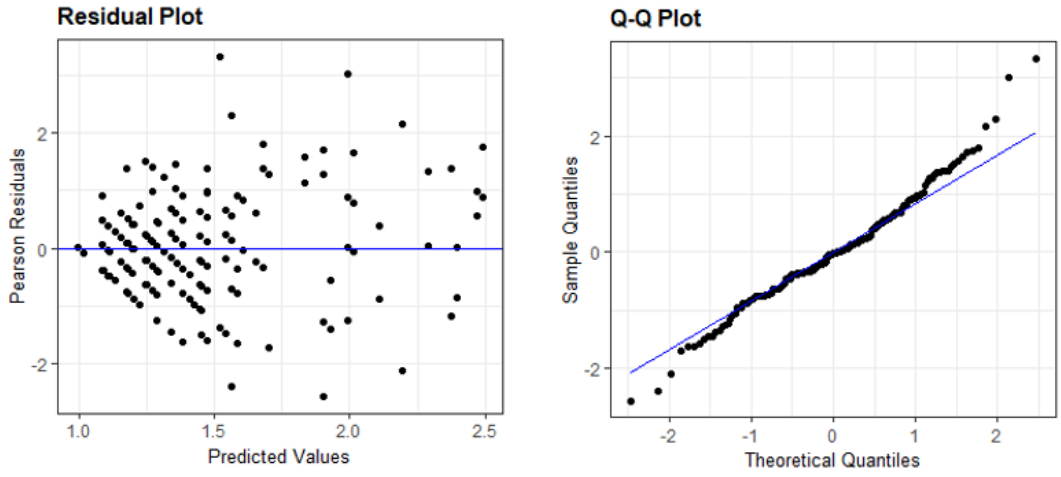
Residual plot and Q-Q plot with positive affect as dependent variable



Note. The residual plot does not indicate any deviations from a linear form. The Q-Q plot (also called a normal probability plot) does not raise any significant concern with normality of the weighted residuals

Figure 10

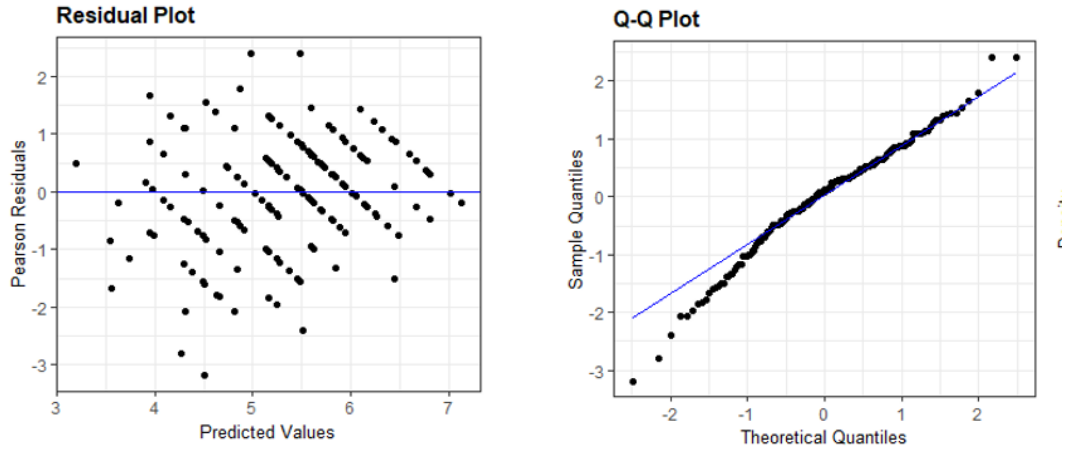
Residual plot and Q-Q plot with negative affect as dependent variable



Note. The residual plot does not indicate any deviations from a linear form. The Q-Q plot does not raise any significant concern with normality of the weighted residuals.

Figure 11

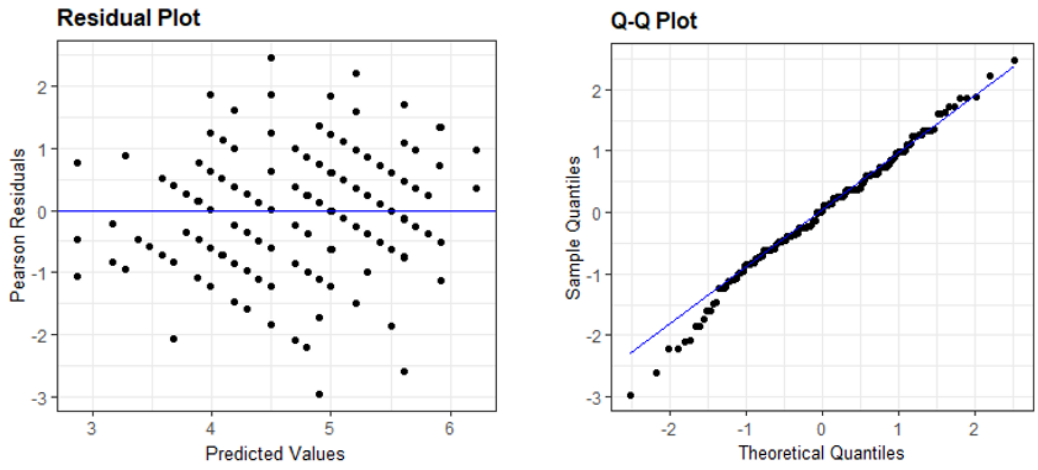
Residual plot and Q-Q plot with wakefulness as dependent variable



Note. The residual plot does not indicate any deviations from a linear form. The Q-Q plot does not raise any significant concern with normality of the weighted residuals.

Figure 12

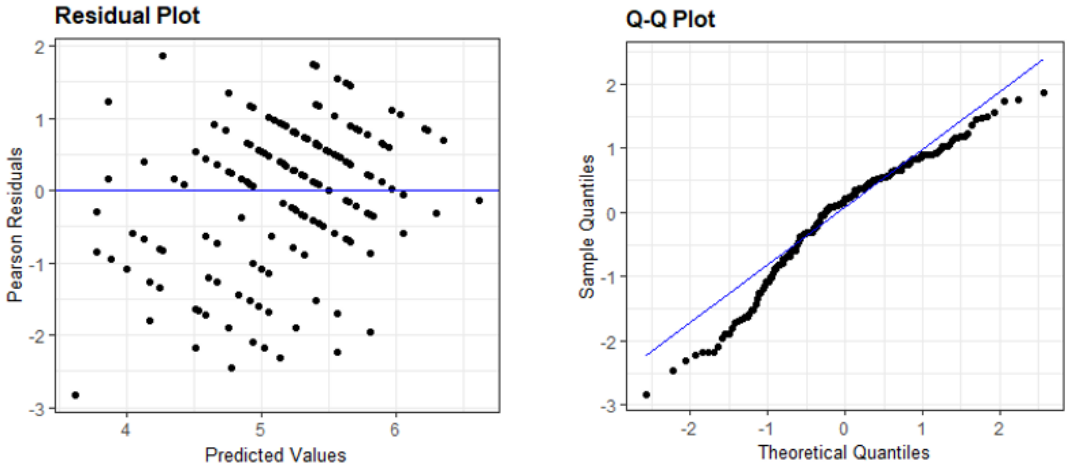
Residual plot and Q-Q plot with mood as dependent variable



Note. The residual plot does not indicate any deviations from a linear form. The Q-Q plot does not raise any significant concern with normality of the weighted residuals.

Figure 13

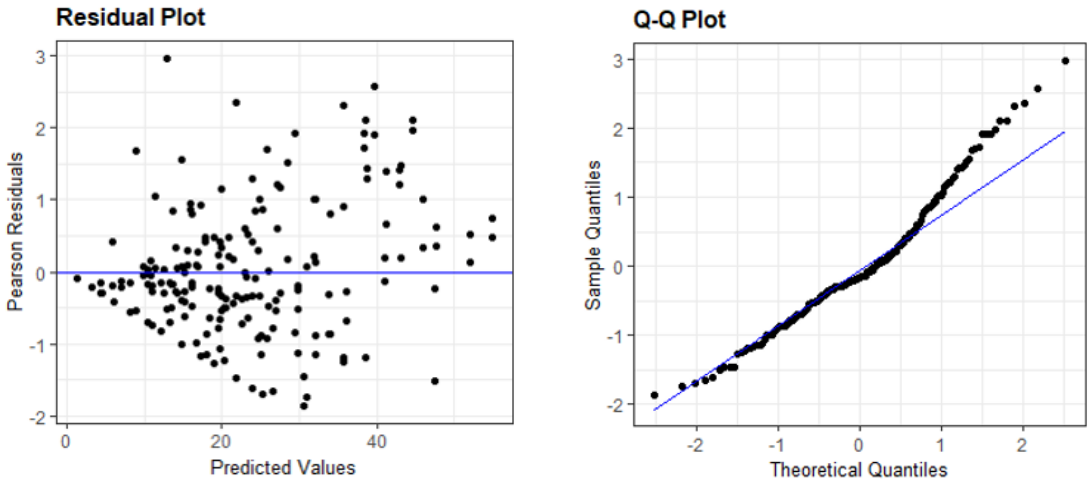
Residual plot and Q-Q plot with calmness as dependent variable



Note. The residual plot does not indicate any deviations from a linear form. The Q-Q plot does show some minor deviations. However, this does not raise any significant concern with normality of the weighted residuals.

Figure 14

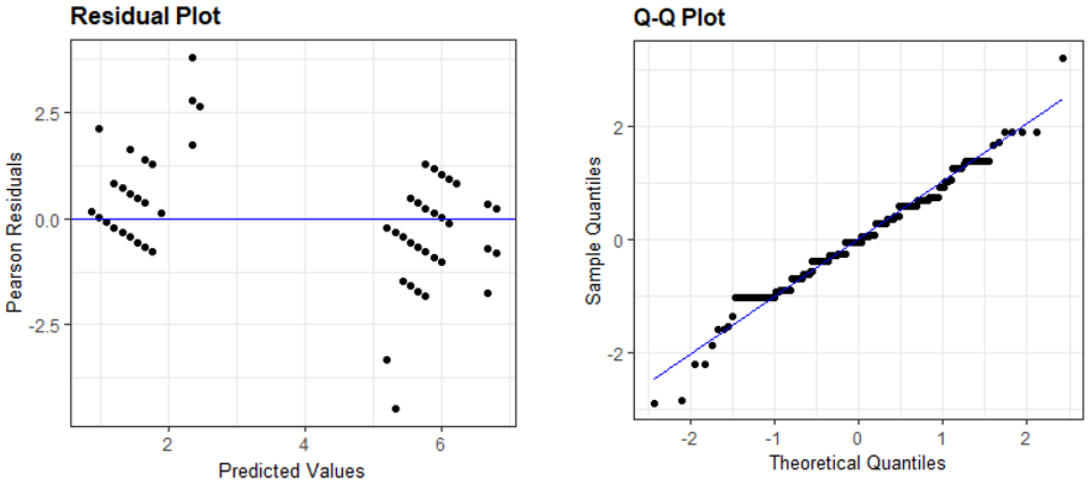
Residual plot and Q-Q plot with perceived stress as dependent variable



Note. The residual plot does not indicate any deviations from a linear form. The Q-Q plot does show some minor deviations. However, this does not raise any significant concern with normality of the weighted residuals.

Figure 15

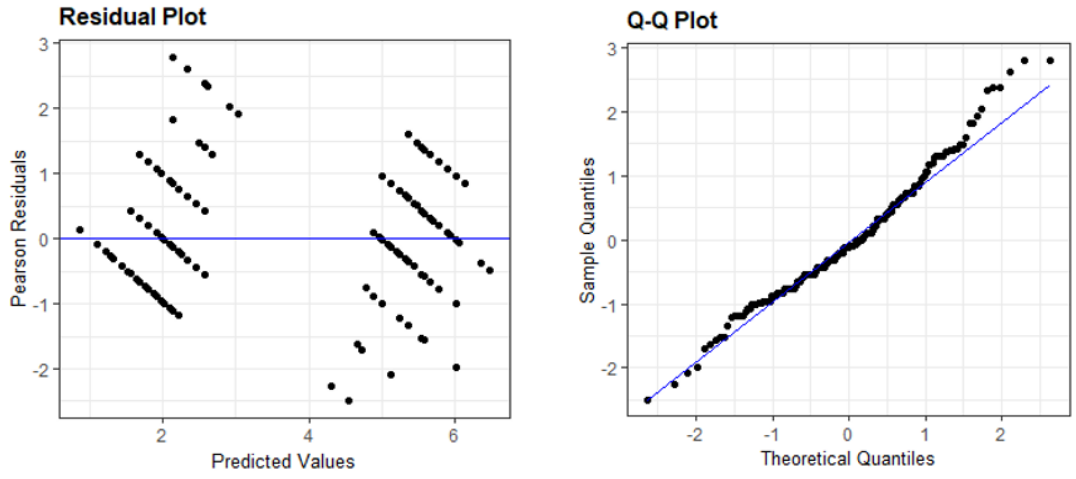
Residual plot and Q-Q plot with perceived movingly beautifulness as dependent



Note The residual plot does not indicate any deviations from a linear form. The Q-Q plot does not raise any significant concern with normality of the weighted residuals.

Figure 16

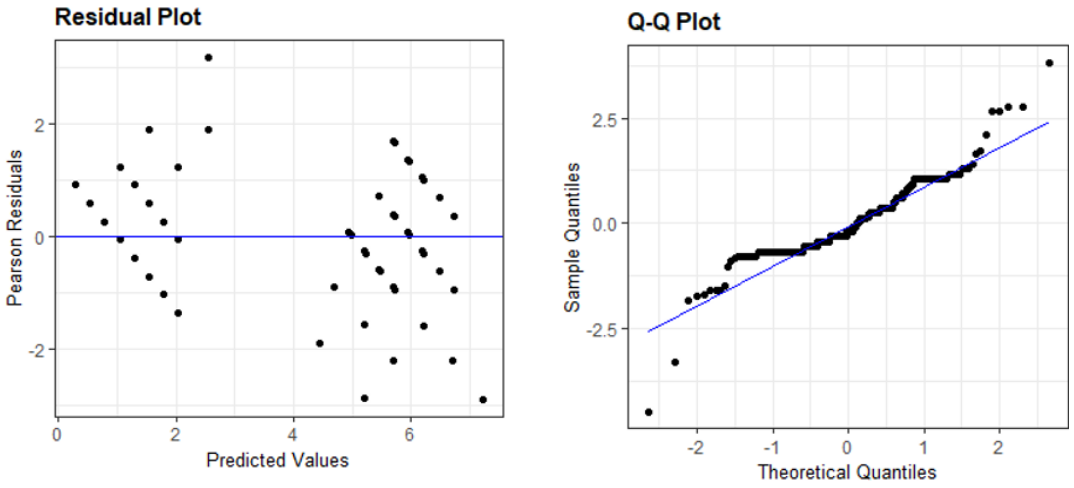
Residual plot and Q-Q plot with perceived aesthetic experience as dependent



Note. The residual plot does not indicate any deviations from a linear form. The Q-Q plot does not raise any significant concern with normality of the weighted residuals.

Figure 17

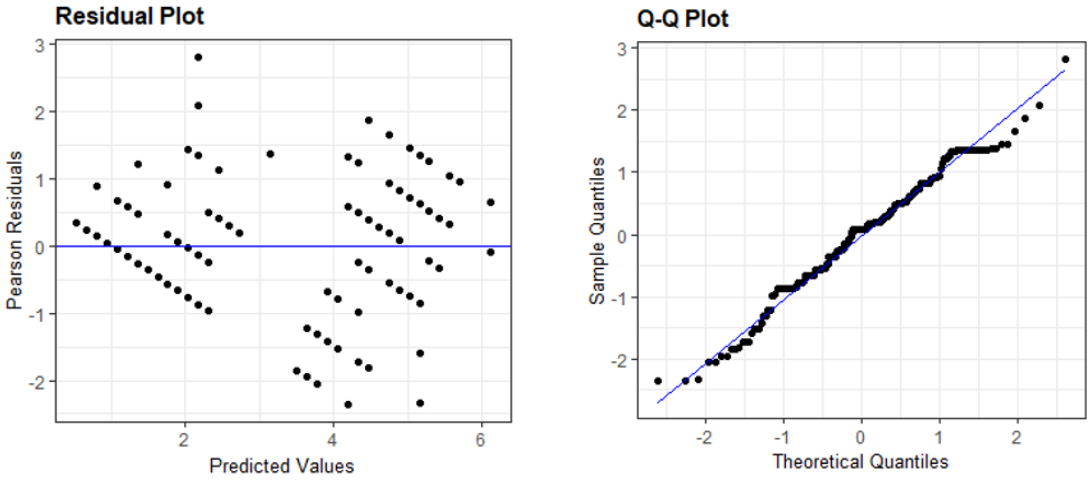
Residual plot and Q-Q plot with perceived positive emotion as dependent variable



Note. The residual plot does not indicate any deviations from a linear form. The Q-Q plot does not raise any significant concern with normality of the weighted residuals.

Figure 18

Residual plot and Q-Q plot with perceived negate emotion as dependent variable



Note. The residual plot does not indicate any deviations from a linear form. The Q-Q plot does not raise any significant concern with normality of the weighted residuals

Appendix C

Abstract

Visual art permeates several aspects of daily life and has historically been associated with pleasure and positive emotions (Robinson, 2004). Through these positive emotions, it could improve health parameters, but so far results remain scarce. To expand the research about the effects of visual art on individual health and well-being, this study examined the effects of viewing art on behavioural correlates of stress. Specifically, I tested if viewing self-selected movingly beautiful visual art – as opposed to viewing self-selected non-beautiful visual art – leads to more positive affect and improved mood and, therefore, reduces subjective stress, negative affect and anxiety after inducing stress. A sample of 53 psychology students were asked to select one movingly beautiful artwork and one non-beautiful artwork. The experiment consisted of two counterbalanced sessions in which mild stress was induced with the cold pressor test while participants viewed either the pre-selected movingly beautiful artwork or the pre-selected non-beautiful artwork. Before and after stress induction, participants rated their subjective levels of positive and negative affect, mood, stress and anxiety. Results show that viewing movingly beautiful art improves mood and positive affect and decreases subjective anxiety and negative affect afters stress induction compared to viewing non-beautiful art. However, no effects on subjective levels of stress were observed. Future research should thus focus on physiological parameters of stress to provide a better understanding of the relationship between aesthetically pleasing visual art and stress.

Zusammenfassung

Visuelle Kunst lässt sich in unterschiedlichsten Orten des täglichen Lebens finden und wird mit Freude und positiven Emotionen in Verbindung gebracht (Robinson, 2004). Durch das Hervorrufen dieser Emotionen könnte sie die Gesundheit verbessern, Forschung hierzu ist allerdings noch spärlich. Um den Forschungsstand bezüglich der Effekte von visueller Kunst auf die Gesundheit zu erweitern, untersuchte diese Studie die Auswirkungen der Betrachtung von Kunst auf unterschiedliche Korrelate von subjektivem Stress. Konkret wurde getestet, ob das Betrachten von selbstgewählter, berührend schöner visueller Kunst – im Gegensatz zum Betrachten von selbstgewählter, nicht-schöner visueller Kunst – zu mehr positivem Affekt und verbesserter Stimmung führt und somit subjektiven Stress, Angst und negativen Affekt nach einer Stressinduktion reduziert. Eine Stichprobe von 53 Psychologiestudent*innen wurde gebeten, ein berührend schönes Kunstwerk und ein nicht-schönes Kunstwerk auszuwählen. Das Experiment bestand aus zwei Sitzungen, in denen milder Stress mit dem Cold Pressor Test induzierte wurde, während die Teilnehmer*innen entweder das zuvor gewählte berührend schöne Kunstwerk oder das zuvor gewählte nicht-schöne Kunstwerk betrachteten. Vor und nach der Stressinduktion wurden positiver und negativer Affekt, Stimmung sowie Stress und Angst der Teilnehmer*innen anhand von Ratingskalen erhoben. Die Ergebnisse veranschaulichen, dass die Betrachtung berührend schöner Kunst – im Vergleich zur Betrachtung nicht-schöner Kunst – die Stimmung und den positiven Affekt verbessert sowie die subjektive Angst und den negativen Affekt nach einer Stressinduktion verringert. Es wurden jedoch keine Effekte von visueller Kunst auf subjektiven Stress beobachtet. Zukünftige Forschung sollte sich daher auf physiologische Parameter von Stress konzentrieren, um ein besseres Verständnis der Beziehung zwischen visueller Kunst und Stress zu erlangen.