Full-Length Article

An Experimental Field Study of the Effects of Listening to Self-selected Music on Emotions, Stress, and Cortisol Levels

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Abstract

Music listening may evoke meaningful emotions in listeners and may enhance certain health benefits. At the same time, it is important to consider individual differences, such as musical taste, when examining musical emotions and in considering their possible health effects. In a field experiment, 21 women listened to their own preferred music on mp3-players daily for 30 minutes during a two week time period in their own homes. One week they listened to their own chosen relaxing music and the other their own chosen energizing music. Self-reported stress, emotions and health were measured by a questionnaire each day and salivary cortisol was measured with 6 samples two consecutive days every week. The experiment group was compared to a control group (N = 20) who were instructed to relax for 30 minutes everyday for three weeks, and with a baseline week when they relaxed without music for one week (before the music intervention weeks). The results showed that when participants in the experiment group listened to their own chosen music they reported to have experienced significantly higher intensity positive emotions and less stress than when they relaxed without music. There was also a significant decrease in cortisol from the baseline week to the second music intervention week. The control group's reported stress levels, perceived emotions and cortisol levels remain stable during all three weeks of the study. Together these results suggest that listening to preferred music may be a more effective way of reducing feelings of stress and cortisol levels and increasing positive emotions than relaxing without music.

Keywords: *music, emotions, stress, cortisol levels.* multilingual abstract | **mmd.iammonline.com**

Music has been shown to be important to people for a variety of reasons, for example to relieve stress, to evoke memories, to express emotions, to get alter mood, and to reduce loneliness [1-5]. Research has also shown that emotion regulation is one of the most important motives for music listening [1-3,6,8]. Effects of music listening on emotions have been described with a variety of measures, including self-reported feelings [9], expressions of emotion [10], regulation [11], physiological responses [12], activation of cortical and subcortical brain regions associated with emotion [13], and action tendency [12]. Research reflects that music primarily evokes positive emotions in listeners [14-16]. Some of the most common emotions experienced during music listening are pleasure, happiness, calm, and nostalgia [1,8,14,17,18].

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Daniel Västfjäll Professor of Cognitive Psychology, Department of Behavioural Sciences and Learning, Linköping University, SE-581 83, Linköping, Sweden E-mail: Daniel.vastfjall@liu.se | COI statement: This research was supported by the Swedish Research Council (VR). The authors have no conflict of interest to declare.

The importance of preferred music

Apart from the music itself, it is essential to consider other factors when studying emotional experiences related to music: the *listener* and the *situation*. Each listener may not, necessarily react in the same way to a piece of music and one piece of music may evoke varying emotions in the same individual at different times. Situational factors may include location, activity [1,5] or other people's presence. Studies have shown that people often experience varying emotions when they listen to music alone as compared with listening to music when other people are present [15,19]. Individual factors may include musical preferences, reasons for listening, and personality [15]. Emotional responses to music are influenced by how much the listener likes the music [14, 20-21]. Research indicates that people tend to like music that evokes emotions, and often favor music that is familiar [22-24]. The impact of having the option to choose the music may affect the response to music [15,25]. When people are provided with the opportunity to select music, they prefer to listen to music that they like, and that tends to result in positive experiencing [26]. The use of people's own preferred music in studies of responses to music has increased in recent years – a fact that

highlights the importance of considering individual differences. Even though there are reportedly components of music (e.g. mode, rhythm, tempo, pitch, harmony) that have been proven to induce certain emotions in listeners [1,9], there is not one type of music that evokes exactly the same emotions in every listener. Positive emotions are often expressed in music with major, high tempo, and high pitch [27], but that does not automatically lead to the *induction* of positive emotions. Emotion induction through music refers to when music evokes emotions in listeners, without focus on the reasons why the emotions were evoked, in contrast to perception of emotions in music, which refers to when listeners perceive or recognize emotions in music, without automatically feeling the emotion [1]. There are musical styles that mainly consist of musical components that express negative emotions (e.g. minor mode; eg. heavy metal), but evoke highly positive emotions in people who preferred that type of music. In encouraging people's choice of which music to listen to, under distinct conditions, the emotional responses will likely be stronger and therefore render higher ecologically validity [15,25,28].

Music and stress

Music listening may provide for opportunities to evoke meaningful associations and emotions, thereby helping to mitigate stress reaction. Research has shown that positive emotional associations may be fundamental for improving both psychological and physical aspects of well-being [29]. The term stress refers to an imbalance between environmental demands and resources available for meeting those demands [30]. The experience of stress is characterized by negative emotions such as fear and tension (e.g., [31]) as well as by heightened levels of physiological parameters such as blood pressure and heart rate [32]. Physiological responses to stress often begin with a perception of stress. The perception leads to activation of the sympathetic divisions of the autonomic nervous system, which stimulate the body's resources to react in stressful situations.

We have earlier found that positive emotions experienced to music minimize self-reported overall stress [14]. Interestingly, a study by McCaffery [33] showed that fast-tempo music was just as effective in reducing stress as slow-tempo music. However, in another study it was found that fast-tempo music reduces stress when the music is the individual's preferred musical taste [34]. This is consistent with research suggesting that listening to preferred music may have the strongest effects on relaxation and stress reduction [35]. According to health psychology research, perceived control play an important role in stress reduction [36]. Labbé, et al. [28] proposed that subject-chosen music is more effective in reducing stress compared to experimenter-chosen music since it give participants some control over the situation by letting them choose music that they find relaxing. In Helsing's et al [37] study of the effects of everyday music listening on recovery after particularly stressful daily events it was found that liking of the music and feelings of control over the situation affected the stress level. The more the participants had liked the music they listened to after a stressful event the less stress they reported to have experienced. The same pattern was seen for perceived control, even though it is possible that it was the feelings of control per se and not in combination with music listening that leads to lower stress levels.

Cortisol, stress and music

Some studies have shown decrease in cortisol levels following positive mood induction or in correlation with trait positive effect [38]. The fight or flight response occurs through two routes: through direct activation of the sympathetic division of the adrenomedullary system which activates adrenal medulla to secrete epinephrine and norepinephrine, and affects the cardiovascular, digestive, and respiratory systems; or through the hypothalamic-pituitary-adrenal (HPA) axis, in which the perception of a threatening event evokes action in the hypothalamus. The hypothalamus response is the release of corticotrophin-releasing hormone, which in turn makes the anterior pituitary to secrete adrenocorticotropic hormone. This hormone stimulates the adrenal cortex to secrete glucocorticoids, including cortisol. The secretion of cortisol raises the level of blood sugar to supply energy for the cells. Cortisol is essential for life. It is involved in a number of vital functions (e.g. modulating central nervous system and immune function, supporting vascular responsiveness, maintaining glucose production from protein, down-regulating inflammatory responses, and facilitating fat metabolism). Cortisol does also have an anti-inflammatory effect [36]. However, chronically elevated cortisol levels may be harmful. Prolonged glucocorticoid exposure can result in for example immunosuppression, muscle atrophy, decreased sensitivity to insulin, impairment of growth and tissue repair, and hypertension [39]. If stress becomes chronic, persistently elevated physiological activation can compromise immune functions and allostatic systems, in turn causing or exacerbating the symptoms of diverse forms of ill health [40]. Studies have shown that cortisol increases in response to laboratory stressors, stressful jobs, stressful activities and daily hassles [41]. Cortisol is secreted in irregular pulses at 1-2 h intervals and it is believed to peak 20-30 minutes after an acute stressor [42]. In adults peak levels of basal cortisol are produced during the last hour of night-time sleep, which leads to high early morning levels that uphold energy levels and stimulate the appetite for carbohydrates. Early morning peak levels decline sharply during the first few hours after sleeping hours [39]. Cortisol appears to be influenced by sleep and light conditions [42]. There is also a gender difference in salivary cortisol, with men showing higher increase than women. Just

the anticipation of an approaching psychosocial stress task has been shown to result in significant saliva cortisol responses in men, but not in women [43]. Caffeine intake can potentially trigger essential mechanisms of the pituitary-adrenocortical response in humans during resting states resulting in increased plasma as well as salivary cortisol levels. Smoking has also been found to affect cortisol levels. After smoking at least two cigarettes, smokers show significantly elevations of salivary cortisol levels [43].

Both Guided Imagery and Music (GIM) and listening to one's preferred music have been seen to result in decreases in cortisol [44]. Khalfa, Bella, Roy, Peretz and Lupien [45] (2003) found that listening to relaxing music was more effective than silence in decreasing cortisol after a stress induction. Listening to classical music has also been found to reduce cortisol levels [46]. Several studies have also shown that music reduced stress and cortisol levels before, during and after medical procedures (see [47]).

Overview of the present study

The focus in most studies in this area has been on the effect of music listening on self- perceived stress and cortisol levels during certain stressful situations (e.g. prior, during or after surgery or dental care) or after a stress induction. The main aim with the present study was to examine whether listening to preferred music, is an effective way of reducing stress in everyday life. This experimental study took place in the participants' own homes which provided a setting more comparable to real life than a laboratory study would have.

The present study addresses the following hypotheses:

1. Music listening will lead to less stress than relaxation without music.
2. Cortisol levels will be lower after music listening than after relaxation.
3. Music listening will evoke positive emotions more frequently and more intensively than relaxation.
4. Music listening will affect the participants' perception of to what extent their physical complaints affect their daily activities (SIC impact scores) in a positive way.

Ethics statement

Experiments were conducted in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki. Studies were approved by the local ethics committees where the data was collected (Västra Götalands regional ethics board). Participants were compensated for their participation and gave their informed consent prior to inclusion in the study. Participants received information about the study prior to participating. After completing their task, participants were thoroughly debriefed.

Method

Subjects

41 women participated in the study. They were between 25 and 45 (M = 32) years old and they were randomly assigned to the experiment group (music listening, N = 21) or the control group (relaxation, N = 20). 39 % worked as teachers, 34 % worked within health care, 7 % worked in social care, and the remaining 20 % worked within other fields. Nineteen participants were single, fifteen lived together with their partner, four had a partner but did not live together, two were married and one was divorced. 81 % were born and raised in Sweden. The participants were informed that their replies would be treated on an anonymous and statistical basis only.

Questionnaires

The participants were instructed to fill out a daily questionnaire for a 3 week time period (including weekends). The questionnaires involved questions about the daily music listening (for experiment group) or the relaxation (for the control group and for the experiment group during the first week), ratings of current emotions (a short version of Positive Affect Negative Affect Scale; see [16]), and experience of stress and feelings of control (both rated on 1-7 Likert scales.). To measure stress more comprehensively the Perceived Stress Scale (PSS; [48]) was used. The PSS is one of the most widely used psychological instrument for measuring perception of stress. It measures the degree to which situations in the respondents life are appraised as stressful. Finally, a self-report measure of health, the Symptoms of Illness Checklist (SIC; [49]) was included. In the present study the impact version of the Symptoms of Illness Checklist (SIC) was used in the daily questionnaires. The impact version of the SIC is supposed to measure to what extent different physical complaints (e.g. sore throat, back problems, abdominal pain, fever) affect the daily activities. In the original SIC, which was used in the background questionnaire, both frequency and impact of physical complaints during the last two month are measured, but in the daily questionnaire which was used in the present study the participants were instructed only to consider to what extent different physical complaints affected their daily activities that day. We believe that even though the original SIC was not intended to necessarily be utilized on a daily basis- that nevertheless, it would serve as a good indicator of how they felt physically each day. Everyone does not experience different physical complaints, for example headache or a runny nose, exactly the same way. We hypothesized that the mean value of the impact version of the SIC for each week would correlate positively with how much stress the participants had experienced weekly since stress might influence health and poor health may be stressful in

itself.

Every Thursday during the three weeks a somewhat extended version of the daily questionnaire was used since the participants were instructed to leave samples of cortisol on Thursdays (see Procedure). The extended version of the daily questionnaire involved questions about the cortisol tests (if the participants had done the tests and how they had experienced the sampling procedure), perceived stress and control during the whole day as oppose to at that moment, and experienced emotions and arousal during specific times during the day (in the morning, on the way to work, at work, and when arriving home from work).

Procedure

The participants were recruited through an advertisement in a local paper (Göteborgsposten), an advertisement in the Swedish union of teachers' newspaper (in Swedish: Lärarnas) and through contact with schools and other workplaces in the Gothenburg area. Women who wanted to participate were asked to contact the author. The screening process excluded those who worked night shifts, did not work full time, would not work three weeks in a row during the study, smoked, consumed a lot of coffee or other drinks high in caffeine, were pregnant, and those who took some prescription medicine (including antidepressants) or medicine for allergy.

The selected participants were randomly assigned groups. Both groups received an email which said that they should contact the first author for a meeting at the Department of Psychology in Gothenburg. The experiment group's email also said that they should pick out 20 pieces of music that they like to listen to; ten relaxing pieces and ten energizing pieces, and bring the music to the meeting (on a USB memory or CDs, or write a list so the author could download the music from Itunes Store). When the participants arrived to the meeting at the Department of Psychology they were informed about the study and were asked to fill out the background questionnaire. The music that participants assigned the experiment group had brought with them was transferred to the author's computer as they filled out the background questionnaire. When signing up for the study, participants agreed to relax/listen to music 30 minutes per day. Thus, roughly 30 minutes of participants own music was transferred onto two mp3-players (one with the relaxing music and one with the energizing music). The decision of the final sample, and order, of music, was made in agreement with the participants. A fixed order of music was used for each participant.

Music listening

Participants in the experiment group were informed that they were supposed to relax for half an hour every day, when coming home from work, during the first week. At the end of that week they would receive an mp3-player by mail, with their own chosen music, which they would start listening to on the following Monday (for half an hour). At the end of the second week of the study the second mp3-player would arrive by mail. The experiment group was told that they should listen to the music for 30 minutes per day, including weekends, when arriving home from work. They were instructed that they should preferably just sit down and listen to the music, but it was also acceptable to do some light housework (e.g. doing the dishes or preparing dinner). They were informed that they were not allowed to watch TV during this time. The experiment group was randomly divided into two groups: the first group got to listen to their relaxing music the first music intervention week and the energizing music the second music intervention week (and the other way around the other half of the experiment group).

Relaxation

Participants in the control group were told that the study would take place in their own home during three weeks and that they were expected to to sit down and relax for half an hour every day when they had arrived home from work (including weekends). They were given instructions of how they could relax (e.g. knit, read a paper, meditate, or pet the cat) and of what they should not do during the relaxation (e.g. listen to music, watch TV, play computer games, or lay down).

Cortisol tests

All participants were informed that they should leave six saliva samples once a week (every Thursday afternoon and evening, and Friday morning) to measure cortisol levels. The saliva was collected using the Salivette system (Sarstedt, Newton, NC) which involves chewing on a cotton roll for about a minute. They were instructed to do this six times: 1) when coming home from work before music listening/relaxation, 2) after the music listening/relaxation, 3) in the evening (before going to bed), 4) just as they woke up the next day (preferably still laying down in bed), 5) when getting out of bed, and 6) 45 minutes later after getting out of bed. Participants were all had similar working hours (8-9 hours per day between 8AM-5PM) and woke up roughly at the same time in the morning (7AM). There was variation in the number of hours of sleep (5-9 hours) as well as sleep quality. However, controlling for the number of hours of sleep did not change any of the results.

The 18 tubes containing the cotton rolls were pre-labelled and placed in three labelled plastic zipper bags, one for each week, and the bags were placed in a cover along with the daily questionnaires. They were instructed not to eat or drink anything or brush their teeth 30 minutes before leaving a sample. If they had rinsed their mouths with water they were instructed to wait five minutes before leaving a sample. The saliva samples were stored in the participants' freezers until retrieved when the study had ended and then stored in a freezer at the Department of Psychology in Gothenburg and later shipped to a laboratory in Germany for analysis. Information about the study, instructions how to leave and store the saliva samples, instructions how to use the mp3-

player (for the experiment group) and contact information were placed in the cover as well. Each Thursday morning the participants received a text message which reminded them that they should leave cortisol samples before and after the relaxation or music listening, and one in the evening, and later that day they received another test message reminding them do leave the cortisol samples the next morning. Not all participants began the study the same week, but everyone started on a Monday. When the study was over the author contacted each participant to make an appointment for retrieving the covers with the questionnaires and saliva samples at the participants' home or workplace.

Results

Among all participants, the most common activities for relaxation during the spare time were watching TV, socializing with friends or family, or reading a book/magazine. Listening to music was the 7th most common activity for relaxation (out of 20 options). 57 % of the participants in the experiment group reported that they listen to music during their spare time to relax, compared to 40 % of the participants in the control group.

Perceived stress

During the first week the experiment group experienced more stress (which from here on will be referred to as 'stress right now') ($M = 2.63$, $SD = 1.07$) compared to the control group ($M = 1.92$, $SD = 1.17$, $t = 2.03$, $p < .05$). The experiment group did also score significantly higher on the Perceived Stress Scale ($M = 14.12$, $SD = 3.33$) than the control group ($M = 11.26$, $SD = 5.03$, $t = 2.13$, $p < .05$) during the baseline week. This shows that the groups were not equally stressed during the baseline week. During the intervention weeks no significant differences were found in either 'stress right now' or PSS between control and experiment groups (between-groups analyses). However, in within-subjects analyses, matched pair t-test showed that the PSS scores for the experiment group was significantly lower the second intervention week ($M = 12.49$, $SD = 4.58$) compared to the baseline week ($M = 14.12$, $SD = 3.33$, $t = 2.42$, $p < .05$). There was a slight difference in PSS scores between the baseline week and the first intervention week for the experiment group, but this was not significant. No such decrease in PSS scores were seen in the control group (see Figure 1). There were no significant differences in self-reported experienced 'stress right now' between the baseline week and intervention weeks.

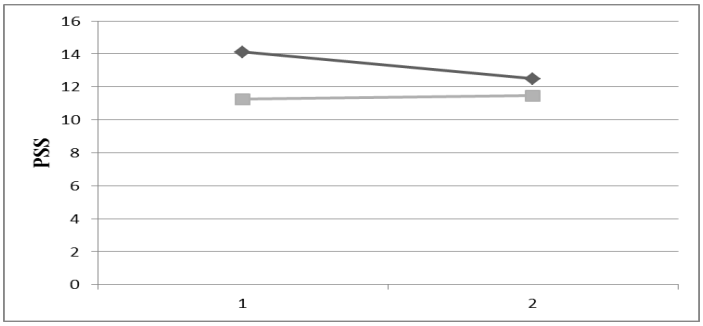

Figure 1. Change in Perceived Stress Scale scores from the baseline week to the second intervention week. The dark line represents the experiment group and the light line the control group.

Cortisol levels

Several comparisons between the groups were made using different measures of cortisol reactivity: 1) area under the curve with respect to ground (AUCg) [50], 2) awakening cortisol (i.e. mean of the three morning cortisol samples) and 3) intervention effect (i.e. before music listening/relaxation minus after music listening/relaxation). A base 10 logarithmic transformation was used prior to analyses since raw cortisol levels are typically highly skewed. There were no significant differences in AUC between the groups during any of the weeks, although the experiment group's AUC decreased from the baseline week ($M = 4.40$, $SD = 0.86$) to the second intervention week ($M = 4.03$, $SD = 0.69$, $t = 2.08$, $p = .051$), whereas the control group's AUC was relatively stable from the baseline week ($M = 4.16$, $SD = 0.81$) to the second intervention week ($M = 4.21$, $SD = 0.99$, $t = -0.25$, $p > .05$) (see figure 2). However, in a 2 (week) x 2 (group) ANOVA the interaction did not reach significance, $F(1, 39) = 2.27$, $p > .05$.

The experiment group and control group's awakening cortisol level was close to identical during the baseline week, but during the first intervention week the experiment group's awakening cortisol level increased whereas the control group's awakening cortisol level decreased, although not significantly. However, there was a significant difference in awakening cortisol level between the experiment group ($M = 1.27$, $SD = 0.15$) and the control group ($M = 1.14$, $SD = 0.19$, $t = 2.38$, $p < .05$) during the first intervention week. During the second intervention week the opposite occurred, the experiment group's awakening cortisol level decreased and the control group's awakening cortisol level increased, although, the changes were not significant.

In summary, there was no significant intervention effect between the control and experimental groups during any of the weeks. Similarly, there were no significant changes in AUC (i.e. from the baseline week to the intervention weeks or between intervention weeks) in within either the experimental or control group. However, the experiment showed a larger immediate decrease in cortisol when they had relaxed during the baseline week compared to when they had listening to

music. The control group, on the other hand, showed a smaller immediate effect of relaxation on cortisol.

In further support of a positive effect of music on cortisol and stress the experiment group's cortisol levels correlated positively with both PSS scores and 'stress right now' during the intervention weeks. The strongest correlations were found between awakening cortisol and 'stress right now' during both weeks (see Table 2 and 3). The control group's correlations between cortisol and perceived stress were not as strong.

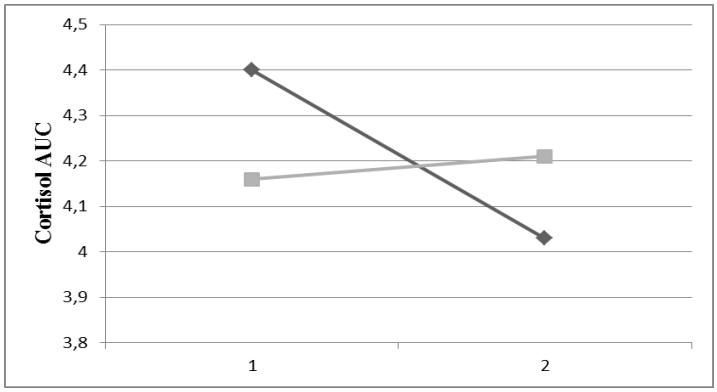

Figure 2. Change in cortisol AUC from the baseline week to the second intervention week. The dark line represents the experiment group and the light line the control group.

Experienced emotions

There were no significant differences in how often or intensively positive emotions were experienced during any of the weeks between the experiment group and the control group. However, the experiment group experienced positive emotions somewhat more intensively than the control group during the intervention weeks (the experiment group experienced positive emotions significantly more intensively during both intervention weeks (M = 3.67, SD = 0.89; M = 3.76, SD = 0.98) compared to the baseline week (M = 3.32, SD = 1.08, t = -.2.35, $p < .05$; t = -2.30, $p < .05$). No such increase of intensity of positive emotions was found for the control group (see figure 3)).

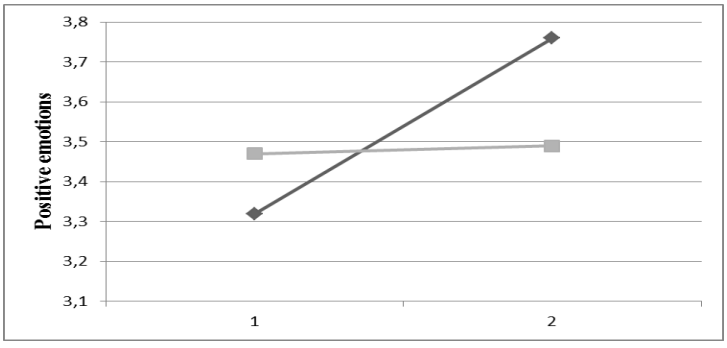

Figure 3. Change in intensity of positive emotions from the baseline week to the second intervention week. The dark line represents the experiment group and the light line the control group.

Relations between stress, emotions, perceived control, cortisol levels and health

During the baseline week all participants' (both groups) intensity of positive emotions correlate negatively with their PSS scores and ratings on 'stress right now'. Perceived level of control correlated significantly negatively with perceived stress (both 'stress right now and PSS) and positively with positive emotions. Scores on the impact version of the SIC correlated positively with perceived stress (both PSS scores and 'stress right now'), and negatively with positive emotions and perceived control (see Table 1)

When looking at the groups separately during the intervention weeks, surprisingly, the experiment group's ratings on 'stress right now' and their reported intensity level of experienced positive emotions did not seem to be correlated during the second intervention week and only weakly positively correlated during the first intervention week, whereas the within the control group negative correlations were seen for both weeks. The control group's scores on the PSS and their experienced positive emotions correlated negatively during both weeks, whereas for the experiment group, a rather small negative correlation was found for the first intervention week and a correlation close to null for the second intervention week. Negative correlations were found for both groups between perceived control and perceived level of stress (both 'stress right now' and PSS). The experiment group's amount of perceived control did not correlate with how intensively they had experienced positive emotions during the first intervention week and only a weak positive correlation was found for the second intervention week, whereas the control group's experienced control correlated positively with positive emotions both weeks. Both groups' SIC scores correlated significantly with their PSS scores and with their ratings on 'stress right now' during both intervention weeks (see table 2 and 3). Results from Fischer's Z-test showed that the magnitude of the negative correlation between 'stress right now' and control during the first intervention week was significantly stronger for the control group (r = -.923) than for the experiment group (r = -.560, z = 2.89, $p < .01$). This was the only significant difference in magnitude of the correlations between the groups, although the correlation between positive emotions and 'stress right now' during the second intervention week, where the control group's correlation was negative and the experiment group's was close to null, was close to significant.

Relaxing music versus energizing music

The experiment group scored somewhat higher on the PSS when listening to their energizing music, and significantly higher during the baseline week when they relaxed without music (M = 14.12, SD = 3.33), than the control group (M = 11.26, SD = 5.03, t = 2.15, $p < .05$), but when they listened to their relaxing music they scored about the same as the control group. A comparison between PSS scores within the

experiment group showed that the relaxing music was related to lower PSS scores (M = 12.01, SD = 4.53) than the energizing music (M = 13.67, SD = 4.53, t = -2.17, p < .05). The experiment group reported to experience positive emotions significantly more intensively during the week when they listened to the relaxing music (M = 3.77, SD = 0.98) compared what they reported to experience during the baseline week (M = 3.32, SD = 1.08, t = -2.75, p < .05). Positive emotions were also more intensively felt when listening to energizing music compared during the baseline week, but the difference was only close to significant. There was no difference in how intensively positive emotions were experienced when listening to the relaxing music compared to the energizing music. Moreover, there were no significant difference between scores on the SIC or ratings on 'stress right now' when listening to the relaxing music compared to when listening to their energizing music.

Discussion and Conclusions

Previous studies have shown that listening to music may result in lower stress levels [28,35,44,51]. However, the majority of these studies have examined the effects of music on stress and/or cortisol levels in relation to certain stressful situations (e.g. dental care or surgery) or after different kinds stress inductions (e.g. speech task). The focus of the present study was on the effect of music on the experience of everyday stress. Instead of investigating the effect music listening have after one single stress induction, in the present study the participants' experiences were recorded everyday for three weeks time, including one baseline week without music intervention. Additionally, instead of comparing the experiment group (who listened to music every day for 30 minutes) to a control group who did not do anything during the three week the study went on, the control group was instructed to actively relax for 30 minutes every day. This provided the opportunity to not only explore the effects of music on everyday stress and cortisol levels, but to compare the effects of music listening to the effects of active relaxation.

Experienced emotions
We hypothesized that music listening would evoke more positive emotions than relaxation, since research has shown that music primarily evokes positive emotions [14,16] and we found partially support for this. There were no significant differences between the experiment group and the control group in either frequency or intensity of positive emotions during any week. However, a significant increase in how intensively positive emotions were experienced was found within the experiment group from the first week when no music occurred to both intervention weeks when participants listened to their own chosen music. Interestingly, no increase of intensity of positive emotions was found for the control group. This supports the notion that listening to one's own preferred music (independent of whether the music was relaxing or energizing) evokes more intense positive emotions than ordinary relaxation without music.

Perceived stress
We also hypothesized that the music listening group would experience less stress than participants in the relaxation group. The result showed a similar pattern as the positive emotions. Even though the experiment group reported significantly more stress than the control group during the first week when both groups relaxed without music, there were no significant differences between them during the intervention weeks. But, as with intensity of positive emotions, a time change could be seen within the experiment group - their scores on the PSS decreased significantly from the first to the third week. Most importantly, as with the intensity of positive emotions, this decrease was not found for the control group, whereby the PSS scores were stable throughout the study. This suggests that actively listen to one's own chosen music may reduce perceived stress. However, an important caveat to consider is that the PSS scores were significantly higher than the control group's in the initial week.

Cortisol levels
A particularly important hypothesis that was tested in the present study was that cortisol levels would be lower after music listening compared to after relaxation. The results showed that the experiment group's cortisol AUC decreased from the first week, when they only relaxed, to the third week, when they had listened to music every day for almost two weeks time The control group's cortisol AUC did however remain at the same level throughout the study, and there was even a slight, but not significant, increase between the first and third week.

The experiment group's decrease may, as the decrease in PSS scores, be partly due to their high cortisol AUC during the baseline week and might therefore partially be a result of regression to the mean. However, since both cortisol AUC and PSS scores showed a similar decrease from the first to the third week for the experiment group, the observed effect is more likely due to that music is more effective in reducing stress than relaxing without music. Further, the results showed no significant differences in intervention effect (i.e. cortisol change) before music listening/relaxation to after; neither between, nor within groups. It even seemed as though the intervention effect for the experiment group was larger during the baseline week when they relaxed than during the two weeks when they listened to their own chosen music.

For awakening cortisol, the two groups showed opposite patterns. Their baseline awakening cortisol level was close to identical, but during the first intervention week the experiment group's awakening cortisol level increased whereas the control group's awakening cortisol level decreased and during the second intervention week the

experiment group's awakening cortisol level decreased and the control group's awakening cortisol level increased. These changes from week to week were not significant but the experiment group's awakening cortisol level was significantly higher than the control group's during the first intervention week. Thus, music may initially lead to stronger activation of the HPA axis (in terms of energized/aroused feelings of both negative and positive valence), but over time lead to a decrease in negatively valenced arousal. One speculation is that listening to one's own chosen music might have a more long-term effect on cortisol levels than an immediate effect, but more research is needed to further corroborate this finding

Relations between stress and emotions

Stress is among other things defined as experiencing negative emotions such as tension [31], and experiencing positive emotions is thought to benefit both our psychological and physical health [29], so therefore should positive emotions and stress be negatively correlate: the more stress, the less positive emotions, and the more positive emotions, the less stress. The results showed that all participants' (both groups together) intensity level of positive emotions correlated negatively with their PSS scores and ratings on 'stress right now' during the baseline week. Surprisingly, for the experiment group, intensity of experienced positive emotions did not seem to be correlated with 'stress right now' or PSS scores during the second intervention week. In addition, a weak positive correlation was found between intensity of positive emotions and 'stress right now' during the first intervention week.

Perceived control plays an important part in stress reduction [36]. Stress can be characterized as an imbalance between environmental demands and which resources one have for meeting those demands [30]. The more control one perceives to have over a situation, the less stress is supposed to be experienced. Thereby stress and control should be negatively correlated with each other. The results showed that the amount of control the participants perceived to have correlated negatively with both their scores on PSS and with the single item stress measure 'stress right now' all three weeks. It seemed however that the correlations between control and 'stress right now' were weaker for the experiment group than the control group, especially during the first intervention week.

Health

Music have been seen to primarily evokes positive emotions in listeners [15] and according to Fredricksson [29] positive emotions be fundamental for improving both psychological and physical aspects of well-being. Research has shown that listening to music may influence both psychological physical health [44]. The final hypothesis explored in the present study was that scores on the impact version of the Symptoms of Illness Checklist (SIC) would be affected by the music intervention. The results showed a decrease in SIC scores within the experiment group from the baseline week, when they relaxed every day without music, to the weeks when they listened to their own chosen relaxing and energizing music. While this indeed is an interesting result, the same decrease was seen for the control group, which indicates that it might not have been the music in itself that caused the decreased SIC scores but that it was the relaxation incorporated with the intervention. Not everyone is able to take a half an hour to themselves after work to relax, so just the mere opportunity to escape the daily demands (e.g. housework, child care, problems with spouse, work related stress) a little while could have lead to feeling less stress and more positive emotions and having more resources for coping with physical health problems. As mentioned before, the impact version on the SIC is not intended to be an indicator of physical health, but to measure to what extent physical complaints affects people's everyday lives. Therefore, by participating in the study, the participants (independent of group) were more or less forced to take 30 minutes of their day to relax which might have given them more energy and ability to recover from different mild physical complaints.

Relaxing music versus energizing music

The participants in the experiment group listened to their own chosen relaxing music during one of the intervention weeks, and their own chosen energizing music during another week. To avoid a time effect of the study interfering with the type of music, half of the group listened to their relaxing music and the other half their energizing music during the first intervention week, and the other way around the second intervention week. The results showed a significant decrease in PSS scores from the week they relaxed (i.e. the baseline week) to the week when they listened to their relaxing music, but no such decrease was seen for the energizing music. There was no difference in how intensively they experienced positive emotions between listening to the relaxing music and the energizing music. This indicates that it does not matter whether the music is relaxing or energizing. Listening to both types of evoked more intense positive emotions than relaxation without music, although it was only the relaxing music that evoked significantly more intense positive emotions.

Limitations

The participants all began the study on a Monday, but they began during different weeks, ranging from May to August. Even though participated during the summer months, because they started at different weeks, weather might have had an effect on their individual emotional experiences. Also, cortisol is influenced by light conditions [42], which are related to weather. Another limitation with the present study was the large differences in perceived stress between the experiment group and the control group during the baseline week in spite

of the attempt to match the groups during the screening process.

One problem with comparing different responses when listening to relaxing music, to the responses when listening to the energizing music is that an important time effect may have been ignored since they did not listen to the same type of music during the same week. When looking at the responses (e.g. stress) from those who listened to the relaxing music, one half of the experiment group had only been listening to music during one week, whereas the other half also had listened to the energizing music the previous week. The reported experiences of those who listened to their relaxing music the second intervention week may therefore have been affected by the possible effects of the energizing music, and thereby experiencing even less stress or more intensive emotions due to the time effect. Another factor that may have yielded this result is music preference. Even though participants' own music was used, perhaps some participants always preferred listening to energizing music when stressed or when returning from work. Future research should take this aspect into account.

Although this study was an attempt to show the stress reducing effects of listening to your own chosen music in a natural setting, it is possible that the music evoked negative emotions and increased stress at times. When studying emotional responses to music it is crucial to consider individual and situational factors as well as the music. The participants chose their own preferred music which they perceived as relaxing and energizing, but this does not mean that the music they chose always will evoke these presumed emotions within them. People use music for many different reasons (e.g. to relax, to alter mood, to regulate emotions, to enhance emotions) and are often good at identifying specific music that leads them toward specific moods. To listen to music that does not match the listener's goal of the listening may have two effects: the music affects them in the way they usually are affected by that music, or they experience negative emotions because the music is not appropriate for that particular situation. For example, in listening to music in the evening with the purpose of unwinding, and a piece of music that is usually listened to get more energy, say, at the gym accidently is played, it will most likely perpetuate negative emotions even though when usually played, the desired effect is achieved, simply because it does not fit the situation and the purpose of the listening. So by forcing the participants in the experiment group to listen to music for 30 minutes every day for two weeks time, although it was their own preferred music, it might not have had the positive effect that we had presumed it would achieve. There is also a risk that the participants became tired of listening to the same playlist day after day for one week and that might have caused negative emotions. For future research it may be a good idea to have a larger sample of each participant's own chosen music to avoid feelings of boredom or anticipation effects due to repetition.

A different interpretation of the present findings is that overall, both interventions, relaxation and listening to music, was effective in lowering stress. However, there was no significant difference between the effectiveness of these two manipulations. It should be noted that comparing two intervention conditions is different than comparing a treatment condition with a usual control condition without any manipulation. It is possible that music (and the relaxation) would have resulted in lower stress compared to control condition without any manipulation.

The choice to not include men in the present study was solely made to avoid the known gender differences in cortisol, where men show greater increases in cortisol than women [43]. But by not including men we lost the opportunity to generalize any result from this study to half of the Swedish population.

Conclusion

Overall, the results from this experimental field study indicate that listening to preferred music may be an effective way of reducing feelings of stress and increasing positive emotions, and even more effectively than relaxation without music. This research adds to the growing literature (for and overview see [51]) showing the psychological and physical benefits of listening to liked music.

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Table 1
Correlations between stress, positive emotions, perceived control and cortisol levels for all participants during the baseline week.

	Positive[c]	Control	SIC[d]	AUC[e]	Awakening[f]	Intervention[g]
PSS[a]	-.319*	-.699**	.661**	.193	-.163	.101
Stress[b]	-.159	-.755**	.553**	.027	-.001	-.014
Positive[c]	-	.240	-.361*	.101	.289	-.049
Control	-	-	-.479**	-.339	-.182	-.101
SIC[d]	-	-	-	.050	-.129	.215

* p < .05, ** p < .001
[a] Perceived Stress Scale
[b] Stress "right now"
[c] Positive emotions
[d] Impact version of the Symptoms of Illness Checklist
[e] Cortisol Area under the curve
[f] Awakening cortisol
[g] Intervention cortisol effect

Table 2
Correlations between stress, positive emotions, perceived control and cortisol levels for both groups during the first intervention week.

	Positive[c]	Control	SIC[d]	AUC[e]	Awakening[f]	Intervention[g]
Experiment group						
PSS[a]	-.229	-.524*	.450*	.325	.329	.083
Stress[b]	.117	-.560*	.445*	.138	.437*	.154
Positive[c]	-	-.052	-.136	-.203	.102	-.021
SIC[d]	-	-	-.248	-.428	-.311	-.093
Control	-	-	-	-.123	-.018	.033
Control group						
PSS[a]	-.417	-.723**	.587**	.135	.143	.032
Stress[b]	-.283	-.923**	.453**	.052	.015	-.119
Positive[c]	-	.387	-.320	.043	-.134	-.134
SIC[d]	-	-	-.351	-.125	-.141	.114
Control	-	-	-	-.215	-.234	-.069

* p < .05, ** p < .001
[a] Perceived Stress Scale
[b] Stress right now
[c] Positive emotions
[d] Impact version of the Symptoms of Illness Checklist
[e] Cortisol Area under the curve
[f] Awakening cortisol
[g] Intervention cortisol effect