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Acute stress recovery through listening to Melomics relaxing music: A randomized controlled trial

De la Torre-Luque, Alejandro,[a*] Caparros-Gonzalez, Rafael Arcangel,[a] Bastard, Teresa,[a] Vico, Francisco Javier,[b] Buela-Casal, Gualberto.[a]

[a]Mind, Brain, and Behavior Research Center (CIMCYC), University of Granada, Granada, Spain;

[b]School of Computer Science, University of Malaga, Malaga, Spain.

*** Correspondence:**

Alejandro de la Torre-Luque.

a.delatorre@uib.es

Mind, Brain, and Behavior Research Center

(CIMCYC), Campus de Cartuja s/n,

18071, Granada, Spain

Abstract

Background: Daily life entails having to cope with many stressful situations. Although stress-related reactions could sometimes provoke impairments in physiological processes due to the frequency of exposure or the stress burden of the event, physiological recovery after coping with stressors is highly implied in the aversive consequences of stress. *Objective*: To analyze the effects of listening to relaxing music (generated by the Melomics computer system) on the cardiovascular recovery and subjective feelings of anxiety after undergoing an acute-stress episode. *Methods*: A double-blind randomized controlled trial was conducted in healthy adults (N = 24; M = 23.05 years, SD = 2.97). Participants reported their levels of psychiatric symptomatology and anxiety and were then exposed to a stress induction protocol. Afterwards, they underwent a period of recovery where they would be exposed to either a relaxing music track or to silence, depending on a random assignation. Heart-derived functioning and self-reported anxiety were monitored throughout the study stages. *Results*: All the participants showed stress-related reactions throughout the study stages, as it was showed for the study outcomes. Regarding the effect of listening to music, participants who listened to relaxing music during the recovery stage showed higher levels of sample entropy than controls, highlighting a large effect size on this difference ($\eta^2_{partial}$ = .59). *Conclusions*: Relaxing music promotes more adaptive emotional regulation after coping with an acutely stressful event. This study aims to shed light about the actual effects of music interventions, and encourage the use of music-based interventions on health services.

Keywords: stress, music, relaxing music, heart rate variability, entropy.

Acute Stress Recovery through Listening to Melomics Relaxing Music: A Randomized Controlled Trial

Stress is present in daily life as a product of today's technological society (Gerber & Pühse, 2009; Yehuda, 2011) and is becoming a health-related trouble. The consequences of stress lead to more significant adverse effects over time (Kudielka & Wüst, 2010; Thoits, 2010). For that reason, stress is also considered a determinant factor implied in health outcomes (World Health Organization, WHO, 2010). This construct is defined as a physiological process that arises when an event is appraised to have high perceived demands and the individual considers his or her own coping resources as insufficient (Kyrou & Tsigos, 2009; Lazarus & Folkman, 1984; Lundberg, 2006). Interestingly, this process is also associated with effective environmental adjustment. Thus, when a stressful event must be coped with, an organism tends to react in order to optimize the adjustment (for a review, see Foley & Kirschbaum, 2010; Steptoe, Hamer, & Chida, 2007). These reactions usually fade out in few minutes, bouncing back physiological basal levels (Chida & Hamer, 2008; Kirschbaum, Pirke, & Hellhammer, 1993).

However, the adjustment after stressful situations can involve some paradoxical consequences. It is, therefore, necessary to distinguish between coping with acute stress and chronic stress responses. Acute stress reactions allow the organism to cope with specific stressful events. These reactions are adaptive and are often exhibited around the stressor. In turn, the chronic stress response that arises when coping with stressful events remains recurrent over time (Smyth, Zawadzki, & Gerin, 2013). Cumulative effects of coping with stressful events recurrently encourage that the organism react against daily situations as those that would be stressful. Additionally, these effects may lead to chronic alterations in physiological processes that are maladaptive in daily contexts. As evidence of this, chronic stress responses have strongly been associated to a wide range of diseases and mortality (Chida & Hamer, 2008; Chida & Steptoe, 2010). Additionally, chronic stress-derived effects could result in affecting cognitive functions and provoking psychiatric disorders (Chida, Hamer, & Steptoe, 2008; Chida, Hamer, Wardle, & Steptoe, 2013; Oei, Everaerd, Elzinga, van Well, & Bermond, 2006).

The relationship between acute and chronic stress, on the surface, seems like an obvious one, but turns out to be more complex of a connection than scientists thought. Thus, it seems that cardiovascular recovery after coping with stressors is highly implied within this relation. Cardiovascular recovery consists of heart-derived functioning returning to regular levels; in other words, the basal functioning, as it was prior to the experience of stress. In this regard, different studies have highlighted that when recovery is impaired, some cardiovascular parameters do not show proper levels of resting functioning. Some studies have highlighted that there are important relations between inefficient cardiovascular recovery and chronic stress (Chatkoff, Maier, & Klein, 2010; Pieper & Brosschot, 2005). The imbalance between the autonomous system paths could also be causing significant impact on the recovery (Steptoe & Kivimäki, 2012; Thayer & Lane, 2009).

Due to the aversive consequences of an impaired cardiovascular recovery, several strategies have been used in order to achieve better adjustment after coping with a stressor (Nyklíček, Mommersteeg, van Beugen, Ramakers, & van Boxtel, 2013; Varvogli & Darviri, 2011). These strategies have been applied in informal contexts as well as part of experimental trials. In this regard, the Trier Social Stress Test (TSST; Kirschbaum, 2010; Kirschbaum et al., 1993) seems to be a suitable protocol within laboratory settings. It basically consists of introducing a performance situation conceptualized as highly uncontrollable, challenging, and threatening; and then incorporating a mental effort task in order to maintain the stress-induced reactions (de la Torre-Luque, Díaz-Piedra, del Pino-Sedeño, González-García, & Buela-Casal, 2012).

Regarding interventions for stress recovery, it is noteworthy that listening to music has been tested in order to clarify the effects derived from its use. Music has extensively been applied for therapeutic purposes in the context of relaxation and stress coping (to review some useful guidelines of application, see Brandes, 2009; Grocke & Wigram, 2007). Many benefits have been observed after that application considering different health-related outcomes, such as pain, negative mood and depression, agitation, etc. (Bradt & Dileo, 2009; Deshmukh, Sarvaiya, Seethalakshmi, & Nayak, 2009; Ghetti, 2012; Haslbeck, 2014; Zhang et al., 2012). In terms of stress-derived reactions, it has been suggested that listening to music could promote healthier levels of recovery. Keeping this in mind, relaxing music melodies may be the most appropriate music-based stimuli for achieving this goal, due to their structural features which have been associated to stress and anxiety reductions, for instance slow tempo, low pitches and regular rhythmic patterns (Elliott, Polman, & McGregor, 2011; Pelletier, 2004). Accordingly, studies on listening to relaxing music have supported this suggestion within laboratory settings (Chafin, Roy, Gerin, & Christenfeld, 2004; Chuang, Han, Li, & Young, 2010;Hatta & Nakumara, 1991; Knight & Rickard, 2001; Thoma, La Marca, Brönnimann, Finkel, Ehlert, & Nater, 2013).

This study aims to shed light about the true effects of an intervention based on listening to relaxing music. In this case, it proposes to analyze the effects of this treatment on the cardiovascular recovery after the exposure to a stressor. It explored the influence of this relaxing music intervention through time domain, frequency domain, and nonlinear heart-derived parameters, in order to obtain a more integrative perspective about health-promoting effects. Moreover, it aims to study the effect of this intervention on the subjective perception of stress and anxiety. All the hypotheses in this study are tested within a laboratory setting through the implementation of a stress induction paradigm.

Methods

Participants

The study sample was composed of healthy undergraduates, with ages ranging from 18 to 35 years old. None of them suffered from any psychiatric disease, auditory impairment, or organic illness, which could affect the cardiovascular system.

The participants were recruited according to some inclusion and exclusion criteria. The inclusion criteria were being an undergraduate student of the University of Granada; being from 18 to 35 years old; having a body mass index (BMI) lower than 30 kg/m^2; and having read, accepted, and signed the consent informed document. The exclusion criteria were being an undergraduate in psychology; having some academic or amateur musical education; having a menstrual period at the time of the test; being an elite athlete; suffering from a diagnosed psychopathology according to DSM-IV-TR (American Psychiatric Association, APA, 2000) criteria; or suffering from psychopathological clinical distress according to the Global Severity Index (GSI) from the Brief Symptom Inventory (BSI; Derogatis & Melisaratos, 1983).

Other exclusion criteria were the presence of high levels of trait anxiety assessed by the State-

Trait Anxiety Inventory-Trait (STAI-T) scale, according to the Spanish version of this test (TEA Ediciones, 1994), which means a score in the STAI-T scale ≥ 37.97 and 45.09 for men and women, respectively; having being diagnosed with an organic disease; engaging in usual practice of meditation within the last month, for at least 4 days per week; the experience of a traumatic event within the last month; and being a usual consumer of illicit drugs and/or any mood-altering medication, which could affect the cardiovascular and the hypothalamus-pituitary-adrenals (HPA) systems.

Sample size and power analysis.

A priori sample size estimation was conducted considering a medium effect size (d = .5) of relaxing music on recovery outcomes. A confidence level of α = .05 and power of 1–β = .8 were kept. A between-stage correlation of .3 was assumed. The sample size was estimated for visualizing an interaction effect Group×Time of measurement, within a model of repeated-measure analysis of variance. As a result, calculations stated that the sample should be made up of 20 to 24 participants. This estimation was obtained by following the guidelines of Maxwell and Delaney (2004).

Instruments

Questionnaires.

We used STAI-T (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983; Spanish version from TEA editions, 1994) to assess how usual an individual responds showing anxiety in a concrete situation (state) or generally (trait). Each scale consists of 20 questions and is based on a 4-point Likert scale. The Cronbach's alpha reliability coefficients are between .87 < α < .93 for the scales.

In addition, a screening interview was used to obtain some relevant information about the participants and make decisions about the selection criteria; this screening interview contained items to measure variables to control.

The study also utilized the Brief Symptom Inventory (BSI; Derogatis & Melisaratos, 1983; Spanish version by Ruipérez, Ibáñez, Lorente, Moro, & Ortet, 2001). This is a 53-item self-report instrument used to assess psychopathological symptoms (Somatization, Obsessive-Compulsive, Interpersonal Sensitivity, Depression, Anxiety, Hostility, Phobic anxiety, Paranoid ideation and Psychoticism) within the last 30 days, scored by a 4-point Likert scale. BSI provides three composite scores to reflect the distress derived from symptomatology (the GSI, the Positive symptom distress index and the Positive symptom total). We used the GSI in this study because it is the best indicator of the symptomatic distress currently experienced by an individual (Derogatis & Melisaratos, 1983). The Cronbach's alpha reliability coefficient of the BSI Spanish version is between $.74 < \alpha < .88$.

As part of the stress induction task, the Paced Auditory Serial Addition Test (PASAT; Gronwall, 1977; Tombaugh, 2006) was used. This test has three series of sets of individual numbers distributed along 61 trials. In this study, only the first series of numbers were used. This instrument is considered valid to induce stress-related reactions as it has been demonstrated in several studies (de la Torre-Luque et al., 2012; Mathias, Stanford, & Houston, 2004).

To assess musical preferences, the Musical Styles Questionnaire (MSQ; Megías & Rodríguez, 2002) was used, which consists of 24 items with a Likert scale. It has a 7-factor factorial structure and the reliability of this MSQ version in the study sample was in the range $.53 < \alpha < .85$.

At the end of the experimental session, the Trial Status Questionnaire was applied to each participant to assess the level of knowledge that they had about the real objectives of the study. This allowed for evaluating the level of participants' blinding. This questionnaire was made up of three items, two of them were distractors (participants responded to them but those responses were not taken into account for analyses) and the last one was related to the study objectives. This item was responded by ticking in one option among four possibilities. Each option was referred to a potential study aim, but only one of them was the real study aim.

Apparatus.

The equipment used were two comfortable armchairs, a folding screen, a table, an environmental sound level meter PCE-222, a video camera (IP RIMAX model 7100), three laptops (one of them was a Packard Bell PEW91, and the other two were MacBook Pro 10.6.8s), and a relaxing music tune. The software used to conduct the experimental sessions were Debut Video Capture v. 1.64, BlingClock, TeamViewer, Microsoft Excel 2010, and Microsoft PowerPoint 2010.

The psychophysiological functioning was recorded by using the Somté PSG v2 system (Compumedics Limited, Abbotsford, Australia) with the ProFusion PSG 3 Lite v. 3.3 software. We obtained electrocardiographic activity from self-adhering silver electrodes placed on the participant chest at a 2-channel setting. Electrocardiographic channels had a low band pass filter of 100 Hz. Cardiographic data were sampled at 256 Hz and were collected for offline processing. To analyse the cardiovascular activity, Kubios HRV 2.1 (Tarvainen, Niskanen, Lipponen, Ranta-aho, & Karjalainen, 2009) was employed.

Additionally, these devices were utilized in our study: a pair of HP Headset H2500 earphones, an iPod®, iTunes 10, and Google Docs, as well as the e-mail and dissemination network of the University of Granada.

Design

A double-blind randomized controlled trial was conducted. The independent variable (IV) was designed as a between-subject factor, labelled as relaxing music and was composed of two levels (music/no music). Participants who were assigned to the music condition were exposed to 15 minutes of listening to relaxing music. Thus, a relaxing tune was composed and synthesized by Melomics computer system (Sánchez, Moreno, Albarracín, Fernández, & Vico, 2013; see also *http://geb.uma.es/melomics*). Otherwise, the participants who were exposed to the non-music condition were played a 15-minute track of silence.

Melomics allows applying tailored music medicine interventions in function to specific therapeutic targets and preferences. The tune used in this study was composed following the recommendations of 10 expert musicians and keeping the features that scientific literature has pointed at inducing relaxing feelings (Bradt & Dileo, 2009; Elliott et al., 2011; Västfjäll, Juslin, & Hartig, 2012; Yamamoto, Naga, & Shimizu, 2007): slow tempo (up to 52-54 beats per minute), low tone, highly predictable melody, lack of dissonances; string and wind instruments. This melody was endorsed as relaxing by the expert musicians aforementioned once this was created, and a sample of general population (Benítez et al., 2013).

The process of creating and validating the relaxing music was based on mixed protocols, combined quantitative and qualitative methods. First, a focus group protocol was used in order to obtain expert knowledge on what features and combination among those should show a music tune to be relaxing. Thus, each expert musician stated their combination of features. Moreover, two more combinations were obtained from the agreement among musicians after discussion sessions. Melodies derived from all these combinations were then composed by means of the Melomics computer system. Afterwards, the musicians assessed each melody in order to obtain an agreement on which one was the most relaxing. As a result, a tune was selected. Finally, this melody was assessed by non-musician people in order to investigate if it was perceived as relaxing for general population, ratifying the musician appraisals. This tune can be listened to on this webpage:

https://soundcloud.com/rafael-caparros/melomics-stress-paradigm-music-tune

Moreover, its score can be explored on this webpage:

https://drive.google.com/file/d/0B1p22oCQILR-amlIUnpCamptQlE/view?usp=sharing

Several subjective and objective dependent variables (DV) were assessed. The objective dependent variables were derived from the cardiovascular functioning (see Physiological processing and analysis section). Moreover, the level of anxiety measured with the state scale of the STAI-T was analysed as subjective measure.

The controlled variables were the age and gender of participants, the body mass index, and the level of psychopathology; the intake of caffeine and tobacco; the consumption of oral contraceptives; some lifestyle features as the sport practice and the participants' preferred music genres, the environmental features of the experimental room (lighting; temperature, set at 21 ºC degrees; and the environmental noise, always kept below 60 dB).

The ethical committee for human research of the University of Granada, reference code 201302400000726, approved this research.

Procedure

Firstly, the recruitment of the sample was done through a web page and by distributing advertisements among the students of the University of Granada. In order to ensure blindness for the purpose of this study, in the search for potential participants, the research was labelled "Musical Emotions." As compensation to participate, participants had the opportunity to enter a raffle for electronic devices. Thus, after an initial contact, the potential participant had to fulfil the screening interview and questionnaires (BSI and the trait version of the STAI-T) through the web page. Additionally, the MSQ was also administered.

Once researchers ascertained the participants' adequacy to selection criteria, a numerical code was designated to each of them. These codes were matched then to an experimental condition randomly at a 1:1 ratio by means of an Excel RAND function (Microsoft Excel, 2010). A third researcher conducted this task. Afterwards, this researcher stored the experimental music tracks on an iPod, taking into account this randomized matching. According to this, if the code of a participant was matched the experimental condition, the Melomics relaxing music track was recorded; otherwise (the code was matched the control condition), the track consisted of silence. This allowed for maintaining the blindness of the rest of researchers (implementers) because this third researcher did not take part into the implementation of protocols throughout the experimental sessions.

Afterwards, each participant was referred to a laboratory session where they participated in an application of a version of the TSST to induce stress-related responses; and had the chance to have a recovery period after the paradigm exposure. It incorporates some adaptations in order to optimize the laboratory resources and experimental environments.

Thus, when the participant arrived at the laboratory, the informed consent had to be read and signed. Afterwards, the participant entered the experimental room and once there, the researcher reminded the relevant information about the study and the physiological recording system was put on. After that, the researcher requested the participant to sit down on a comfortable armchair. At this moment, the researcher left the experimental room and the basal cardiovascular functioning was recorded for 6 minutes, while the participant was seated. Later, the participant fulfilled the state version of the STAIT-T questionnaire by using a laptop located in the experimental room.

Subsequently, the stress-induction paradigm (TSST modified version; see de la Torre-Luque et al., 2012) was implemented by using the laptop.

This protocol included offering a collaborative position within a research group (a research student fellowship supervised by a senior researcher) in which the participant had to carry out some tasks of low difficulty. This simulated situation aimed the participant noticing great benefits and relatively low assignments. The only requirement of the position was to perform a 5-minute presentation, stressing the main strengths that this participant could provide to this position. This task would be evaluated in order to make a decision about the job selection. Part of the project required that the participants introduced themselves standing up in front of an IP camera (exposition stage).

The participant could also watch his/her performance on the laptop screen and the time spent by a countdown application. Prior to the presentation, the participant had a 3-minute period to prepare it (the so-called, anticipatory stage).

After the exposition stage, the participant had to complete a task that required mental effort. The first part of the PASAT was thereby administered through the laptop. Once this had been accomplished, the participant was asked to fulfill the state version of the STAI-T again.

Then, the 16-minute recovery stage began. At this moment, the researcher went back to the experimental room and gave the participant the pair of earphones and the iPod® device with the randomly assigned track. This researcher did not know which track the device contained. Afterwards, the participant seated on the armchair again and the researcher instructed them to listen to the tracks on the devices. While the participants had the earphones on, none of the researchers stayed in the experimental room.

As the final task, each participant had to refill out the state version of the STAI-T. Then, the physiological recording system was removed. Finally, the participant filled out the Trial Status Questionnaire.

When all the participants had gone through the experimental session, an e-mail was sent to them, exposing the true aims of the study, and the results of the device raffle were published.

Physiological processing and analysis.

Heart-derived functioning was monitored along the experimental session. A low-pass filter of 100 Hz was applied prior to processing the signal. Then, default filters of the analysis software removed the DC drift from the time series.

The electrocardiographic data obtained was segmented, depending on TSST protocol, in consecutive non-overlapped time periods. The heart-derived indexes of 3 experimental stages were analyzed: the 6-minute baseline (the first minute was discarded due to control the experimental reactivity effects), the 5-minute exposition stage, considered as the main stressful period within the induction; and the 15-minute recovery stage (the first minute was discarded as well).

Heart-derived parameters were processed following the rules proposed by the European Society of Cardiology and the North American Society of Pacing and Electrophysiology (1996). Thus, time domain, frequency domain, and nonlinear indexes were calculated. As time domain measures, it studied the mean interval between two successive R peaks (mean RR). This parameter allows calculating the heart rate, or the amount of heart beats per minute. The root mean square of the successive differences (RMSSD) was also calculated. The RMSSD is the square root of the mean of the sum of the squares of differences between adjacent RR intervals and constitute a measure of linear variability between heartbeats. On the other hand, frequency domain parameters allow extracting information related to the energy or the power of the RR time series. For this domain, it studied the amount of frequencies in the low-band spectrum (frequencies between .04 and .15 Hz), high-band (frequencies between .15 and .40 Hz), and the balance between the potency in both the obtained bands by a ratio. These power bands have been associated with sympathetic/parasympathetic balance implied in the regulation of emotional responses (for a review, see Thayer & Lane, 2009).

Finally, a nonlinear-based parameter of cardiovascular functioning was studied: the sample entropy (SampEn). This is a measure of the chaotic regularity and complexity (Bornas, 2009). This measure allows knowing what new information an organic system displays over time. Large values of SampEn indicate high irregularity/complexity over time (Richman & Moorman, 2000). SampEn is estimated as the negative natural logarithm of the conditional probability that a data (*C*) with length *N* having repeated itself in a sequence of *m* points, remain similar for *m* + 1 (see Equation 1). Hence, three parameters are needed to calculate SampEn: the length of the time series (*N*), the length of the sequences to be compared (*m*); and the level of tolerance (*r*) accepted by which the sequences can be compared.

$$SampEn\ (m,r,N) = -\ln[C^{m}(r) / C^{m+1}(r)] \qquad \text{(Equation 1)}$$

These measures were calculated by using Kubios HRV 2.1 (Tarvainen et al., 2009). Frequency domain indexes were normalized by using a log-linear scale.

Data Analysis

Descriptive statistical analyses were performed using the Mann-Whitney U test for scalar variables; for nominal and ordinal variables, the $\chi 2$ independence test was used.

Keeping in mind the assumptions that at least one variable was associated with the criterion, or would cause a direct effect on it, it was determined whether or not any psychopathological variable should be included as a covariate (Miller & Chapman, 2001). The other assumption was that a variable should be considered as a covariate if between-group significant differences did derive from it. However, none of the relevant variables registered in this study satisfied these conditions ($p > .05$). The analyses were therefore conducted by using independent analyses of variance (ANOVA).

Independent ANOVAS were conducted in relation to each of the dependent variables throughout the stages of the experimental session. Analyses considered three temporary stages: baseline, exposition stage (as most stressful stage within the protocol), and recovery. Bonferroni post hoc tests were used to explore differences on criteria between pairs of stages. Additionally, the Greenhouse-Geisser correction was applied when homoscedasticity assumption was not satisfied. Furthermore, effect size estimations were calculated by using $\eta^2_{partial}$ statistic (Fritz, Morris, & Richler, 2012). The analyses were conducted by using Statistics IBM SPSS v. 20.

Results

One hundred and twenty-six individuals filled out the questionnaires that composed the screening stage. Although, 24 of these were incorporated as participants into this study (see Figure 1), however, due to illegible recordings, three participants were excluded. Hence, data from 21 participants was included into the analyses. Twenty-four percent of these participants were male. The sample mean age was 23.05 years (*SD* = 2.97) and the BMI was 23.23 kg/m^2 (*SD* = 3.22). Most of the sample did not smoke (81.80% of the participants); and more than half of the participants usually took coffee or other caffeinated drinks (59.1% and 58.2% of the participants, male and female, respectively). None of the participants were undergoing pharmacological treatments that could affect the cardiovascular or HPA system; however, 35% of the sample was taking birth control pills. Most of the participants reported that they had no knowledge about the actual study purposes: 69.30% of the participants ticked in the distraction-based options on the Trial Status Questionnaire.

(Insert Figure 1 here)

Regarding the psychological symptomatology, all participants showed non-clinical levels in all BSI factors, even considering the levels of trait anxiety according with the trait version of the STAI (M = 22.45; SD = 12.07). None experienced any traumatic event in the last month prior to the study.

Table 1 displays the levels of the different sociodemographic variables, as well as lifestyle and psychopathological features according to the group assignment. There were no statistically significant differences between experimental groups in relation to these relevant factors.

(Insert Table 1 here)

Stress Induction and Recovery

Table 2 shows the descriptive and contrast-based statistics, related to cardiovascular functioning. It is noteworthy that some significant differences were observed in relation to time domain measures, as well as frequency domain parameters. Concretely, main effects were detected for the average interval between successive RR peaks ($p < .001$), showing higher levels along the baseline and recovery stages than during the exposition-induced stage. In relation to frequency domain parameters, significant main effects were also found for low-band and high-band potency ($p < .05$, for both measures). Thus, opposite profiles were observed for these parameters throughout the study stages. As expected, the potency of low-band spectrum was lower along the baseline and recovery phases, but greater within the high-band spectrum; otherwise, low potency was observed for high frequency (HF) band and high potency for low frequency (LF) band. No significant interaction effects were found.

(Insert Table 2 here)

Regarding heart-derived sample entropy, a statistically significant main effect was found considering the stages of the experimental session, with $F\ (2, 26) = 18.78$, $p < .001$; $\eta^2_{partial} = .59$.

Thus, the higher levels of sample entropy were observed along the baseline and recovery stages, and the lower levels along the exposition stage. Additionally, an interaction phase×group effect was also found taking into account the sample entropy, with $F(2, 26) = 3.69$, $p < .04$; $\eta^2_{partial} = .22$. This effect revealed that there were differences between groups when the sample entropy is considered within the recovery stage. The participants of the experimental group therefore showed greater levels of sample entropy than the controls. This means that more complex heart-derived series were shown for participants who listened to the relaxing music. Sample entropy patterns are attached in Figure 2.

Finally, the subjective perception of anxiety was analyzed through the state version of STAI. The ANOVA used for this purpose revealed a main effect taking into account the stages of the experimental session. This effect was supported by the statistics $F(2, 38) = 3.33$, $p < .05$; $\eta^2_{partial} = .15$. However, no interaction phase×group effect was detected in relation to this criterion. These results suggest that there were differences among study stages but not according to the treatment application. Higher levels of self-reported states of anxiety were therefore observed to all participants after the stress induction (M = 18.19; SD = 7.65), in comparison to the baseline (M= 16.24; SD = 6.65) and the recovery measurements (M = 16.71; SD = 8.08).

(Insert Figure 2 here).

Discussion

This study aimed to analyze the effects of relaxing music on the recovery after the exposure to an acute stressor. A further aim was to explore these effects regarding different systems of response (physiological-based reactions and self-reports). In order to test these effects, a randomized controlled trial was conducted. That implied to display a laboratory setting procedure. Protocols derived from these controlled settings ensure greater levels of internal validity to determine the actual effects of the studied intervention (Levine & Parkinson, 1994).

Regarding the study objectives, it is noteworthy that significant effects were found when the relaxing music intervention was applied and sample entropy was considered. However, no effects were shown to be of significance when other dependent variables were analyzed. These results support that participants who were exposed to the relaxing music intervention after the stress induction showed higher levels of sample entropy—or adjustment to context—than the control-group participants; nonetheless, no other between-group differences showed up in either physiological parameters or subjective reports.

With respect to the study aims, it should be highlighted that the stress induction protocol led participants to display significant stress-related responses, as were shown by the changes in heart rate and heart-derived spectral power parameters. Additionally, changes in sample entropy were also observed throughout the study stages, as other studies have found (Melillo, Bracale, & Pecchia, 2011). Moreover, when participants were exposed to the stress induction protocol, they displayed higher heart rate and higher influence of heart-derived low-band power. This power is often associated with the action of the sympathetic autonomous system (for a review, see Thayer & Lane, 2009). The action of parasympathetic activity and typical relaxation responses was denoted by the high-frequency power which was decremented in the assessed stress-induction stage. Levels of self-reported state anxiety were aligned to the tendencies observed on the physiological parameters.

In relation to sample entropy, findings from this study revealed that the stress induction resulted in lower levels of this parameter when the stress induction was ongoing. However, a significant between-group effect was visualised in the recovery period. Interestingly, participants who listened to the relaxing music during this stage showed significantly higher levels of sample entropy than controls. Entropy allows quantifying how a system incorporates new information over time (Guastello, 2011; Shelhamer, 2007; Yassouridis, Ludwig, Steiger, & Leisch, 2012). In other words, a biological system tends to organize itself by a more chaotic semblance over time. Despite the negative implications that could be expected from this chaotic appearance, systems with higher complexity are often considered to be better adjusted to the context because they become more flexible to environmental demands (Bornas, 2009). Regarding the field of anxiety and stress, it is noteworthy that when a biological system is stressed or affected by an anxiety disorder, it often shows lower levels of entropy (Balle, Tortella-Feliu, & Bornas, 2013; Williamon, Aufegger, Wasley, Looney, & Mandic, 2013). Likewise, when a treatment leads to ameliorating the effects of the anxiety disorders, it can be seen that the levels of entropy increase (Bornas et al., 2007; Vlemincx, Vigo, Vansteenwegen, van den Bergh, & van Diest, 2013). In this current study, it was observed that participants who were exposed to the relaxing music intervention showed greater sample entropy than controls. This result supports that the music can contribute to improve the adjustment to the daily context after facing with an acute stressor.

On the other hand, this study did not find significant differences regarding other parameters to study physiological heart-derived responses and subjective reports. It is important to point out that results derived from this study agree with those provided from other trials in the same conditions (Chafin et al., 2004; Thoma et al., 2013). Other studies that analysed the effect of music after exposure to a stressor concluded that there are no differences between groups when different heart-derived parameters are explored. However, it is easier to detect some changes when other parameters are assessed, such as blood pressure or hormonal fluctuations (Bradt & Dileo, 2009; Khalfa, Bella, Roy, Peretz, & Lupien, 2003). For that reason, some authors recommend to use other indexes when heart rate variability is studied (Friedman, 2007; Thayer & Lane, 2009; Yassouridis et al., 2013). Thus, nonlinear parameters would provide another perspective to explain the actual effect of different interventions on heart-derived functioning, even in the field of music medicine.

To sum up, relaxing music can improve the adjustment to context after experiencing a daily stressor by means of promoting cardiac flexibility. That is supported by changes observed in the sample entropy, a nonlinear-based measure. The traditional heart-derived measures (heart rate, RMSSD, among others) are influenced by a great amount of variables such as respiratory pace, postural changes, and so on. These variables may turn into imprecise and may also hide the true effects of music medicine on cardiovascular system. Besides, these measures do not allow us observing the complex and rich nature of the heart beating in depth (see Bornas et al., 2007). For these reasons, specialists on heart system studies strongly recommend that nonlinear measures are incorporated (European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996; Thayer & Lane, 2009). In this study, participants who listened to relaxing music after the exposure to a stress induction protocol showed higher levels of sample entropy than those in the control group. Emotional contagion mechanisms might be involved within these effects

(Juslin & Västfjäll, 2008): individuals who listen to the music perceive the "emotional expression" that this stimulus transmits and, then, "mimic" this expression inwards. Relaxing music pursues to engage participant on feeling its emotional expression leading to greater flexibility in terms of contextual adjustment and recovering daily levels of heart-derived functioning faster, subsequently.

These results stem from an empirical trial with robust controls, such as those typical of randomized controlled trials in laboratory setting. Additionally, the current study includes an innovative framework that aims to clarify the effects that derive from a music-based intervention to regulate affective states just after the stressor is faced.

As a limitation, this study had a slightly small sample size. Although, the assumptions needed for conducting the suited data analyses were satisfactory (Maxwell & Delaney, 2004). We plan to incorporate more participants in order to test these study hypotheses with a more representative sample in the future. On the other hand, the stress experience was partially approached due to the absence of measures derived from other physiological systems (i.e., endocrine system) which are involved in stress-related responses and contextual adjustment. For that reason, future research should analyze this type of intervention by integrating measures derived from different systems of response.

In conclusion, many people have pointed out that listening to music is their preferred strategy to regulate their own mood and affect regarding the management of difficult or stressful daily events (Dibben & Williamson, 2007; Haake, 2011; Västfjäll et al., 2012). Melomics relaxing music can contribute to improve the flexibility when coping with these situations through emotional contagion-based mechanisms leading to healthier contextual adjustment. Additionally, listening to relaxing music can be implemented in varying contexts and no side effects have been described after its application. Findings derived from this study can encourage tailored-music interventions, as Melomics system can deliver, to be incorporated into health services in order to improve the quality of life and wellbeing of persons who suffer from organic and psychological illnesses, and exhibit high levels of anxiety.

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References

American Psychiatric Association. (2000). *Diagnostic and Statistical Manual of Mental Disorders.* (4th ed., text rev.) Washington, DC: Author.

Balle, M., Tortella-Feliu, M., & Bornas, X. (2013). Distinguishing youths at risk for anxiety disorders from self-reported BIS sensitivity and its psychophysiological concomitants. *International Journal of Psychology, 48,* 964–977. doi:10.1080/00207594.2012.723804

Benítez, I., Hita- Yáñez, E., de la Torre-Luque, A., del Río-Bermúdez, C., Díaz -Piedra, C., & Buela-Casal, G. (2013). A methodological proposal to create music within a therapeutic context. In I. Alonso-Arbiol & K. Diez (Eds.), *12th European Conference on Psychological Assessment July 17–20, 2013, San Sebastian, Spain: Book of Abstracts* (p. 192). San Sebastian: Fotocopias Zorroaga, S. L.

Bornas, X. (2009). *Psicopatología y Caos* [Psychopathology and chaos]. Palma de Mallorca: Bubok.

Bornas, X., Llabrés, J., Tortella-Feliu, M., Fullana, M. A., Montoya, P., Lopez, A., Noguera, M., & Gelabert, J. M. (2007). Vagally mediated heart rate variability and heart rate entropy as predictors of treatment outcome in flight phobia. *Biological Psychology, 76*, 188–195. doi:10.1016/j.biopsycho.2007.07.007

Bradt, J., & Dileo, C. (2009). Music for stress and anxiety reduction in coronary heart disease patients. *Cochrane Database of Systematic Reviews*, CD006577. doi:10.1002/14651858.CD006577.pub2

Brandes, V. (2009). Music as a medicine: incorporating music into standard hospital care. In R. Haas & V. Brandes (Eds.), *Music that works. Contribution of biology, neurophysiology, psychology, sociology, medicine and musicology* (pp. 329-342). Wien: Springer-Verlag.

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

Chatkoff, D. K., Maier, K. J., & Klein, C. (2010). Nonlinear associations between chronic stress and cardiovascular reactivity and recovery. *International Journal of Psychophysiology, 77*, 150–156. doi:10.1016/j.ijpsycho.2010.05.008

Chida, Y., & Hamer, M. (2008). Chronic psychosocial factors and acute physiological responses to laboratory-induced stress in healthy populations: A quantitative review of 30 years of investigations. *Psychological Bulletin, 134*, 829–885. doi:10.1037/a0013342

Chida, Y., Hamer, M., & Steptoe, A. (2008). A bidirectional relationship between psychosocial factors and atopic disorders: A systematic review and meta-analysis. *Psychosomatic Medicine*, *70*, 102–116. doi:10.1097/PSY.0b013e31815c1b71

Chida, Y., Hamer, M., Wardle, J., & Steptoe, A. (2008). Do stress-related psychosocial factors contribute to cancer incidence and survival? *Nature Clinical Practice Oncology, 5,* 466–475. doi:10.1038/ncponc1134

Chida, Y., & Steptoe, A. (2010). Greater cardiovascular responses to laboratory mental stress are associated with poor subsequent cardiovascular risk status: A meta-analysis of prospective evidence. *Hypertension, 55*, 1026–1032. doi:10.1161/HYPERTENSIONAHA.109.146621

Chuang, C., Han, W., Li, P., & Young, S. (2010). Effects of music therapy on subjective sensations and heart rate variability in treated cancer survivors: a pilot study. *Complementary Therapies in Medicine, 18,* 224-226. doi:10.1016/j.ctim.2010.08.003

De la Torre-Luque A., Díaz-Piedra C., del Pino-Sedeño T., González-García C., & Buela-Casal G. (2012). Inducción de estrés: Validación de un procedimiento en contexto de laboratorio [Stress induction: Validation of a procedure within laboratory settings]. In R. Quevedo-Blasco R & V. J. Quevedo-Blasco (Comps.), *Avances en Psicología Clínica* [Advances in Clinical Psychology] (pp. 316–319). Granada: Asociación Española de Psicología Conductual.

Derogatis, L. R., & Melisaratos, N. (1983). The Brief Symptom Inventory: An introductory report. *Psychological Medicine, 13*, 595–605. doi:10.1017/S0033291700048017

Deshmukh, A. D., Sarvaiya, A. A., Seethalakshmi, R., & Nayak, A. S. (2009). Effect of Indian classical music on quality of sleep in depressed patients: A randomized controlled trial. *Nordic Journal of Music Therapy, 18*, 70–78. doi:10.1080/08098130802697269

Dibben, N., & Williamson, V. J. (2007). An exploratory survey of in-vehicle music listening. *Psychology of Music, 35*, 571–589. doi:10.1177/0305735607079725

Elliott, D., Polman, R., & McGregor, R. (2011). Relaxing music for anxiety control. *Journal of Music*

Therapy, 48, 264–288. doi:10.1093/jmt/48.3.264

Foley, P., & Kirschbaum, C. (2010). Human hypothalamus-pituitary-adrenal axis responses to acute psychosocial stress in laboratory settings. *Neuroscience and Biobehavioral Reviews, 35*, 91–96. doi:10.1016/j.neubiorev.2010.01.010

Friedman, B. H. (2007). An autonomic flexibility-neurovisceral integration model of anxiety and cardiac vagal tone. *Biological Psychology, 74*, 185–199. doi:10.1016/j.biopsycho.2005.08.009

Fritz, C. O., Morris, P. E., & Richler, J. J. (2012). Effect size estimates: current use, calculations, and interpretation. *Journal of Experimental Psychology: General, 141*, 2–18. doi: 10.1037/a0024338

Gerber, M., & Pühse, U. (2009). Do exercise and fitness protect against stress-induced health complaints? A review of the literature. *Scandinavian Journal of Public Health, 37*, 801–819. doi:10.1177/1403494809350522

Ghetti, C. M. (2012). Music therapy as procedural support for invasive medical procedures: Toward the development of music therapy theory. *Nordic Journal of Music Therapy, 21*, 3–35. doi:10.1080/08098131.2011.571278

Grocke, D., & Wigram, T. (2007). *Receptive methods in music therapy: Techniques and clinical applications for music therapy clinicians, educators and students* (1st ed.). London: Jessica Kingsley Publishers.

Gronwall, D. M. (1977). Paced auditory serial addition task: A measure of recovery from concussion. *Perception and Motor Skills, 44*, 367–373.

Guastello, S. J. (2010). Entropy. In S. J. Guastello & R. A. M. Gregson (Eds.), *Nonlinear dynamical systems analysis for the behavioral sciences using real data* (pp. 213–230). New York: CRC Press.

Haake, A. B. (2011). Individual music listening in workplace settings: an exploratory survey of offices in the UK. *Musicae Scientiae, 15*, 107–129.

Haslbeck, F. B. (2014). The interactive potential of creative music therapy with premature infants and their parents: A qualitative analysis. *Nordic Journal of Music Therapy, 23*, 36–70.

doi:10.1080/08098131.2013.790918

Hatta, T., & Nakamura, M. (1991). Can antistress music tapes reduce mental stress? *Stress Medicine, 7,* 181–184. doi:10.1002/smi.2460070309

Juslin, P. N., & Västfjäll, D. (2008). Emotional responses to music: the need to consider underlying mechanisms. *Behavioral and Brain Sciences, 31,* 559–575. doi:10.1017/S0140525X08005293

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

Kirschbaum, C. (2010). Trier Social Stress Test. In I. P. Stolerman (Ed.), *Encyclopedia of Psychopharmacology* (chapter ID: 0001093214). Berlin: Springer-Verlag; 2010. doi:10.1007/978-3-540-68706-1

Kirschbaum, C., Pirke, K. M., & Hellhammer, D. H. (1993). The ‘Trier Social Stress Test’ – A tool for investigating psychobiological stress responses in a laboratory setting. *Neuropsychobiology, 28,* 76–81.

Knight, W. E. J., & Rickard, N. S. (2001). Relaxing music prevents stress-induced increases in subjective anxiety, systolic blood pressure, and heart rate in healthy males and females. *Journal of Music Therapy, 38,* 254-272.

Kudielka, B. M, & Wüst, S. (2010). Human models in acute and chronic stress: Assessing determinants of individual hypothalamus-pituitary-adrenal axis activity and reactivity. *Stress, 13,* 1–14. doi:10.3109/10253890902874913

Kyrou, I., & Tsigos, C. (2009). Stress hormones: Physiological stress and regulation of metabolism. *Current Opinion Pharmacology, 9,* 787–793. doi:10.1016/j.coph.2009.08.007

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

Levine, G., & Parkinson, S. (1994). Single-factor designs: Simple experimental designs that incorporate the rules for research. In G. Levine & S. Parkinson (Eds.), *Experimental Methods in Psychology* (pp.54–88). New York: Lawrence Erlbaum Associates, Inc.

Lundberg, U. (2006). Stress, subjective and objective health. *International Journal of Social Welfare, 15,* S41–48. doi:10.1111/j.1468-2397.2006.00443.x

Maxwell, S. D., & Delaney, H. D. (2004). *Designing experiments and analysing data* (2nd ed., vol. 1). Mahwah: Lawrence Erlbaum Associates, Inc.

Megías, I., & Rodríguez, E. (2002). *Jóvenes entre sonidos: hábitos, gustos y referentes musicales* [Youth between sounds. Habits, hobbies and musical references]. Madrid: Fundación de Ayuda contra la Drogadicción.

Melillo, P., Bracale, M., & Pecchia, L. (2011). Nonlinear heart rate variability features for real-life stress detection. Case study: Students under stress due to university examination. *Biomedical Engineering Online, 10*, 96. doi:10.1186/1475-925X-10-96

Miller, G. A., & Chapman, J. P. (2001). Misunderstanding analysis of covariance. *Journal of Abnormal Psychology, 110*, 40–48. doi:10.1037//0021-843X.110.1.40

Nyklíček, I., Mommersteeg, P. M. C., van Beugen, S., Ramakers, C., & van Boxtel, G. J. (2013). Mindfulness-based stress reduction and physiological activity during acute stress: A randomized controlled trial. *Health Psychology, 32*, 1110–1113. doi:10.1037/a0032200

Oei, N. Y. L., Everaerd, W. T. A. M., Elzinga, B. M., van Well, S., & Bermond, B. (2006). Psychosocial stress impairs working memory at high loads: An association with cortisol levels and memory retrieval. *Stress: The International Journal on the Biology of Stress, 9*, 133–141. doi:10.1080/10253890600965773

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

Pieper, S., & Brosschot, J.F. (2005). Prolonged stress-related cardiovascular activation: Is there any? *Annals of Behavioral Medicine, 30*, 91–103. doi:10.1207/s15324796abm3002_1

Richman, J. A., & Moorman, J. R. (2000). Physiological time-series analysis using approximate entropy and sample entropy. *American Journal of Physiology. Heart and Circulatory Physiology, 278*, H2039–H2049.

Ruipérez, M. A., Ibáñez, M. I., Lorente, E., Moro, M., & Ortet, G. (2001). Psychometric properties of the Spanish version of the BSI: Contributions to the relationship between personality and psychopathology. *European Journal of Psychological Assessment, 17*, 241–250. doi:10.1027//1015-5759.17.3.241

Sánchez, C., Moreno, F., Albarracín, D., Fernández, J. D., & Vico, F. J. (2013). Melomics: A case-study of AI in Spain. *AI Magazine, 34,* 99–103. doi:10.1609/aimag.v34i3.2464

Shelhamer, M. (2007). *Nonlinear dynamics in physiology. A state-space approach* (pp. 149–150). Singapore: World Scientific Publishing.

Smyth, J., Zawadzki, M., & Gerin, W. (2013). Stress and disease: A structural and functional analysis. *Social and Personality Psychology Compass*, *7*, 217–227. doi:10.1111/spc3.12020

Spielberger, C. D,, Gorsuch, R. L., Lushene, R,, Vagg, P. R,, & Jacobs, G. A. (1983· *Manual for the State-Trait Anxiety Inventory (Form Y) ("self-evaluation questionnaire")*. Palo Alto: Consulting Psychologists Press.

Steptoe, A., Hamer, M., & Chida, Y. (2007). The effects of acute psychological stress on circulating inflammatory factors in humans: A review and meta-analysis. *Brain, Behavior, and Immunity, 21*, 901–912. doi:10.1016/j.bbi.2007.03.011

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

Tarvainen, M. P., Niskanen, J. P., Lipponen, J. A., Ranta-aho, P. O., & Karjalainen, P. A. (2009). Kubios HRV – A software for advanced heart rate variability analysis. In J. van der Sloten, P. Verdonck, M. Nyssen, & J. Haueisen (Eds.), *4th European Conference of the International Federation for Medical and Biological Engineering IFMBE Proceedings* (Vol. 22) (pp. 1022–1025). Antwerp: Springer.

Task Force of the European Society of Cardiology & North American Society of Pacing and Electrophysiology. (1996). Heart rate variability: Standards of measurement, physiological interpretation, and clinical use. *Circulation, 93*, 1043–1065. doi:10.1161/01.CIR.93.5.1043

TEA Ediciones. (1994). *Adaptación española del Cuestionario de Ansiedad Estado-Rasgo* [Spanish adaptation of State-Trait Anxiety Inventory]. Madrid: TEA Ediciones.

Thayer, J. F., & Lane, R. D. (2009). Claude Bernard and the heart-brain connection: Further elaboration of a model of neurovisceral integration. *Neuroscience and Biobehavioral Reviews, 33*, 81–88. doi:10.1016/j.neubiorev.2008.08.004

Thoits, P. A. (2010). Stress and Health: Major findings and policy implications. *Journal of Health and*

Social Behavior, 51, S41-S53. doi:10.1177/0022146510383499

Thoma, M. V., La Marca, R., Brönnimann, R., Finkel, L., Ehlert, U., & Nater, U. M. (2013). The effect of music on the human stress response. *PLoS One, 8*, e70158. doi:10.1371/journal.pone.0070156

Tombaugh, T. N. (2006). A comprehensive review of the Paced Auditory Serial Addition Test (PASAT). *Archives of Clinical Neuropsychology*, *21*, 53–76. doi:10.1016/j.acn.2005.07.006

Varvogli, L., & Darviri, C. (2011). Stress management techniques: Evidence-based procedures that reduce stress and promote health. *Health Science Journal*, *5*, 74–89.

Västfjäll, D., Juslin, P. N., & Hartig, T. (2012). Music, subjective wellbeing, and health: the role of everyday emotions. In R. A. R. MacDonald, G. Kreutz & L. Mitchell (Eds.), *Music, health, and wellbeing* (pp. 405–423). New York: Oxford University Press.

Vlemincx, E., Vigo, D., Vansteenwegen, D., van den Bergh, O., & Van Diest, I. (2013). Do not worry, be mindful: Effects of induced worry and mindfulness on respiratory variability in a nonanxious population. *International Journal of Psychophysiology, 87*, 147–151. doi:10.1016/j.ijpsycho.2012.12.002

Williamon, A., Aufegger, L., Wasley, D., Looney, D., & Mandic, D. P. (2013). Complexity of physiological responses decreases in high-stress musical performance. *Journal of the Royal Society, Interface, 25*, 20130719. doi:10.1098/rsif.2013.0719

World Health Organization. (2008). *Global health diplomacy: Negotiating health in the 21st century*. Retrieved from http://www.who.int/dg/speeches/2008/20081021/en/

Yamamoto, M., Naga, S., & Shimizu, J. (2007). Positive musical effects on two types of negative stressful conditions. *Psychology of Music, 35*, 249–275. doi: 10.1177/0305735607070375

Yassouridis, A., Ludwig, T., Steiger, A., & Leisch, F. (2012). A new way of identifying biomarkers in biomedical basic-research studies. *PLoS One, 7,* e35741. doi:10.1371/journal.pone.0035741

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

Zhang, J. M., Wang, P., Yao, J. X., Zhao, L., Davis, M. P., Walsh, D., & Yue, G. H. (2012). Music interventions for psychological and physical outcomes in cancer: A systematic review and meta-analysis. *Supportive Care in Cancer, 20*, 3043–3053. doi:10.1007/s00520-012-1606-5

Tables and Figures

Table 1

Sociodemographic, lifestyle, and psychopathological features of sample.

	Experimental groups		Contrast
	Control	Relaxing music	
Sociodemographics			
Age (years)	22.50 (3.22)	23.70 (2.31)	43.50
Gender (% males)	25	30	.07
BMI (kg/m^2)	22.99 (2.96)	23.52 (3.66)	55.00
Lifestyle features			
Tobacco consumption (% smokers)	25	10	.82
Cigarettes/day	7 (5.20)	10 (0)	1.00
Coffee intake (cup/day)	1.73 (.65)	2.57 (.98)	18.50
Other caffeinated drinks (cup/day)	1.92 (.79)	2.10 (.88)	52.50
Sport practice (% practitioners)	75	60	.57
Frequency of practice (days)	1.64 (1.43)	1.89 (2.03)	47.00
Preferred music styles †			
African-American music	6.78 (3.53)	9.50 (4.37)	16.00
Latin and Spanish music	3 (2.34)	4.33 (2.80)	20.00
Hard rock and related music	8.11 (3.41)	6.50 (4.59)	18.00
Pop and soft music	8.67 (2.45)	7.67 (3.08)	21.00
Rebellious music	4.56 (2.92)	5.83 (2.14)	19.50
Dance music	2.22 (2.99)	4.83 (2.48)	16.00
Regional and folk music	3.22 (2.11)	4.33 (2.34)	18.00
Psychopathology			
GSI•	.75 (.52)	.46 (.25)	32.50
PSDI•	1.48 (.36)	1.41 (.33)	41.00
PST•	24.36 (12.58)	17 (8.55)	28.00
Trait version of STAI	21.91 (11.92)	20.25 (10.35)	40.50

Note. Each variable attaches the correspondent unit of measure between brackets.
Quantitative variables are represented by the average and standard deviation (between brackets). Categorical variables are expressed by the percentage of cases.
Contrast tests were calculated by using the statistics *U* (for quantitative variables) and χ^2 (for categorical variables). For all contrasts, $p > .05$.
† Categories that compose this variable refer to the factors of the MSQ.
• Second-order factors of Brief Symptom Inventory (BSI): GSI=Global Severity Index; PST= Positive Symptom Total; PSDI=Positive Symptom Distress Index.

Table 2

Cardiovascular functioning throughout the study stages.

	Study stages				$\eta^2_{partial}$
	Baseline	Exposition	Recovery	*F*	
Time domain parameters					
Mean RR	791.65 (126.22)	673.82 (82.50)	871.13 (155.01)	22.33***	.61
RMSSD	44.41 (18.04)	125.64 (255.78)	381.65 (1264.10)	.65	.04
Frequency domain parameters					
LF	1.67 (.11)	1.81 (.11)	1.71 (.14)	10.37***	.43
HF	1.50 (.13)	1.25 (.36)	1.39 (.22)	3.42*	.20
Ratio LF/HF	1.08 (.57)	3.98 (5.06)	4.85 (14.35)	.48	.05

Note. The Mean RR is expressed in ms. LF refers to the potency in low frequency band; HF refers to the potency in high frequency band.

It was found post hoc differences for all variables with significant main effects. The differences were between baseline and exposition stages; and post hoc differences between exposition and recovery stages ($p < .05$, for both cases).

* $p < .05$; ** $p < .01$; *** $p < .001$.

Figure 1

Study CONSORT flow diagram.

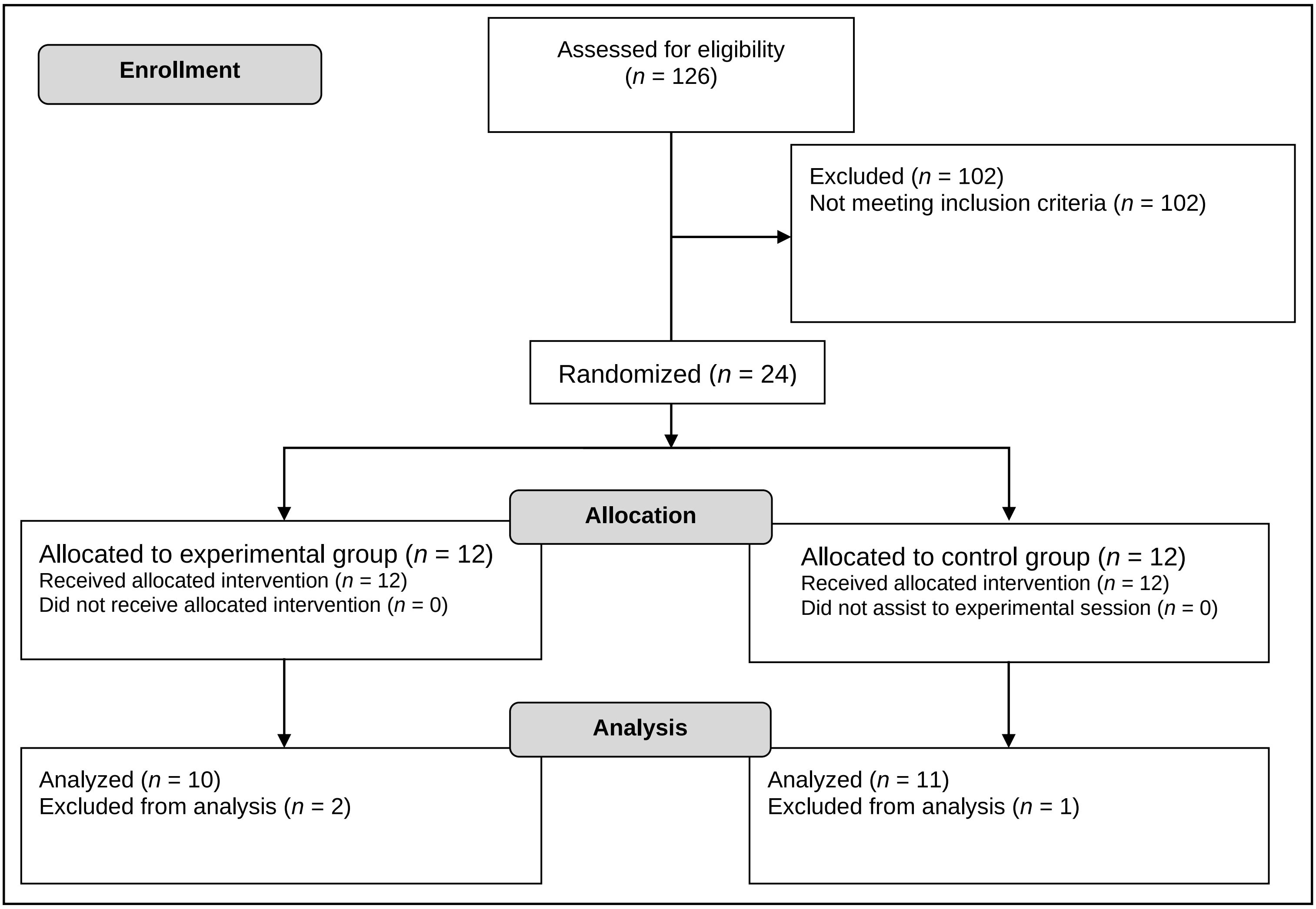
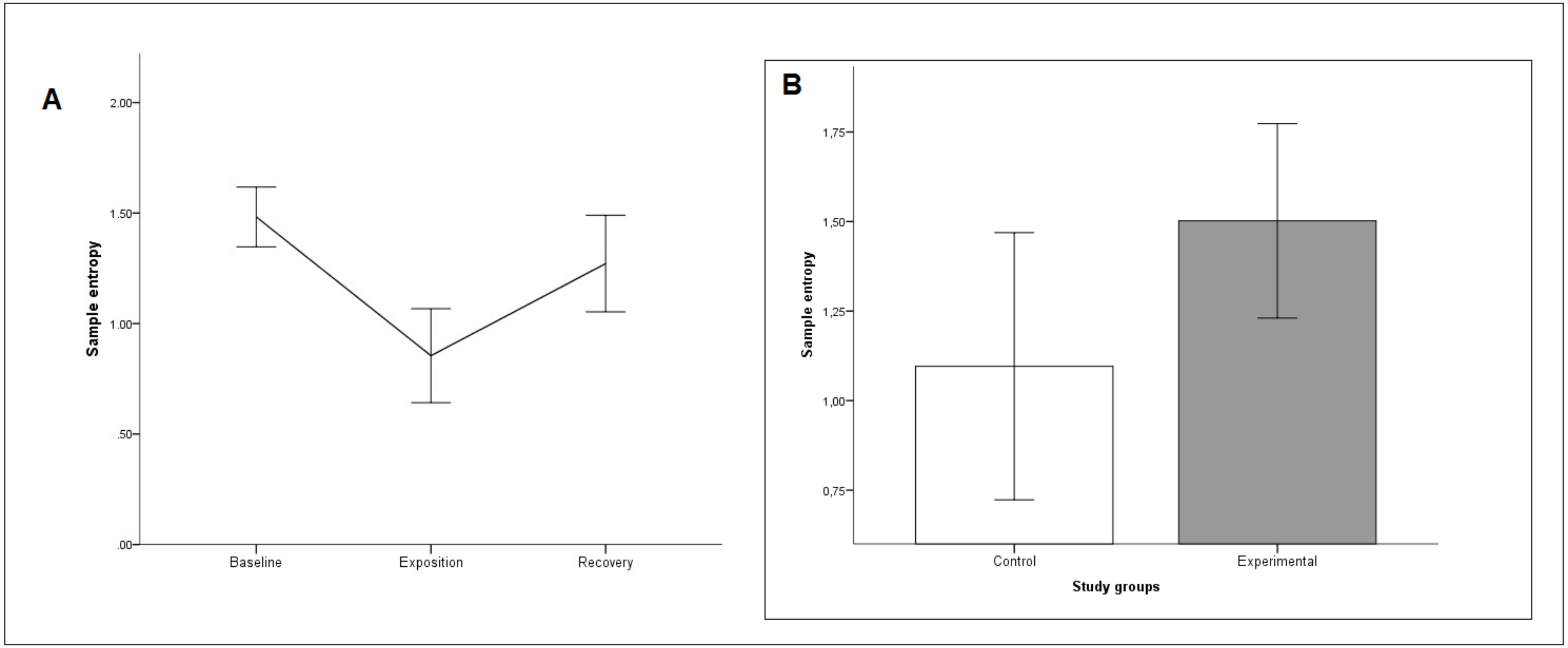


Figure 2

Sample entropy throughout the stages of the experimental session.



Note. Figure A shows the mean of sample entropy throughout the experimental session stages. Figure B displays the mean of sample entropy between study groups in the recovery stage.

Confidence interval at 95% level is represented in the figures by the error bars attached.