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The effect of music in anxiety reduction: A psychological and physiological assessment

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Abstract

Extensive research has been published on the effects of music in reducing anxiety. Yet, for most of the existing works, a common methodology regarding musical genres and measurement techniques is missing, which limits considerably the comparison between them. In this study, we assess, for the first time, markedly different musical genres with both psychological and physiological measurements. Three previously studied musical samples from different genres—classical (Pachelbel's Canon in D), Turkish (Hüseyin Makam), and electroacoustic (pure electronic)—were employed to influence "everyday anxiety" in 50 German participants (25 females, 25 males). Psychological (self-perception assessment) and physiological (heart rate measurement) indicators of anxiety, as most typical of prior work, were considered. Our study shows that listening to Pachelbel's Canon increases the self-perception of calm, whereas listening to the electroacoustic sample decreases it; the Turkish sample is in between. No differences in heart rate are found for any of the musical genres. Our study also suggests that listeners' self-perception might be biased by the statements used in the psychological evaluation (positive or negative), which are interpreted differently by the subjects depending on their current state.

Keywords

anxiety, self-perception, heart rate, STAI scale, Pachelbel Canon, electroacoustic music, Hüseyin Makam

Music has been used to improve human wellbeing from antiquity, a time when the conception of illness and medicine was mostly related to evil and curative supernatural powers (West, 2017). Theoretical evidence for the positive effects of music originated with Pythagoras, considered to be "the founder" of music therapy (Nilsson, 2008) and well known—beyond

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his geometrical theorem—for the doctrine of the *Harmony of the Spheres* (Godwin, 1993); according to this, music, soul, and universe would be governed by the same principles of mathematical order. Beyond theory, the effect of music has also been investigated from antiquity in terms of practice, as shown by the medieval Islamic medicine, which gave music a prominent role (Shiloah, 2017).

By listening to music, it is possible to counterbalance unpleasant symptoms of negative psychological processes such as anxiety. Pythagoras used to sing to his disciples to bring them to a serene mood (West, 2017), and even nowadays, the application of music-based treatments to reduce anxiety is rapidly gaining popularity (Nilsson, 2008). Yet, despite the numerous studies presented on this topic, comparisons between them are limited by great methodological diversity. For instance, although the evaluation of anxiety should encompass both subjective (psychological) and objective (physiological) measurements (Beck, Emery, & Greenberg, 2005), these two are not always performed simultaneously. Different researchers also follow different assessment criteria (Panteleeva, Ceschi, Glowinski, Courvoisier, & Grandjean, 2018), sometimes obtaining contradictory findings; yet, due to the methodological diversity, these are hardly interpretable (DeMarco, Alexander, Nehrenz, & Gallagher, 2012; Thoma et al., 2013). Finally, there is also a prominent bias toward the utilization of classical music, disfavoring other musical genres (Pelletier, 2004).

In this work, we evaluate to which extent music from three previously studied different genres—classical (Knight & Rickard, 2001), Turkish (Doğan & Şenturan, 2012), and electroacoustic (Parada-Cabaleiro, Baird, Cummins, & Schuller, 2017)—may reduce subjective and objective indicators of anxiety in 50 German participants (25 females, 25 males). The subjective measurement (based on the State-Trait Anxiety Inventory [STAI] scale) (Marteau & Bekker, 1992) and the objective measurement (based on resting heart rate [RHR]) were chosen as adequate assessment according to prior work (Nilsson, 2008; Pelletier, 2004). Unlike musical preference—whose role in reducing stress is not yet clear (Allen & Blascovich, 1994; Iwanaga & Moroki, 1999; Jiang, Zhou, Rickson, & Jiang, 2013)—listeners' familiarity was also considered. Furthermore, considering that music is often used by people to reduce stress (DeNora, 1999), "everyday" anxiety was evaluated.

In this study, we apply for the first time a "common methodology" by evaluating the use of music for anxiety reduction, based on previously studied musical genres and the most typically considered measurement procedures. We assess three musical samples by the simultaneous measurement of well-established psychological and physiological anxiety indicators; in previous work, these have not always been assessed concomitantly, and the considered measurement procedures were often different across studies, by that limiting their comparison. With this approach, we aim to enhance the comparability between our results and those from previous work. Furthermore, by studying "everyday" anxiety, we also aim to encourage the understanding of how therapeutic properties of music might be employed in real-life situations and not only in experimental settings.

The rest of the article is laid out as follows: section "Related research" summarizes the previous work; sections "Musical stimuli" and "Methodology" describe the musical stimuli and the methodology, respectively; section "Results" evaluates the results; section "Discussion and limitations" provides a general discussion and limitations of our work; finally, section "Conclusion and future work" concludes the article and outlines future goals.

Related research

It is generally accepted that music effectively decreases stress (Pelletier, 2004), but the specific psycho-physiological mechanisms and musical features involved in this process are not clear so far. Many authors agree that likable music might trigger good memories (Allen et al., 2001), distracting the listener from anxious states and therefore counterbalancing negative feelings (Jiang et al., 2013; Nilsson, 2008; Van Goethem & Sloboda, 2011). It has also been shown that using music to mask unpleasant noises in regional anesthesia interventions (Mok & Wong, 2003) reduces patients' levels of stress and that musical rhythm induces relaxation by regulating—through synchronization—listeners' heart rate (HR) and respiration (Mok &Wong, 2003). Moreover, the positive effects of music on patients with coronary heart diseases have been studied extensively (Bradt & Dileo, 2009). Interesting remarks on the influence of music in anxiety can also be found in the comprehensive research about music and emotion (Juslin, Liljeström, Västfjäll, Barradas, & Silva, 2008; Van Goethem & Sloboda, 2011)—specifically when related to fear. In this regard, the relationship between the emotions evoked by music and the physiological reactions to it has also been evaluated (Hu, Li, & Ng, 2018).

Previous work on the effect of music in reducing anxiety evaluates mostly three kinds of conditions: (1) "medical" anxiety, typically caused by a stressful event related to a medical intervention such as a surgical procedure or labor (Allen et al., 2001; Doğan & Şenturan, 2012; Phumdoung & Good, 2003); (2) "induced" anxiety, prompted by performing stressful tasks, for example, a challenging arithmetic exercise or a public speaking situation (Jiang et al., 2013; Knight & Rickard, 2001; Labbé, Schmidt, Babin, & Pharr, 2007; Thoma et al., 2013); and (3) "everyday" anxiety (Hubbard, 2003), caused by the daily "risks" typical of contemporary societies, such as fear of crime or occupational stress (Iwanaga & Moroki, 1999; Rohner & Miller, 1980). However, although listening to music with the aim of reducing stress is a common strategy used by people in their everyday lives (DeNora, 1999), the study of how music might reduce "everyday" anxiety, with respect to "medical" or "induced" anxiety, has received less attention (Linnemann, Ditzen, Strahler, Doerr, & Nater, 2015; Lonsdale & North, 2011; Pelletier, 2004).

Generally, these studies assess two types of anxiety indicators: psychological (subjectively measured) and physiological (objectively measured) (Nilsson, 2008; Pelletier, 2004). Yet, a standard procedure to evaluate such indicators is still missing, as shown by the great variety of methods employed by different researchers. For instance, the subjective measurement can be performed considering self-reported arousal, the STAI scale, or self-perception of mood (Nilsson, 2008; Pelletier, 2004); the objective measurement can be done by measuring HR, blood pressure, or respiratory rate, among others (Nilsson, 2008; Pelletier, 2004). The outcomes of measuring psychological and physiological indicators of anxiety might also be contradictory (DeMarco et al., 2012; Thoma et al., 2013). Thus, considering that many studies evaluate only one of them, a synopsis of the state-of-the-art is hardly doable. Moreover, previous research on this topic is biased toward the study of classical music (Iwanaga & Moroki, 1999; Pelletier, 2004; Rohner & Miller, 1980), while less conventional genres and *soundscapes* (Truax, 2008) have rarely been considered (Baird, Parada-Cabaleiro, Fraser, Hantke, & Schuller, 2018; Thoma et al., 2013). Factors such as familiarity and preference have also been investigated: while some studies showed that listeners' relaxation is mostly elicited when the music is familiar (Mok &Wong, 2003) and likable (Jiang et al., 2013), others showed that music influences listeners' relaxation regardless of their preferences (Iwanaga & Moroki, 1999). As some studies considered that preference would encourage listeners' relaxation, they allowed the users to choose the songs themselves (Mok & Wong, 2003), by that reducing experimental control and limiting a real understanding of the generic impact of specific musical features on decreasing anxiety.

Musical stimuli

In this study, as a first attempt to present a systematic evaluation across musical genres, we consider three samples from different music traditions, all of them already evaluated in prior research: classical music (Knight & Rickard, 2001; Lee & Orsillo, 2014), Turkish music (Doğan & Şenturan, 2012), and electroacoustic music (Parada-Cabaleiro et al., 2017); this guarantees comparability between the presented outcomes and those from previous research. As in previous work (Iwanaga & Moroki, 1999), samples of around 5 min were taken into account. To have full control over the selection of the musical samples, listeners' preference was not considered; this is a factor whose role in anxiety reduction is not yet clear (Iwanaga & Moroki, 1999; Jiang et al., 2013). In the evaluation of music familiarity (cf. subsection "Anxiety assessment"), using a scale from 1 to 5, all the listeners indicated to be familiar with the classical music sample ($M = 4.8$, $SD = 0.4$) and unfamiliar with the Turkish ($M = 1.7$, $SD = 0.6$) and electroacoustic ($M = 1.1$, $SD = 0.3$) samples. None of the samples had lyrics, as these are considered to be a confounding factor when using music for therapeutic purposes (Nilsson, 2008).

Classical music

Pachelbel's Canon in D, due to its slow tempo, repetitive rhythm, gentle contours, and strings timbre, is a typical example of "relaxing" music (Knight & Rickard, 2001). It has been repeatedly used by studies aimed to investigate the influence of music in reducing psychological and physiological indicators of stress (Allen & Blascovich, 1994; Chafin, Roy, Gerin, & Christenfeld, 2004; Knight & Rickard, 2001; Lee & Orsillo, 2014). A recording of Pachelbel's Canon in D major (*Deutsche Grammophon Resonance* series)[1] of 6.20-min length, performed by the *Lucerne Festival Strings* chamber orchestra and directed by R. Baumgartner, was considered. The recording was performed at 58 bpm (beats per minute); it was chosen as a compromise between slower performances considered in previous work, as, for example, that taken into account by Knight and Rickard (2001), and faster interpretations that follow historical criteria, which put emphasis on the use of "original" principles from the time in which the opera was composed, such as the baroque temperament, ornamentation, and interpretation style (Voices of Music, 2005).

Turkish music

According to the *Turkish music and movement therapy tradition*,[2] Hüseyin Makam[3] contains a variety of acoustic properties that are beneficial for human beings, showing, for instance, a special predisposition toward inducing relaxation. The Hüseyin Makam has been considered in the treatment of autism spectrum condition (Iseri et al., 2014) as well as for reducing anxiety (Doğan & Şenturan, 2012). A piece of instrumental music in Hüseyin Makam, published by Otag Music Center[4] and produced by Tümata[5] under the leadership of Dr Rahmi Oruç Güvenç, was considered. The first 6.20 min was taken into account; to give the listener the sensation of conclusion, the segment was cut at the end of a section and the sonority was dissolved through a fade-out. The musical sample starts with an improvisatory "introduction" performance of a solo with a *nay* (an end-blown flute made from cane); after that, the melodies of the *nay* flow above a rhythmic *ostinato* at 63 bpm in ternary subdivision performed by several string instruments (*rebab*, *çeng*, *ud*, *dombra*, and *rübab*), as well as a gurgle—sound of water created by pouring water from one container to another.

Electroacoustic music

The absolute control in sound generation inherent of electroacoustic music offers the possibility of creating infinite acoustic solutions. Still, despite the great amount of research on music

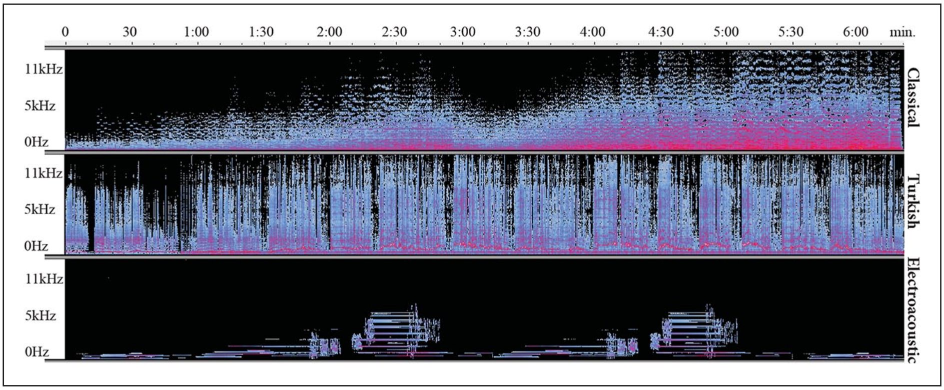

Figure 1. Spectrogram for Each Musical Sample: Classical Sample (Above), Turkish Sample (Middle), and Electroacoustic Sample (Below). Spectral Distribution Is Given Up to 11 kHz Over the 6.20 Min of Each Sample.

psychology (Thompson, 2015), it has rarely been investigated how the myriads of acoustic features typical of this music might be modeled to influence human psychology (Fan, Tatar, Thorogood, & Pasquier, 2017; Lykartsis, Pysiewicz, von Coler, & Lepa, 2013; Parada-Cabaleiro et al., 2017) and never, to the best of our knowledge, with the specific purpose of treating anxiety. A piece of *pure electronic* music based on additive synthesis and presented by Parada-Cabaleiro et al. (2017) as *Environment C*[6] was considered. The musical sample was repeated twice to match the length of 6.20 min;[7] it was chosen as highly dissimilar to the other two. Indeed, according to the concept of *Identidad SOnora* (ISO)[8] in Benenzon's music therapy theorization (Benenzon, 1991), this piece, which does not relate to the physiology or cultural past of the listeners, would be totally strange to them. From the acoustic point of view, it presents a spectral content compressed in a frequency band up to 5 kHz, thus contrasting with the other two, which display a rich harmonic distribution (cf. Figure 1). It is also rhythmically dissimilar because it develops through the addition and dissoluteness of overimposed sonic layers with different timbres, which are not rhythmically identifiable.

Methodology

To guarantee that the participants had a specific stress level before starting the experiment, previous research has considered to apply MIPs, that is, *Mood Induction Procedures* (Martin, 1990; Westermann, Stahl, Spies, & Hesse, 1996), to elicit anxiety (Jiang et al., 2013; Knight & Rickard, 2001; Thoma et al., 2013). Yet, from an ethical point of view, such mechanisms must be used carefully, since subjects' psychological stability should not be altered; thus, only transitory and low-intensity states might be elicited (Parada-Cabaleiro, Costantini, Batliner, Schmitt, & Schuller, 2019). Furthermore, the use of MIPs may also easily evoke the *demand effect*, that is, a condition in which the participants understand the purpose of the induction procedure; this might influence their behavior (Vaughan, 2011). Considering this and in accordance with previous work (Iwanaga & Moroki, 1999; Rohner & Miller, 1980), we assessed the effect of music in "everyday anxiety," that is, no induction procedure to elicit anxiety was employed; individuals' stress level was evaluated through a pre-/post-test comparison design, as typical of prior research on this topic (da Silva et al., 2014; Knight & Rickard, 2001; Mok & Wong, 2003).

Anxiety assessment

Anxiety is an emotional state characterized by unpleasant feelings such as nervousness and by physiological symptoms such as tremor, sweating, or increment in pulse rate (Beck et al., 2005). Therefore, an episode of anxiety is mainly linked to two factors: the subjective feeling and the objective symptoms. Indeed, both psychological and physiological measurements have already been considered in previous work (Nilsson, 2008; Pelletier, 2004) for evaluating the effect of music in reducing anxiety. Thus, we take into account both subjective and objective measurements.

Subjective measurement of anxiety. For the subjective assessment, we employed the six-item short-form of the *Spielberger State-Trait Anxiety Inventory* (STAI: Y-6 item), developed by (Marteau & Bekker, 1992) and extensively used in previous work on music and anxiety (Bradt & Dileo, 2009; Hammer, 1996; Knight & Rickard, 2001; Lee & Orsillo, 2014; Mok & Wong, 2003; Panteleeva et al., 2018; Pelletier, 2004; Thoma et al., 2013). The STAI: Y-6 scale presents six statements, which are rated by the user according to a four-level scale, where 1 stands for *not at all*, 2 for *somewhat*, 3 for *moderately*, and 4 for *very much*. Three of the six statements relate to positive feelings: "I feel calm," "I am relaxed," and "I feel content" and the other three to negative feelings: "I am tensed," "I feel upset," and "I am worried." Both kinds of statements are mixed. As the type of statement (positive/negative) might influence participants' responses, the ratings for each type were evaluated as separate scores—from now on identified as STAI-calm and STAI-anx (anxious) for the self-perception of positive and negative statements, respectively. Note that for both self-perceptions of calm and of anxious, three statements were rated according to a four-level scale; thus, the average score for each of these will be interpreted from a minimum of 3 (meaning *not at all*) to a maximum of 12 (*very much*); 6 (*somehow*), and 9 (*moderately*) are in between. The STAI-6 was performed before and after the participants listened to the music.

Objective measurement of anxiety. For the objective assessment, we measured the heart rate (HR) of the participants; this is a physiological indicator of distress conditions (Beck et al., 2005) and is typically considered in previous work on music and anxiety (Bradt & Dileo, 2009; Knight & Rickard, 2001; Mok & Wong, 2003; Pelletier, 2004; Thoma et al., 2013). Although both heart rate variability (HRV) and resting heart rate (RHR) are commonly considered to predict stress disorders, HRV has been shown to be biased toward high HR ranges, which are typical of females (Khanade & Sasangohar, 2017). Furthermore, HRV has also been shown not to be affected by different musical rhythms (da Silva et al., 2014) or in patients with coronary heart diseases treated by music-based intervention (Bradt & Dileo, 2009). According to this, only RHR—measured before and after listening to music—was considered; from now on, we refer to RHR as HR.

Listening test set-up

A total of 50 subjects (25 females, 25 males) with ages from 17 to 71 years ($M = 26$, $SD = 11.2$) listened to the three musical samples. To avoid a different cultural bias (Stevens, 2012), all the listeners were German. To evaluate how the considered musical genres might influence listeners' level of anxiety, before and after listening to each sample, two measures of anxiety—subjective (STAI-6) and objective (HR)—were performed. To avoid an influence of sequentially listening to the different samples one after the other, the listening experiment for each musical genre took place on different days, and the order in which the samples were presented to each participant was randomly assigned.

Subjective and objective assessments were simultaneous, that is, the HR of the participants was measured while they were performing the STAI-6. The STAI-6 was presented through a forced-choice smartphone-based interface hosted on the online platform *Typeform*,[9] whereas the HR was measured by a (nonwearable) device for self-monitoring (*aponorm* by microlife). Once the first assessment was performed, that is, subjective and objective measurements before listening to the music (pre-test), one of the three musical samples (randomly chosen) was presented to the participants on headphones through the *Typeform* interface; after that, the subjective and objective assessments were again performed (post-test). At the end of each session, the participants also evaluated through a scale from 1 to 5 (where 1 indicates *not at all* and 5 indicates *very much*) the level of musical familiarity with respect to the sample they listened to.

Statistical evaluation

We follow an analysis design in which subjective and objective measurements collected before and after listening to the music were compared. To minimize the differences between the initial anxiety level across participants, all the scores collected before the listening test (i.e., during the three pre-tests) were evaluated together as a unique class,[10] whereas for those collected thereafter (i.e., during the three post-tests) the musical genres were treated separately. The following variables were considered: (1) two independent variables (IVs): LISTENING-CONDITION (nominal: Before music, After (A)-classical, A-Turkish, A-electroacoustic) and GENDER (binary: female, male); (2) one covariance variable (CV): age (scale: 17–71 years); (3) three dependent variables (DVs): two subjective, that is, STAI-calm and STAI-anx (scale: 3–12 points) and one objective, that is, HR (continuous: 60–99 bpm).

The results are evaluated through multivariate and univariate analysis of variance and covariance and simple linear regression (Field, 2013; Pituch & Stevens, 2015). For the multivariate analysis, the statistic test Wilks' lambda (Λ) is reported; eta-squared (η^2) as measure of effect size is indicated for both multivariate and univariate evaluations. In multiple comparisons, Tukey's post hoc was chosen and Cohen's *d* is given as effect size. For the analysis of covariance, simple contrast and Bonferroni correction for confidence interval adjustment were considered; in tests with 1 degree of freedom, unstandardized coefficient B and Pearson's correlation coefficient r are indicated, and in linear regression, R^2 is also given. For all the tests, degrees of freedom and *F* statistics are indicated. We report *p*-values as a descriptive device, not as criteria for a binary "significant/not significant" decision.[11] For reproducibility, we make the SPSS (International Business Machines [IBM] Corporation, 2012) dataset collected for this study freely accessible.[12]

Results

Subjective measurement: STAI scale

A 2-way multivariate analysis of variance (MANOVA) and two 2-way univariate analyses of variance (ANOVAs) were performed to assess whether the IVs (LISTENING-CONDITION and GENDER) might have an effect on the subjective DVs (STAI-calm and STAI-anx). The analysis of the interaction effect for the multivariate analysis shows no meaningful relationship between

Table 1. Results for 2-way MANOVA on the combined subjective dependent variables (DVs).

Effect	IV	Λ	*df*1	*df*2	*F*	*p*	η²
Int.	*	.985	6	582	0.713	.639	.007
Main	GEN	.999	2	291	0.182	.834	.001
	LIST-CON	.735	6	582	16.109	.000	.142

MANOVA: multivariate analysis of variance.
Effects: Interaction (Int.), Main; Independent variables (IVs): gender (gen), listening-condition (list-con), interaction of both (*); Wilks' lambda (Λ), degrees of freedom (*df*1, *df*2), *F*-test, *p*-value, and eta-squared (η^2) are given.

Table 2. Results for 2-way ANOVA on the subjective dependent variables (DVs): STAI-calm and STAI-anx.

Effect	IV	DV	*df*1	*df*2	*F*	*p*	η²
Int.	*	STAI-calm	3	292	1.339	.262	.014
		STAI-anx	3	292	0.407	.748	.004
Main	GEN	STAI-calm	1	292	0.240	.624	.001
		STAI-anx	1	292	0.008	.930	.000
Main	LIST-CON	STAI-calm	3	292	24.019	.000	.198
		STAI-anx	3	292	2.789	.041	.028

ANOVA: analysis of variance; STAI: State-Trait Anxiety Inventory.
Effects: Interaction (Int.), Main; Independent variables (IVs): GENDER (GEN), LISTENING-CONDITION (LIST-CON), interaction of both (*); degrees of freedom (*df*1, *df*2); *F*-test; *p*-value; and eta-squared (η^2).

Table 3. Mean, *SD*, and sample size (*N*) of the scores given by GENDER (GEN): female (F), male (M), and both (total); in the STAI-6 (STAI-calm and STAI-anx), for all the LISTENING-CONDITIONS (LIST-CON): *before* and *after* (*A*) listening to the *classical, Turkish*, and *electroacoustic* samples.

LIST-CON	GEN	*N*	STAI-anx		STAI-calm	
			Mean	*SD*	Mean	*SD*
Before	F	75	4.71	1.75	8.83	2.21
	M	75	4.67	1.85	8.73	2.02
	Total	150	4.69	1.79	8.78	2.11
A-classical	F	25	4.84	1.74	11.0	1.55
	M	25	5.16	1.74	10.5	1.63
	Total	50	5.00	1.74	10.7	1.59
A-Turkish	F	25	4.36	1.63	8.64	1.75
	M	25	3.92	1.18	9.40	1.65
	Total	50	4.14	1.42	9.02	1.73
A-electroacoustic	F	25	5.00	1.97	7.84	1.99
	M	25	5.08	1.89	7.16	1.88
	Total	50	5.04	1.91	7.50	1.95

STAI: State-Trait Anxiety Inventory.

the IVs and their influence on the combined subjective DVs, as shown by a very small effect size: $\eta^2 = .007$ (cf. Int. in Table 1). The same holds for the univariate analysis, that is, no interaction effect between the two IVs is shown for STAI-calm: $\eta^2 = .014$ or for STAI-anx: $\eta^2 = .004$ (cf.

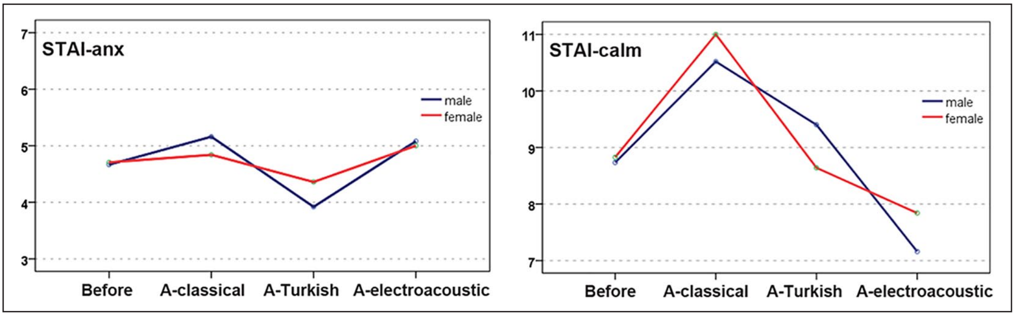

Figure 2. Mean Scores (from a Minimum of 3 to a Maximum of 12) Given by Males and Females *Before* and *After* (*A*) Listening to the Musical Samples: *Classical, Turkish*, and *Electroacoustic*; for the Self-Perception of Anxious (STAI-anx) and Calm (STAI-calm).
STAI: State-Trait Anxiety Inventory.

Int. in Table 2). This indicates that there is no noticeable difference between females' and males' self-perception of calm and anxious in any of the listening conditions, as also shown by their similar mean scores within each of them (cf. Table 3).

The analysis of the main effects confirms that GENDER does not influence the combined subjective DVs, as shown by a very small effect size: $\eta^2 = .001$ (cf. Main GEN in Table 1). This also holds for the univariate analysis, that is, GENDER does not influence any of the DVs, as shown by their small effect sizes: $\eta^2 = .001$ for STAI-calm; $\eta^2 < .001$ for STAI-anx (cf. Main GEN in Table 2). Differently, LISTENING-CONDITION influences the combined subjective DVs, which is shown by a big effect size: $\eta^2 = .142$ (cf. Main LIST-CON in Table 1). The univariate analysis indicates that this influence is very strong for STAI-calm: $\eta^2 = .198$ and small for STAI-anx: $\eta^2 = .028$ (cf. Main LIST-CON in Table 2). This difference might be due to the effect of STAI statements (positive/negative) on listeners' self-perception. Considering that participants' state before listening to the samples was generally positive—the mean score for STAI-calm was 8.78 (almost *moderately* calm), whereas for STAI-anx it was 4.69 (rather *not at all* anxious), cf. *Before* total in Table 3—we interpret that the participants might be more sensitive to express their state in positive statements.

Multiple comparisons of the IV LISTENING-CONDITION—taking the class *Before* as a reference—were performed for the subjective DVs separately. As the IV GENDER did not show an effect in ANOVA, it was no longer taken into account. The multiple comparisons show no noticeable differences between the STAI-anx scores collected before and after listening to the music, as displayed by their similar mean scores (cf. "*Before* vs. *A-classical, A-Turkish*, and *A-electroacoustic*" in Figure 2, left). Indeed, the higher difference—"*Before* vs. *A-Turkish*"—is still irrelevant, as indicated by its small effect size: $d = 0.34$ (mean diff. = 0.55, $p = .230$), cf. difference between *Before* total and *A-Turkish* total in Table 3. Differently, the STAI-calm scores collected before and after listening to music are markedly different. Classical music highly increases the self-perception of calm, as indicated by the large effect size shown for "*Before* vs. *A-classical*": $d = 1.05$ (mean diff. = 1.98, $p < .001$), cf. difference between *Before* total and *A-classical* total in Table 3. On the contrary, listening to the electroacoustic sample moderately decreases it, as shown by the medium effect size for "*Before* vs. *A-electroacoustic*": $d = 0.62$ (mean diff. = −1.28, $p < .001$), cf. difference between *Before* total and *A-electroacoustic* total in Table 3. Minimal gender-related differences are illustrated in Figure 2, whereas the exact figures are given in Table 3.

Table 4. Results for MANCOVA (*) and ANCOVA for the effect of the IV LISTENING-CONDITION and the CV AGE on the subjective dependent variables (DVs): STAI-calm and STAI-anx.

DV	Λ	*df*1	*df*2	*F*	*p*	η^2	*B*	*r*
*	.971	2	294	4.451	.012	.029	–	–
STAI-calm	–	1	296	4.857	.028	.016	–.019	.015
STAI-anx	–	1	296	0.543	.462	.002	–.006	.001

MANCOVA: multivariate analysis of covariance; ANCOVA: analysis of covariance; STAI: State-Trait Anxiety Inventory; IV: independent variable; CV: covariance variable.
Wilks' lambda (Λ), degrees of freedom (*df*1, *df*2), *F*-test, *p*-value, eta-squared (η^2), *B*, and Pearson's correlation coefficient (*r*) are given.

Table 5. Results for 2-way ANOVA on the objective DV and linear regression with AGE.

IV	*df*1	*df*2	*F*	*p*	η^2	R^2	*B*	*r*
*	3	292	0.032	.992	.000	–	–	–
GENDER	1	292	3.151	.077	.011	–	–	–
LIST-CON	3	292	1.300	.275	.013	–	–	–
AGE	1	298	26.511	.017	.000	.082	−.208	.286

ANOVA: analysis of variance; DV: dependent variable; IV: independent variable.
IVs: GENDER (GEN), LISTENING-CONDITION (LIST-CON), interaction (*); degrees of freedom (*df*1, *df*2); *F*-test; *p*-value; eta-squared (η^2), R^2 , *B*, and Pearson's correlation coefficient (*r*) are given.

To evaluate whether the CV AGE might have a relationship with the IV LISTENING-CONDITION in the subjective DVs (STAI-calm and STAI-anx), a multivariate analysis of covariance (MANCOVA) and two univariate analyses of covariance (ANCOVAs) were performed. The multivariate analysis indicates that AGE has almost no influence on the combined subjective DVs, as shown by the small effect size $\eta^2 = .029$ (cf. * in Table 4). The negative B coefficients in the univariate analysis indicate that as the age increases, the self-perception of both calm ($B = -.019$) and anxious ($B = -.006$) decreases. Still, the influence of AGE is small for STAI-calm ($\eta^2 = .016$) and irrelevant for STAI-anx ($\eta^2 = .002$), showing in both cases a negligible correlation: STAI-calm ($r = .015$) and STAI-anx ($r = .001$), cf. STAI-calm and STAI-anx in Table 4.

Objective measurement: HR

A 2-way ANOVA was performed to evaluate whether the two IVs (GENDER and LISTENING-CONDITION) might have an effect on the objective DV HR. The analysis of the interaction effect shows no noticeable relationship between the IVs and its influence on the DV, as shown by a null effect size: $\eta^2 = .000$ (cf. * in Table 5). The same holds for the simple main effects analysis, which shows no noticeable differences in HR either for GENDER: $\eta^2 = .011$ or for LISTENING-CONDITION: $\eta^2 = .013$ (cf. GENDER and LIST-CON in Table 5). This indicates that the participants' HR was not affected by any of the musical samples, as shown by their similar mean HR across GENDER and LISTENING-CONDITION (cf. Table 6). Still, these results might not be totally accurate due to the violation of the homogeneity assumption for the ANOVA, with Levene's test yielding $F(7, 292) = 3.336$ and $p = .002$. To evaluate the relationship between the continuous IV AGE and the objective DV HR, a simple linear regression was performed (cf. AGE in Table 5). The negative B coefficient ($B = -.208$) indicates that as age increases, the HR

Table 6. Mean and *SD* of the HR of female, male, and both (total) participants, in the different LISTENING-CONDITIONS (LIST-CON).

LIST-CON	Female		Male		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*
Before	77.1	13.1	74.5	11.1	75.7	12.1
A-classical	72.9	12.9	73.3	11.5	73.1	12.1
A-Turkish	74.0	12.6	70.4	12.6	72.2	11.6
A-electroacoustic	76.0	10.2	73.4	10.4	74.6	10.3

HR: heart rate.
For the sample size, cf. Table 3.

decreases. Still, Pearson's correlation coefficient indicates that the correlation between AGE and HR is low ($r = .286$), cf. AGE in Table 5.

Before vs. after: Delta comparisons

Our results show that self-perception of calm increases after listening to Pachelbel's Canon and decreases after listening to electroacoustic music, whereas Turkish music does not have a noticeable influence. This is displayed by comparing the Delta (Δ) scores of the evaluated samples, computed between before and after listening to music: For classical music, the Delta scores are predominantly positive (sum of Δ=102); for electroacoustic, negative (sum of Δ=–105); and for Turkish, in between (sum of Δ=50); cf. STAI-calm in Figure 3. The self-perception of anxious seems not to be specially affected by any of the musical samples; however, this might be due to the relatively calm initial state of the listeners. This is shown by the similarity between the Delta scores across the evaluated musical samples, especially for classical and electroacoustic (sum of Δ=23 and Δ=27, respectively); for the Turkish sample, the sum is slightly negative (sum of Δ=–44); cf. STAI-anx in Figure 3. Indeed, our study indicates that the statements used to assess participants' emotional state are interpreted differently depending on their current state, that is, anxious listeners would be more predisposed to evaluate their self-perception with negative statements—reacting rather neutral to the positive ones—whereas calm listeners would be more sensitive to positive statements. Listener's HR seems not be affected by any of the musical samples either, as shown by the high similarity between the Delta scores, all of them being negative: classical (sum of Δ=–70), Turkish (sum of Δ=–50), and electroacoustic (sum of Δ=–97); cf. HR in Figure 3.

Discussion and limitations

In line with previous research (DeMarco et al., 2012), the physiology of participants was not affected by listening to music. Indeed, even though Pachelbel's Canon (which had a slow bpm) was effective in increasing the self-perception of calm—by that confirming previous research (Knight & Rickard, 2001), this sample did not show an effect in participants' HR—by that corroborating some previous findings (da Silva et al., 2014) but contradicting others (Knight & Rickard, 2001). Previous work with a similar experimental design to ours, that is, a pre- and post-test comparison, has in fact shown contradictory outcomes: On the one hand, research has shown that neither Pachelbel's Canon nor other contrasting musical genres, such as heavy

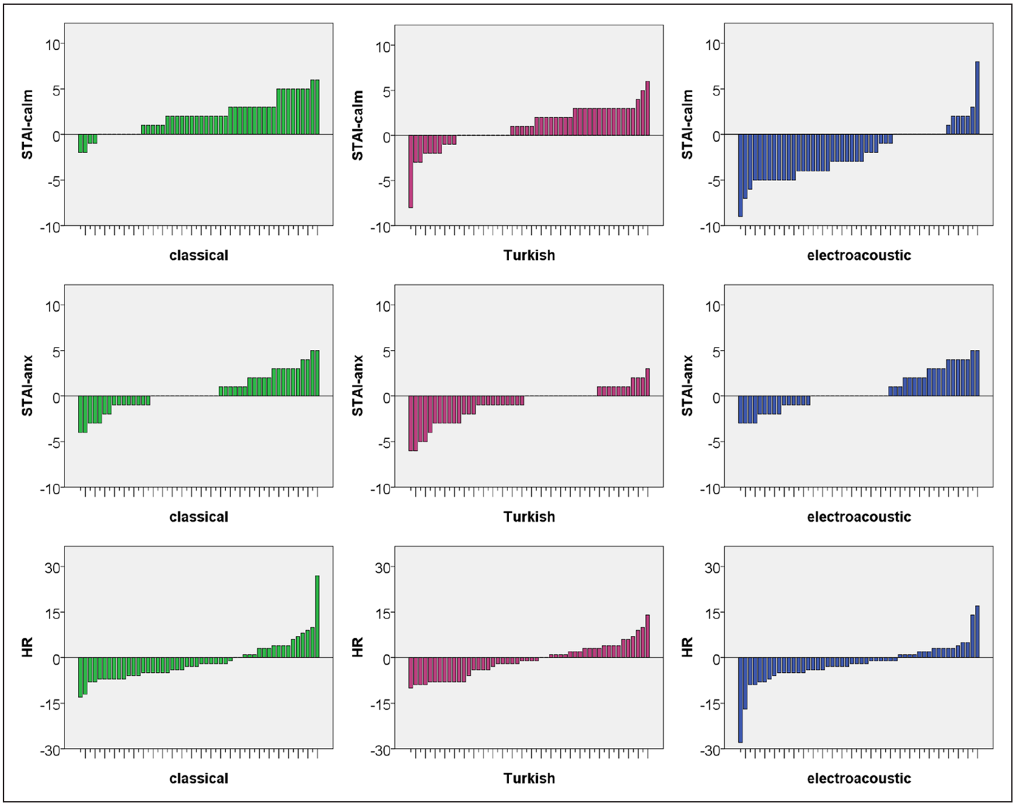

Figure 3. Delta (Δ) Values for the Independent Variable LISTENING-CONDITION, that is, Difference between Before and After Listening to Each Musical Sample (Classical, Turkish, and Electroacoustic) Is Indicated, Ordered from Lower to Higher, for All the Participants; Values for the Two Subjective Dependent Variables STAI-calm and STAI-anx and for the Objective Dependent Variable HR Are Given.
HR: heart rate; STAI: State-Trait Anxiety Inventory.

metal, influence listener's HR regulation (da Silva et al., 2014); on the other hand, research has shown that Pachelbel's Canon reduces listeners' HR with respect to a control group without listening to music (Knight & Rickard, 2001). In our study, none of the evaluated musical samples showed an effect in listener's HR, which is indicated by the high similarity of the Delta scores across the samples (cf. HR in Figure 3). We could attribute this discrepancy to the experimental procedure: The use of a non-wearable device might have influenced the participants' responses; however, the short length of the musical samples (6.20 min each) may have reduced the music effectiveness (Nilsson, 2008). Nevertheless, previous work considering less intrusive devises (such as a heart monitor belt placed around the thorax) and longer music sessions (20 min) showed comparable outcomes with respect to those herein presented (da Silva et al., 2014). Indeed, these contradicting outcomes might also be due to differences in the experimental design: evaluating the effect of music in reducing "induced" anxiety (Knight & Rickard, 2001) versus "everyday" anxiety.

Supporting previous findings (Mok & Wong, 2003), music familiarity seems to play a role in the relaxing effect of music. This general statement seems to be confirmed by comparing our outcomes for each musical sample with those presented in previous research. Pachelbel's

Canon, known by all the participants, increased the self-perception of calm, as already shown in previous work considering also the STAI scale (Knight & Rickard, 2001). Electroacoustic music, totally unfamiliar to the listeners, decreased their self-perception of calm,[13] which confirms that the considered sample in particular, and electroacoustic music in general, promotes negative emotional states (Parada-Cabaleiro et al., 2017). Turkish music, unknown but presenting clearly identifiable rhythms, that is, a familiar musical feature missing in the electroacoustic sample, did not show an effect, by that contradicting the outcomes from previous work on the same musical sample (Doğan & Şenturan, 2012). This might be due, as previously pointed out, to the experimental differences between the two studies: evaluating the effect of Hüseyin Makam in reducing "medical" anxiety (Doğan & Şenturan, 2012) versus "everyday" anxiety. However, the difference between Turkish and electroacoustic music might also depend on whether these are pleasant or not for the listeners—a factor whose role is not yet clear in anxiety reduction (Allen & Blascovich, 1994; Iwanaga & Moroki, 1999; Jiang et al., 2013); this should be further investigated.

Our study showed that listening to Pachelbel's Canon increases the self-perception of calm, listening to the Turkish sample does not cause an effect, and listening to the electroacoustic one decreases it. These outcomes might be interpreted along the lines of ISO, that is, the *Identidad SOnora* (Benenzon, 1991); in music therapy, this indicates the "Music Sound Identity," which is unique to each person and emerges from human unconscious knowledge, often related to the surrounding environment in childhood (MacDonald, Kreutz, & Mitchell, 2012). According to this theory, Pachelbel's Canon (for string chamber orchestra) would be the closest to Western listeners, the electroacoustic sample (based on synthetic sound) would be totally strange to them, and the Turkish sample (based on Turkish musical instruments) would be in between. Furthermore, this goes also along with the idea that the sound of string instruments—predominant in Pachelbel's Canon—is beneficial when using music with therapeutic purposes (Nilsson, 2008). Yet, the myriads of musical parameters involved in every musical composition impairs a clear understanding of this hypothesis, which should be further investigated, for example, by evaluating several baroque works with different scoring. The idea that low frequencies are mostly beneficial to reduce stress (Nilsson, 2008) was only partially confirmed. The Turkish sample—richer in high frequency harmonics—was less efficient than Pachelbel's Canon in improving the self-perception of calm, but the electroacoustic sample—almost void of high harmonics—did not improve it either. Indeed, the inherent complexity of music makes it mandatory to evaluate other factors—which might be meaningful in anxiety reduction, such as tempo, harmony, or texture—in future research.

In this regard, one of the main limitations of our work is the consideration of only one sample of each musical genre; different samples are needed to understand the role of specific musical parameters, such as scoring, tempo, or tonality, in anxiety reduction. Another limitation of our work is that we have employed slots of 6.20-min length; this is way less than the 30 min recommended by Nilsson (2008). Although our choice of performing a short listening test was motivated by the fact that, by assessing "everyday" stress, we aimed to create a listening experience that could be realistically integrated in users' everyday routine, alternative experimental procedures should also be developed to increase the participants' musical exposure even in a non-experimental environment; this could be facilitated by the use of wearable devices (e. g., smart-watches) for both listening to the music and collecting users' responses. We assume that the non-existing difference in the self-perception of anxious was caused by the relatively "positive" initial state of the listeners who rather belong to the typical population. It might have been different if we selected an atypical sample with, for instance, anxiety disorders.

Conclusion and future work

The presented work, based on experimental procedures typical of previous research, enables a more comprehensive evaluation—compared with prior outcomes—of how three samples from different musical genres might be effective in reducing listener's anxiety. Our work aims also to encourage further research in performing both psychological and physiological assessment as a standard procedure. Confirming previous research, our findings show that Pachelbel's Canon in D Major increases listeners' self-perception of calm, whereas the considered electroacoustic sample decreases it. This can be explained by the listeners' familiarity with the evaluated samples (canon familiar, electroacoustic sample unfamiliar), as well as by their sonority: The canon is performed by musical instruments (related to the listeners' cultural ISO) and the electroacoustic piece by synthetic sounds (totally strange to them). Our study also suggests that listeners' self-perception is biased by the experimental procedure, that is, positive and negative statements would be more accurately rated when matching the listeners' state. Music did not influence listeners' physiology, which might be due to the use of a distracting measurement procedure and due to the use of too short musical samples. In the future, we plan to adapt the experimental set-up by considering wearable devices for the physiological measurement and longer listening sessions. Furthermore, we will also consider listeners' musical preferences, as well as more than one sample of each musical genre.

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Notes

1. Deutsche Grammophon – 2535 105, LP, Italy, 1977. Note that only the *Canon*, unlike the *Giga*, was considered.
2. https://tumata.com/en/turkish-music-therapy/
3. In Turkish music, the makam system is a set of compositional rules that regulates the melodic component of a musical piece (Signell, 1986).
4. https://www.otagmusic.com/
5. https://tumata.com/en/tumata/
6. http://bit.ly/2n5sBYx
7. Note that despite the fact that repeating the sample twice might to some extent induce repetition/familiarity in the listener, to take into account a sample already evaluated in research was considered a better option than choosing a longer sample whose emotional impact has been never assessed before.
8. The *Identidad SOnora* (ISO) is the Music Sound Identity unique of each person, which emerges from human unconscious knowledge, for example, related to childhood environmental sounds (*Cultural* ISO; MacDonald, Kreutz, & Mitchell, 2012).
9. https://www.typeform.com/
10. Note that we do not assume the beginning level of anxiety of all the participants to be exactly the same; still, we consider that everyday anxiety, as well as everyday emotions, would not reach extreme levels (Douglas-Cowie, Cowie, & Schröder, 2000). For both subjective and objective measurements, the mean of the standard deviations across the three pre-tests was higher than the mean of the

standard deviations across the 50 subjects: for heart rate (HR), 9.83 and 5.20; for STAI-calm, 2.02 and 1.08; for STAI-anx, 1.79 and 1.41, respectively. This indicates that the inter-rater variability was lower than the inter-test variability, showing that the initial anxiety level between participants was similar enough to consider the scores as a unique class.

11. Null hypothesis testing with *p*-values as decisive criterion has been repeatedly criticized, as stated by the American Statistical Association (Wasserstein & Lazar, 2016).
12. https://amzn.to/33DrgKz
13. This confirms that despite repeating the electroacoustic sample twice to match the length of the other samples, this did not change its effect on the listeners, who seem to perceive it in any blue as unfamiliar.

References

Allen, K., & Blascovich, J. (1994). Effects of music on cardiovascular reactivity among surgeons. *Journal of American Medical Association*, *272*, 882–884.

Allen, K., Golden, L., Izzo, J., Ching, M. I., Forrest, A., Niles, C. R., & Barlow, J. C. (2001). Normalization of hypertensive responses during ambulatory surgical stress by perioperative music. *Psychosomatic Medicine*, *63*, 487–492.

Baird, A., Parada-Cabaleiro, E., Fraser, C., Hantke, S., & Schuller, B. (2018). The perceived emotion of isolated synthetic audio: The EmoSynth dataset and results. In *Proceedings of the audio mostly, North Wales, UK* (pp. 1–8). New York, NY: Association for Computing Machinery.

Beck, A., Emery, G., & Greenberg, R. (2005). *Anxiety disorders and phobias*. Cambridge, MA: Basic Books.

Benenzon, R. (1991). *Teoría de la musicoterapia*. Madrid, Spain: Mandala.

Bradt, J., & Dileo, C. (2009). Music for stress and anxiety reduction in coronary heart disease patients. *Cochrane Database of Systematic Reviews*, *12*, CD006577.

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.

da Silva, A., Guida, H. L., Antônio, A. M. D. S., Marcomini, R. S., Fontes, A. M., de Abreu, L. C. . . . Valenti, V. E. (2014). An exploration of heart rate response to differing music rhythm and tempos. *Complementary Therapies in Clinical Practice*, *20*, 130–134.

DeMarco, J., Alexander, J., Nehrenz, G., & Gallagher, L. (2012). The benefit of music for the reduction of stress and anxiety in patients undergoing elective cosmetic surgery. *Music and Medicine*, *4*, 44–48.

DeNora, T. (1999). Music as a technology of the self. *Poetics*, *27*, 31–56.

Doğan, M., & Şenturan, L. (2012). The effect of music therapy on the level of anxiety in the patients undergoing coronary angiography. *Open Journal of Nursing*, *2*, 165–169.

Douglas-Cowie, E., Cowie, R., & Schröder, M. (2000). A new emotion database: Considerations, sources and scope. In *Proceedings of the ISCA tutorial and research workshop* (pp. 39–44). Newcastle, UK: International Speech and Communication Association.

Fan, J., Tatar, K., Thorogood, M., & Pasquier, P. (2017). Ranking-based emotion recognition for experimental music. In *Proceedings of the international society for music information retrieval conference* (pp. 368–375), Suzhou, China: International Society of Music Information Retrieval.

Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. London, England: SAGE.

Godwin, J. (1993). *The harmony of the spheres*. Rochester, VT: Inner Traditions.

Hammer, S. (1996). The effects of guided imagery through music on state and trait anxiety. *Journal of Music Therapy*, *33*, 47–70.

Hu, X., Li, F., & Ng, J. (2018). The relationships between music-induced emotion and physiological signals. In *Proceedings of the international society for music information retrieval conference* (pp. 362–369), Paris, France: International Society of Music Information Retrieval.

Hubbard, P. (2003). Fear and loathing at the multiplex. *Capital & Class*, *27*, 51–75.

International Business Machines Corporation. (2012). *IBM SPSS statistics for windows* (Version 21.0). Armonk, NY: Author.

Iseri, E., Guney, E., Guvenc, R., Guvenc, A. A., ıCeylan, M. F. C., rak, E., & Sener, S. (2014). Music therapy and hormonal responses in autism. *Gazi Medical Journal*, *25*, 55–58.

Iwanaga, M., & Moroki, Y. (1999). Subjective and physiological responses to music stimuli controlled over activity and preference. *Journal of Music Therapy*, *36*, 26–38.

Jiang, J., Zhou, L., Rickson, D., & Jiang, C. (2013). The effects of sedative and stimulative music on stress reduction depend on music preference. *The Arts in Psychotherapy*, *40*, 201–205.

Juslin, P., Liljeström, S., Västfjäll, D., Barradas, G., & Silva, A. (2008). An experience sampling study of emotional reactions to music: Listener, music, and situation. *Emotion*, *8*, 668–683.

Khanade, K., & Sasangohar, F. (2017). Efficacy of using heart rate measurements as an indicator to monitor anxiety disorders. In *Proceedings of the Human Factors and Ergonomics Society annual meeting* (p. 1783–1787). Austin, TX: Human Factors and Ergonomics Society.

Knight, W., & Rickard, N. (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.

Labbé, E., Schmidt, N., Babin, J., & Pharr, M. (2007). Coping with stress: The effectiveness of different types of music. *Applied Psychophysiology and Biofeedback*, *32*(3–4), 163–168.

Lee, J., & Orsillo, S. (2014). Investigating cognitive flexibility as a potential mechanism of mindfulness in generalized anxiety disorder. *Journal of Behavior Therapy and Experimental Psychiatry*, *45*, 208–216.

Linnemann, A., Ditzen, B., Strahler, J., Doerr, J. M., & Nater, U. M. (2015). Music listening as a means of stress reduction in daily life. *Psychoneuroendocrinology*, *60*, 82–90.

Lonsdale, A., & North, A. (2011). Why do we listen to music? A uses and gratifications analysis. *British Journal of Psychology*, *102*, 108–134.

Lykartsis, A., Pysiewicz, A., von Coler, H., & Lepa, S. (2013, February). *The emotionality of sonic events*. Proceedings of the Music & Emotion, Jyväskylä, Finland, University of Jyväskylä.

MacDonald, R., Kreutz, G., & Mitchell, L. (2012). *Music, health, and wellbeing*. Oxford, UK: Oxford University Press.

Marteau, T., & Bekker, H. (1992). The development of a six-item short-form of the state scale of the Spielberger State-Trait Anxiety Inventory. *British Journal of Clinical Psychology*, *31*, 301–306.

Martin, M. (1990). On the induction of mood. *Clinical Psychology Review*, *10*, 669–697.

Mok, E., & Wong, K.-Y. (2003). Effects of music on patient anxiety. *AORN Journal*, *77*, 396–410.

Nilsson, U. (2008). The anxiety-and pain-reducing effects of music interventions. *AORN Journal*, *87*, 780–807.

Panteleeva, Y., Ceschi, G., Glowinski, D., Courvoisier, D. S., & Grandjean, D. (2018). Music for anxiety? Meta-analysis of anxiety reduction in non-clinical samples. *Psychology of Music*, *46*, 473–487.

Parada-Cabaleiro, E., Baird, A., Cummins, N., & Schuller, B. (2017). Stimulation of psychological listener experiences by semi-automatically composed electroacoustic environments. In *Proceedings of the international conference on multimedia and expo, Hong Kong, China* (pp. 1051–1056). New York: Institute of Electrical and Electronics Engineers.

Parada-Cabaleiro, E., Costantini, G., Batliner, A., Schmitt, M., & Schuller, B. W. (2019). DEMoS: An Italian emotional speech corpus. Elicitation methods, machine learning, and perception. *Language, Resources, and Evaluation*, *54*, 341–383.

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

Phumdoung, S., & Good, M. (2003). Music reduces sensation and distress of labor pain. *Pain Management Nursing*, *4*, 54–61.

Pituch, K., & Stevens, J. (2015). *Applied multivariate statistics for the social sciences*. London, UK: Routledge.

Rohner, S., & Miller, R. (1980). Degrees of familiar and affective music and their effects on state anxiety. *Journal of Music Therapy*, *17*, 2–15.

Shiloah, A. (2017). Jewish and Muslim traditions of music therapy. In: P. Horden (Ed.), *Music as medicine* (pp. 69–83). London, UK: Routledge.

Signell, K. L. (1986). *Makam: Modal practice in Turkish art music*. New York, NY: Da Capo Press.

Stevens, C. J. (2012). Music perception and cognition. *Topics in Cognitive Science*, *4*, 653–667.

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*, Article e70156.
Thompson, W. F. (2015). *Music, thought, and feeling*. New York, NY: Oxford University Press.
Truax, B. (2008). Soundscape composition as global music. *Organised Sound, 13*, 103–109.
Van Goethem, A., & Sloboda, J. (2011). The functions of music for affect regulation. *Musicae Scientiae*, *15*, 208–228.
Vaughan, B. (2011). *Naturalistic emotional speech corpora with large scale emotional dimension ratings* (PhD thesis). Dublin Institute of Technology, UK.
Voices of Music. (2005). *Concerto barocco* (Recorded in St. Stephen's Episcopal Church). Belvedere, CA: Magnatune.
Wasserstein, R. L., & Lazar, N. A. (2016). The ASA's statement on p-values: Context, process, and purpose. *The American Statistician, 70*, 129–133.
West, M. (2017). Music therapy in antiquity. In P. Horden (Ed.), *Music as medicine* (pp. 51–68). London, England: Routledge.
Westermann, R., Stahl, G., Spies, K., & Hesse, F. W. (1996). Relative effectiveness and validity of mood induction procedures. *European Journal of Social Psychology*, *26*, 557–580.