Hear what you feel, feel what you hear: The effect of musical sequences on emotional processing

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A B S T R A C T

Music has a unique ability to access affective and motivational systems of the brain. However, there is a gap in research on the association between musical stimuli and their impact on emotional processing, a crucial component for the success of the therapeutic process. The present study thus sought to explore both the capacity of music to access the affective system, to induce emotions, and to change emotional states, as well as to facilitate emotional processing leading to the resolution of emotional distress. Pascual-Leone and Greenberg's validated sequential model of emotional processing in psychotherapy, was used to test this dual capacity. Three musical sequences with distinct components were developed and presented in an online platform. One musical sequence followed the order of the sequential model (first experimental sequence), another musical sequence inverted that same order (second experimental sequence), and the last musical sequence was intended to serve as a baseline (control sequence). All musical sequences, not only led to alterations in participant's emotional states, but also led to an increase of participant's emotional resolution. Some of the results were surprising, since the control sequence also led to an increase of emotional resolution and the first experimental sequence didn't present itself as the winning candidate by leading to a higher emotional resolution. Nevertheless, these surprising results demonstrated that emotional processing could occur under different experiences of music and allow future studies to keep exploring this relationship.

Music can be described as the creation of emotions. Juslin and Västjfäll [1]; p. 572) mention that "what is unique about musical emotions is not the underlying mechanisms or the emotions they evoke, but rather the fact that music is often intentionally designed to induce emotions, using whatever means available". At least, it is difficult, if not impossible, to imagine the absence of a relationship between music and emotion.

1. Music and emotion

The connection between music and emotions has intrigued academics from several different areas and has been studied since ancient Greece [2]. Indeed, the presence of music in people's everyday life goes far in our past, since sound expression seems to be one of the oldest and most universal forms of human communication [3]. Hevner [4], early on, pointed out that the symbolism of music is not as exact or as specific as verbal symbolism, but it is also not chaotic and has a system of

understanding that governs its functioning.

Thus, one could infer that this system of understanding is associated with the structural components that integrate and govern the musical functioning. The musical tone, the rhythm, the level of complexity, the expressiveness, the harmony, and the timbre represent the main structural components of the music, allowing, through varied combinations of these, to generate different emotions [4–7]. The time dimension of this type of stimulus, reminded Hevner [4], should be emphasized. Díaz [8]; p. 543) thus concluded that music presents itself as a "stimulus organized in terms of its sonorous, spatial and time components, which results in a complete auditory perception endowed with emotional and figurative states that are aesthetically conscious and culturally valued".

Having a solid system of understanding allowed music to have a strong presence in human culture [9–12]. This presence is expressed in different ways in our daily lives, being commonly used in the liberation and regulation of emotions [1,10,13–15], for comfort and stress relief [13,16], to relive valued past experiences [17] or as an accompaniment

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in the performance of daily tasks [18].

The study of music's strong presence in human culture has resulted in the development of an emotivist position. This position proposes several explanatory theories for how and why the musical stimuli induces emotions [2]. Several authors also demonstrated how music is capable of provoking behavioural signals, including changes in the activity of limbic and paralimbic structures [9], in skin conductance levels [6,9], in heart rate [6,19] and in neuronal activity [9,20,21].

Still within this position, Juslin and Västjfäll [14] proposed a theoretical framework to explain the relationship between music and emotions, by presenting six distinct mechanisms through which musical stimuli evoke emotions: brainstem reflex, evaluation by conditioning, emotional contagion, visual imagery, episodic memory, and musical expectation. These mechanisms vary accordingly to their characteristics, so there is not only one mechanism responsible for all instances of musically induced emotions. This framework was later updated [22], including a seventh mechanism as suggested by peer review: rhythmic entrainment. Juslin [23] claims that the proposed framework, along with cognitive appraisal, was able to explain the majority of emotions induced by musical events in everyday life. Later on, an eight mechanism was still included: aesthetic judgment [23]. Together, not only this framework describes the mechanisms that underlie emotional responses to music, but it also became extremely useful in the design of empirical research in music-evoked emotions [24].

The emotivist position was then able to formulate the perspective that music has a unique ability to access the brain's affective and motivational systems [25]. Specifically, Thaut and Wheeler [26] stated that music was regarded as one of the greatest mechanisms for therapeutic efficacy by: 1) assuming a role in influencing and modifying affective states and 2) assuming a role in affective modification by accessing the totality of the patient's cognitions, perceptions, states and behavioural organization. The authors also underlined that music can be defined as a powerful language that can be used to involve the patient in a complex process of thought-emotion, directed towards functional non-musical rehabilitation goals, where a translational behavior space is created for patients to experience, (re)learn and train desired behaviours through music-based therapeutic exercises. The development and implementation of the SEED model [27] is a practical adaptation of the above-mentioned idea, where music is combined with reminiscence therapy to facilitate the access of autobiographical memories, to evoke strong emotional reactions, to elicit physiological responses and to define identity. Both theory and practical examples point to the possibility of music being used as method with therapeutic potential.

Neurological research also reinforced this idea by formalizing the influence, change, and education that music can have on cognitive, affective and sensorimotor processes in the brain [26,28]. [29] reviewed several functional neuroimaging studies that point to the ability of music to evoke changes in the activity of central brain structures to cause the induction of emotions, thus raising the possibility of several applications in therapies based on music. Accordingly, Lee et al. [30] emphasized that Koelsch's study, by pointing out music as a modulator that activates neuronal regions related to emotional functions, allowed the utilization of music to evoke emotions and subjective feelings in psychotherapy.

Sekyung [31] states that "neuroscience and music research provide emerging evidence linking music and emotion regulation". Over the last two decades, not only several studies demonstrated that music-evoked emotions can modulate activities in networks integral to the generation and regulation of emotions [32–34], but others also proposed how music can be incorporated in daily or therapeutic settings to aid emotional regulation (Hides et al.[35], 2018 [36]; Silverman[37], 2019; [31]. Together, the knowledge from these studies may be directed to support and strengthen clinical music therapy practices.

Although there is a number of studies on music-evoked emotions and music as an emotion regulation strategy, some gaps can still be found in the understanding of the link between music and emotional processing. Considering that music can be proposed as a method with therapeutic potential, one could ponder on its effect in the facilitation of therapeutic processes, such as emotional processing. In music therapy, the Bonny Method of Guided Imagery and Music [38] stands out as the most commonly known and used method where music interacts with the brain to evoke images that induce emotions and memories, allowing the transformation from painful emotions to positive emotions [30]. However, this method is not supported and has no connection with a theoretical emotional processing model, being largely based on free exploration and interpretation.

In emotion research, some studies explored the influence of sad music on mood and on the processing of negative emotions (Garrido & Schubert, 2013[39]; [40]. These studies allowed to better understand the impact that so called moody melodies or sad music can have on mood management and emotional processing, emphasizing the situations where this type of music hearing can be adaptive and pleasurable.

The gaps in the understanding of the link between music and emotional processing thus lie in a shortage of studies connecting music listening to a theoretical emotional processing model. Serôdio [41] tried to bridge this gap, by exploring whether certain musical excerpts would facilitate the occurrence of affective states associated with different levels of emotional processing. Results revealed how participants were able to differentiate most musical excerpts regarding the level of emotional processing. However, no practical or therapeutic impacts were explored.

This is an important gap to reflect upon since emotional processing is regarded as one of the main elements of the therapeutic process. The attempt of connecting music listening to a theoretical emotional processing model may help to build and sustain a more robust framework on music stimuli as a facilitator for the experience of sequences of specific affective states that lead to the resolution of emotional distress.

2. Emotional processing

Greenberg and Paivio [42] described emotional processing in three steps that underlie specific therapeutic tasks. Firstly, as being necessary to evoke and focus on the negative emotions associated with non-adaptive emotional schemes that contribute, or are at the origin, of the sensation of psychological malaise. Secondly, by deconstructing these emotional schemes, the level of analysis for the exploration of cognitive-affective sequences associated with negative emotional experiences is deepened. Thirdly, a dynamic integration is developed by meaning construction from the felt sense, bringing a new perspective on the situation that is generating the psychological malaise, allowing the reorganisation of the self and the formation of new emotional contents.

Based on these, Pascual-Leone and Greenberg [43] proposed a sequential model of emotional processing, at a higher level of abstraction, which clarifies the resolution of emotional distress according to therapeutic evolution. In this sequential model, one starts from undifferentiated or unintegrated emotions and progresses to emotional experiences of acceptance, regardless of the specificity of the therapeutic tasks performed. This independence allows the exploration of different methods with therapeutic potential, even outside the scope of psychotherapy.

The sequencing of these emotional experiences is formalised in a division of emotional states, into two subjective categories, with different characteristics related to their levels of activation, action tendencies, and specificity of meaning: Early Expressions of Distress (EED) and Advanced Meaning Making (AMM).

The EED category is composed of initial states described as necessary and inevitable steps to achieve emotional change, encompassing both secondary and primary maladaptive emotions [44–46]. Global distress is identified as an unprocessed emotion with high activation and low meaning, being commonly described as a reaction of affliction expressed emotionally with little or no intention of elaboration. Individuals then move on to the states of fear/shame, where feelings of loneliness,

incapacity and maladaptive action tendencies persist, or rejecting anger, where feelings of protest, repulsion, or hatred originate with high levels of activation and tendencies of maladaptive action. Through meaning elaboration of all these states, it is possible to experience even more differentiated states of emotional processing. This meaning elaboration can occur through: 1) elaboration of meanings associated with rejecting anger, transforming it into assertive anger; 2) passage through an intermediate level of meaning creation associated with a dialectic construction where two opposite states cooccur (need and negative evaluation about the self), leading to a reassessment of the self.

In the AMM category there is a facilitation of adaptive primary emotions, where new feelings are experienced in the moment and expressed, clearly, in an integrative and affirmative way [44–46]. The assertive anger state is characterized by an anger that has enough differentiation to incorporate a positive self-evaluation and a clear affirmation of individual needs. At the same time, the individual may experience the self-soothing state, where there is a direct response to the individual needs. On the same level as the previous states, the grief/hurt state translates in sadness combined with the recognition of loss or dissatisfaction with the needs of the self. Finally, through a second dialectic construction that synthesises the previous states, the acceptance and agency state originates from a new positive evaluation of the self as confident and future-oriented, and as being able to recognize past losses and to channel its capacities to deal with them.

The sequence of the presented emotional states is nonlinear [43]. Not only is substantive emotional change a developmental process where some emotion sequences may be inherent to the trajectory of therapeutic emotional developments, but also the idiosyncratic characteristics of each individual must be considered as factors that contribute, or not, to greater involvement in different emotional states [45]. The sequence's nonlinearity raises interesting questions and possibilities about the order through which subjects may receive and experience these emotional states. Nevertheless, all the emotional states mentioned are necessary to reach a higher level of emotional processing [43].

Several authors consistently advocate emotional exploration through activation of a problematic emotional state, followed by activation of adaptive emotional states [47]. Within the therapeutic setting, in Short-Term Dynamic therapy [44], in Emotion-Focused Therapy, in Clarification-Oriented therapy and in Attachment based Family therapy [48], elements of therapeutic and emotional change were explained by the sequential model, being specified that sequential emotional processing may generalize across the course of treatments, even if each case engages in a different process route to reach the same outcome goal.

Outside the therapeutic setting, since the sequential emotional processing model does not link its emotional states to specific therapeutic tasks, it is possible to explore different methods with therapeutic potential. Rohde et al. [49] explored the gains of cognitive-affective meaning-building by inducing different phases of emotional processing through an expressive writing task based on Pennebaker's writing paradigm (1997)[50]. Similarly, Harrington et al. [51] also examined the potentials of expressive writing by exploring fundamental aspects of emotional processing. Both studies demonstrated the potential of expressive writing to induce different levels of emotional processing, thus raising the possibility of using other types of stimuli to induce emotional states associated with emotional processing. As such, one could also ponder about the therapeutic potential of music to access the affective system and to facilitate emotional processing leading to the resolution of emotional distress.

3. Present study

In the present study, as a follow-up to the work started by Serôdio [41], the experimental paradigm employed by Rohde et al. [49] was adapted in order to use musical stimuli, instead of writing, to induce emotional states associated with the sequential model. The association of a musical stimuli with the sequential model poses itself as an attempt

to better fill the identified gap in the emotivist position, as it deepens the level and type of utility that music has in inducing and processing emotions. Obtaining this understanding is extremely relevant since it provides the opportunity to understand what type of emotional experiences different musical sequences may facilitate individuals' progress in emotional resolution.

Juslin and Västjfäll [14] framework complemented the design of the present study. Mainly, the emotional contagion mechanism was focused on with the intention of selecting musical excerpts corresponding to a specific emotional state that would allow the induction of this same state in the participants. In Pascual-Leone and Greenberg's [43] sequential model of emotional processing there are ten well described and outlined emotional states, that serve as a strong basis to build musical sequences with ten musical excerpts intended to induce those same states. Additionally, the nonlinearity of the sequential model allows us to ponder on the possibility of providing different types of emotional processing experiences to participants.

4. Hypothesis

The present study seeks to explore if the experience of being exposed to musical sequences with certain characteristics allows to achieve lesser or greater emotional resolution of emotional distress.

4.1. Emotional activation hypothesis

In accordance to Rohde et al. [49], before trying to induce an experience of emotional processing, one must first ensure that the participants experience emotional activation. Therefore, the first hypothesis questions if listening to both types of musical sequences (experimental and control) will lead to an emotional activation of the participants reflected in an alteration in participants' emotional state. These alterations will be measure in terms of changes in the dimensions of valence, arousal, and control. To ensure the correct adaptation of authors' paradigm, to control for possible confounds to the experimental manipulation, it is analysed whether participants are emotionally engaged to an equal extent in all conditions.

4.2. Emotional processing hypothesis

Supporting and expanding the understanding that integrated cognitive-emotional processing of emotional disturbances correlates with beneficial outcome [49], the second hypothesis focuses on the question of whether listening to the experimental musical sequences, regardless of progression order, and in comparison to the control musical sequence, will lead to an increase in the emotional resolution. It is expected that participants in the EED-AMM and in the AMM-EED conditions will report fewer unresolved intra- or interpersonal grievances, and that they will report more mastery experience, more clarification of meaning, and rate the music listening as more useful as compared to participants in the control condition.

Going a step further, it is also hypothesised that listening to the musical sequence with the EED-AMM progression will lead to a higher level of emotional resolution, compared to the control musical sequence (with no specified progression) and to the AMM-EED progression. It is thus expected for the EED-AMM condition to be the winning candidate by leading to a higher emotional resolution.

5. Method

5.1. Research design

The present study employs an experimental design where, through the implementation of a mixed method approach, the impact of music on alterations in emotional states, as well as on resolution of emotional distress, was explored. Three distinct conditions were implemented, two

Table 1
Musical excerpts selected for the present study.

Emotional State	Excerpt selected (Compositor and play)	Minutes from Excerpt selected	Number of votes per Excerpt
Global Distress (GD)	Tomaso Albinoni's Adagio in G Minor	03:12 to 04:23	14
Fear (F)	Béla Bartóks Music for Strings, Percussion and Celeste	04:30 to 05:55	15
Shame (S)	Tomaso Albinoni's Adagio in G Minor	00:00 to 01:40	15
Need (N)	Bach's Inventions No. 11 in G Minor	00:00 to 01:58	14
Negative Evaluation (NE)	Schubert's String Quartet No. 14 in D Minor	00:00 to 01:30	11
Rejecting Anger (RA)	James Horner's Futile Escape	02:10 to 03:29	13
Assertive Anger (AA)	Beethoven's Symphony No. 3, 3rd Movement	00:41 to 02:17	19
Self-Soothing (SS)	Debussy's Reflections on the Water	00:00 to 01:30	12
Grief and Hurt (GH)	Mozart's Piano Concert No. 23 in A Major	00:00 to 01:30	15
Acceptance and Agency (AAA)	Japanese Usagi Folk Music	00:00 to 01:20	15

experimental conditions and one control condition, and a pretest-–posttest design was applied.

5.2. Participants

The study sample consisted of 90 volunteers (33 male, 54 female and 3 other genre) aged 18–65 years, ($M = 28$, $SD = 12.13$). Participants were recruited if they were 18 or more years old and fluent in Portuguese. Ethical approval for this study was obtained from the faculty's Ethics Committee.

5.3. Stimuli description

Both the stimuli and the music intervention descriptions were guided by Robb's[52] music intervention reporting standard (2018). One of three different musical sequences was presented to the participants. In the two experimental conditions, the musical sequences had as an objective to simulate the affective states described in the emotional processing model of Pascual-Leone and Greenberg [43]. Thus, each musical excerpt present in these sequences was selected to correspond to a specific emotional state, with the intention of inducing this same state in the participants through the activation of the emotional contagion mechanism [14]. Only orchestral/instrumental musical excerpt were selected, as there is less familiarity of the general population with this musical genre [53], thus reducing the probability of activation of the evaluation by conditioning and episodic memory mechanisms [14].

The selection of musical excerpts that integrate the two experimental musical sequences went through two stages of selection: 1) options based on the literature review, 2) best candidate based on a pre-test applied to the general population. This selection process was carried out by the main researcher of the present study (no formal background of musical education nor of music therapy training). As for the first selection phase, three candidate options were gathered for each emotional state based on musical pieces already explored and proven in the literature as being associated with the induction of a specific emotion or emotional category [3,4,6,54]; Lopez Serôdio, 2016[41]; [55]. After gathering the three candidate options for each emotional state, specific music excerpts were selected, with a duration of about 1–2 min, from the musical pieces explored in the literature.

After selecting the specific music excerpts to be used, the selection process for the best candidate was carried out as a pretest to the general population through an online questionnaire developed on the Qualtrics platform (www.Qualitrics.com). Throughout the questionnaire, participants were only presented and asked to listen to the three candidate options of a single emotional state, followed by a short description of that same emotional state consistent with the operationalizations in the sequential model of Pascual-Leone and Greenberg [43]. The participants where then asked to select which of the three options best suited and which worst suited the description of the emotional state presented. The online questionnaire was circulated through the general population via various social platforms (Facebook, Instagram, Twitter, LinkedIn and Reddit). A total of 300 responses were obtained, with 30 responses for

each of the ten emotional states presented. Based on the data obtained, a descriptive analysis was performed using the IBM SPSS *Statistics* software (version 26.0), allowing the selection of the final musical excerpts. All music excerpts had a duration of 1–2 min, which allowed us to use the excerpts with the highest number of votes for best candidates in the final sequences.

The two final musical sequences for the experimental conditions were thus developed: the first musical sequence following the order of the affective states described in the sequential model (EED-AMM Sequence), and the second musical sequence reversing the order of the same affective states (AMM-EED Sequence). Both musical sequences have a total duration of 14 min. The final musical excerpts selected for the present study are shown in Table 1, for full musical citations, please check Appendix A, and for full analysis of the musical elements in each music excerpt, please check Appendix B.

Lastly, the third musical sequence did not intend to simulate the sequential model, so it didn't include any of the musical excerpts presented. In the control condition a neutral sequence was created to serve as a baseline (Control Sequence). To achieve this purpose, the first 6 min and 6 s of the musical piece Les Sylphides, by Chopin, were selected, as this musical piece has been associated with a state of neutrality based on GSR measurements (Zimny & Weidenfeller, 2015[56]). In order to match the duration of all musical sequences, the present sequence was duplicated and extended, leading to a total duration of 14 min. In Fig. 1 we can observe a visual composition of each of the final musical sequences.

6. Measures

6.1. Self-assessment manikin (SAM)

This measure intended to assess participant's emotional state before and after the experimental induction, allowing to analyse if the musical sequences impacted the emotional state of the participants. Developed by Lang [57], SAM is characterized as a brief graphic and non-verbal scale that intends to evaluate emotional states in 3 dimensions: valence (i.e., pleasant/unpleasant dimension), arousal (i.e., relaxation/activation dimension) and dominance (i.e., lack of control/possession of control dimension). These dimensions are evaluated based on a continuous 9-point scale, which is presented in different sequences of 5 figures.

6.2. Resolution of long-standing interpersonal grievances (UFB-RS)

Translated to Portuguese by the researchers of the present study, this measure was only completed by the participants who selected Resentment and Hurt in an Important Relationship as the emotional marker to work on. This measure was filled out pre and post experimental induction, allowing to determine if the musical sequences impacted participants' emotional resolution. The UFB-RS was developed by Singh in 1994, with the objective to evaluate how the participants feel about their unfinished interpersonal matters [49]. The scale consists of 11
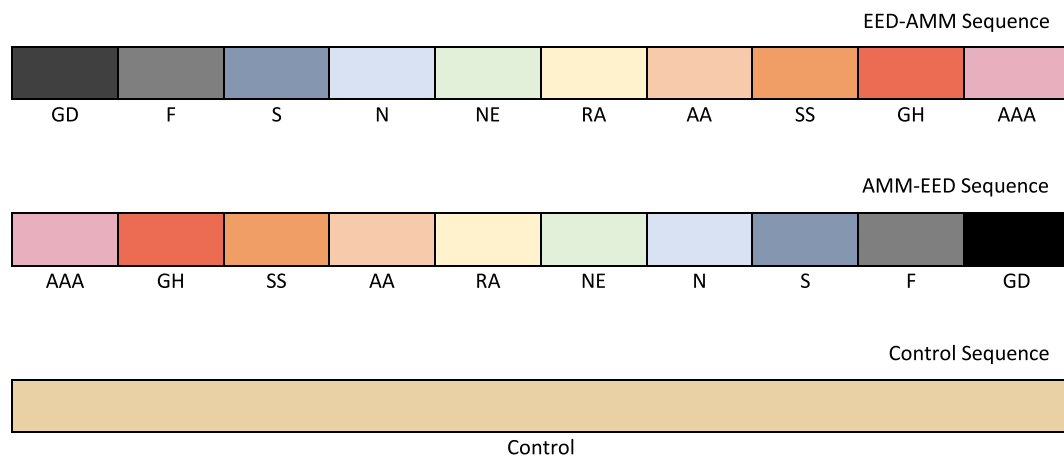
EED-AMM Sequence

| GD | F | S | N | NE | RA | AA | SS | GH | AAA |

AMM-EED Sequence

| AAA | GH | SS | AA | RA | NE | N | S | F | GD |

Control Sequence

| Control |

Fig. 1. Final composition of the musical sequences.

items evaluated on a 5-point Likert scale, where the lower the total sum of the scores of the 11 items, the smaller the number of reported grievances and the greater the emotional resolution. Since some items of this scale are reversed, it was necessary to uniform the scale before initiating its statistical analysis. The internal consistency in this study was $\alpha = 0.74$.

6.3. Resolution of long-standing emotional self-neglect (ESN-RS)

The ESN-RS was developed for this study, as an adaptation of UFB-RS, and this measure was only completed by the participants who selected Self-neglect as the emotional marker to work on. This measure was filled out pre and post experimental induction, allowing to determine if the musical sequences impacted participants' emotional resolution. Instead of the items assessing feelings towards another, they assessed feelings towards the self, allowing us, in turn, to assess how the participants feel about the self-neglect they enact on disliked parts of the self. Being structurally and semantically identical to the original UFB-RS, this scale consists of 11 items evaluated on a 5-point Likert scale, where the lower the total sum of the scores of the 11 items, the smaller the number of reported grievances and the greater the emotional resolution. Since some items of this scale are reversed, it was necessary to uniform the scale before initiating its statistical analysis. ESN-RS as a construct may contain self-criticism, but not necessarily. The internal consistency in this study was $\alpha = 0.77$.

6.4. Bern post session report (BPSR-P)

Translated to Portuguese by the researchers of the present study, this measure intended to evaluate, post experimental induction, the impact of the musical sequences in the psychotherapeutically relevant process variables. This scale was developed by Flückiger with the objective to assess different psychotherapeutically relevant process variables, being adapted by Rohde et al. [49] to measure mechanisms of change and experience present in an expressive writing task. For the present study, it was pertinent to adapt the version developed by Rohde et al. [49], using some of its items but adapting them for a musical listening task. The 6 items used in this scale were divided into 4 subscales: Problem Activation (items 1 and 2), Problem Mastery (items 3 and 4), Problem Clarification (item 5) and Perceived Utility (item 6). The higher the total sum in each of the subscales, the greater the psychotherapeutic quality. The items are evaluated on a 7-point Likert scale.

6.5. Expressive writing task

Immediately after the experimental induction, participants were

given the choice to voluntarily perform an expressive writing task, similar to the writing paradigm developed by Pennebaker [50]. After listening to the musical sequence, the participants were asked if they noticed any changes or internal transformation in relation to the emotional marker they had chosen to work on, and, if they answered yes, they were asked to describe it in some detail. The completion of this task by the participants intended to ascertain and better clarify the level of emotional processing induced.

7. Procedure

7.1. Recruitment

Participants were recruited via publications on social media platforms (e.g., Facebook, LinkedIn, Twitter, Instagram). They were told that the aim of the study was to investigate the influence of music on emotional processing and were informed that they would engage in a unique music experience.

7.2. General procedure

The present study was developed as an online questionnaire, through the Qualtrics platform (www.Qualtrics.com). The online questionnaire was applied to participants in only one session, no interruptions or intervals, with an approximated duration of 30 min. Participants filled the measures and listened to the musical sequences in the comfort of their homes, with no supervision from the researchers of the present study.

First and foremost, the informed consent and general instructions were presented, and it was specifically indicated to participants that they would be randomly assigned to listen to one of three existing musical sequences that could be more or less facilitative of emotional processing. The experience only started after the confirmation of these information's conscious reading and the affirmation of the desire to continue. Next, participants were presented with a scheme that described two distinct emotional markers: Self-neglect or Resentment and Hurt in an Important Relationship. The participants were then given the choice to work with only one of the presented markers. Finally, it was asked for them to define, briefly, what the topic of the selected emotional marker was and to classify how much the selected marker disturbed/activated or emotionally affected them in the present moment.

7.3. Experimental induction

In the pre induction phase, that is, before listening to the musical sequence, participants were asked to answer to two different measures:

SAM, for all participants, and UFB-RS or ESN-RS, accordingly to the emotional marker selected. Subsequently, participants were randomly assigned to one of the study's conditions, through the *Randomizer* generator of the Qualtrics's platform.

Experimental induction was initiated with a set of specific instructions. Participants that chose to work the Self-neglect marker were shown the following instructions: "Please avoid interruptions while listening to the music and let your body and mind process the theme you chose to work on emotionally. To process the theme you have chosen to work on, we ask you to try: (a) See the unpleasant feelings around an aspect or pattern that you dislike as a communication, expression or reaction of a small part within you, or a part of you (and not the whole of you); (b) See if that part of you is angry, scared, overwhelmed, embarrassed or sad and, as such, needs you to notice its existence, to see how it needs to be taken care of by you; (c) See if you can direct your attention, approach that part of you with an attitude of curiosity and willingness to try to take care of the need that it presents when it expresses in that way". Participants that chose to work Resentment and Hurt in an Important Relationship were shown the following instructions: "Please avoid interruptions while listening to the music and let your body and mind process the theme you chose to work on emotionally. To process the theme you have chosen to work on, we ask you to try: (a) Getting in touch with the unpleasant feelings, thoughts, and sensations around that feeling of unfinished business with the other person, connecting with the pain, hurt or anger in order to find the core of these; (b) Recognize your needs that have not been validated or met by the other person, give voice and expression to these within yourself, realizing how you would like or need them to have been listened to and taken care of; (c) Imagine expressing your protest towards the other person, identifying within yourself what you would have liked to have said to the other person and what you would have liked to have heard".

Next, participants listened to one of the three musical sequences. Finally, in the post induction phase, that is, after listening to the musical sequence, participants were asked to complete a short writing task (of voluntary participation) and to answer to three different measures: SAM, for all participants, UFB-RS or ESN-RS accordingly to the emotional marker selected, and BPSR-P for all participants.

Participants were asked to use earphones/headphones during this experiment and to try to minimize contact with potentially stimulating external stimuli. These instructions intended to create a more engaging and more introspective experience and to facilitate a neutral environment common amongst the participants. In addition to the measures mentioned, sociodemographic measures were also collected after the experimental induction.

8. Data analysis

The data obtained was statistically analysed with the IBM SPSS *Statistics* software (version 26.0) and with the JASP software (version 0.16.1). For all the statistical analyses carried out, the data from the samples of participants that filled in the UFB-RS or ESN-RS scales were aggregated, since both allow the measuring of emotional resolution. We did not intend to differentiate between the level of emotional resolution achieved in each marker, but rather the overall level of emotional resolution achieved. Variables were analysed separately according to each condition (EED-AMM Sequence, n = 30; AMM-EED Sequence, n = 30; Control Sequence, n = 30).

Among the dependent variables, only Emotional Resolution met the necessary assumptions for the use of parametric tests, verified with the Kolmogorov-Smirnov and with the Levene tests. However, considering that the present study employs an experimental design, we should analyse the data accordingly to it. Thus, even if the dependent variable Emotional State and the dependent variable of Therapeutic Process didn't met the necessary parametric assumptions for the use of parametric tests, an experimental design was also applied for the statistical analysis of all the data.

The data obtained in the Expressive Writing Task was analysed using the Nvivo 12 software. As this was an optional task, it was only completed by 47 (52%) of the 90 participants. For a comprehensive content analysis [58], the main researcher of the present study carried out, manually, an analysis of the lexicon present in the descriptions of the emotional transformation felt by the participants. All references of emotional states were analysed and distributed, also manually, into the formulated categories of EED states and AMM states, consistent with the categories operationalized in the sequential model by Pascual-Leone and Greenberg [43]. It is important to note that, amongst each of the 47 descriptions analysed, several cases contained references of emotional states that fell into the category of EED states, and other references that fell into the category of AMM states. In total 65 valid references were considered.

9. Results

9.1. Sample characterization

With Chi-square statistical tests it was verified that there were no differences between the groups of participants present in each condition, regarding their sociodemographic characteristics. Therefore, the three groups did not differ regarding age, gender, previous musical learning experience, classical music appreciation, type of selected emotional marker and arousal of the selected emotional marker (all p values > 0.05). The sociodemographic characteristics for each of the three conditions are reported in Table 2. Since no differences were found between the groups of participants in the different conditions, it is possible to assume that the aforementioned characteristics did not influence the results achieved in the remaining analyses.

9.2. Analysis regarding emotional state

Emotional arousal is considered a prerequisite for subsequent emotional processing [49]. Thus, it became important to verify whether listening to the musical sequences led participants to become similarly emotionally active in the various conditions.

To ascertain differences in emotional state within the study conditions, a repeated-measures ANOVA was used. Mauchly's test indicated that the assumption of sphericity had been violated, $\chi 2$ (3) = 0.00, $p < 0.001$. Therefore, degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = 1.00$). The results determined that the emotional state dimensions' valence, arousal and control differed significantly between pre-to post-test (valence dimension: F (1.000, 87.000) = 15.832, $p < 0.01$; arousal dimension: F (1.000, 87.000) = 18.253, $p < 0.01$; control dimension: F (1.000, 87.000) = 14.868, $p < 0.01$). A significant effect of the type of musical sequence on emotional activation was also found for the valence (F (2.000, 87.000) = 2.988, $p = 0.05$) and arousal (F (2.000, 87.000) = 6.847, $p = 0.002$) dimensions.

To better understand the expression of this phenomenon, post hoc tests were applied. Pairwise comparisons using a Bonferroni adjustment revealed that the valence dimension was only significantly increased in

Table 2
Sample's characteristics.

Sociodemographic Characteristics	Sequence		
	EED-AMM	AMM-EED	Control
Sample Size	30	30	30
Age in years M (SD)	29.8 (13.96)	27.8 (10.88)	27.87 (11.65)
Gender (female)	17 (56.7%)	14 (46.7%)	23 (76.7%)
Previous musical education (yes)	13 (43.3%)	14 (46.7%)	15 (50%)
Classical music appreciation M (SD)	6.9 (2.53)	6.9 (2.14)	6.8 (2.20)
Selected Emotional Marker (self-neglect)	22 (73.3%)	21 (70%)	21 (70%)
Emotional marker arousal M (SD)	6.8 (1.72)	6.3 (1.71)	6.8 (1.67)

Table 3

Mean values (and standard deviations) obtained in the SAM and in the BPRS Problem Activation subscale.

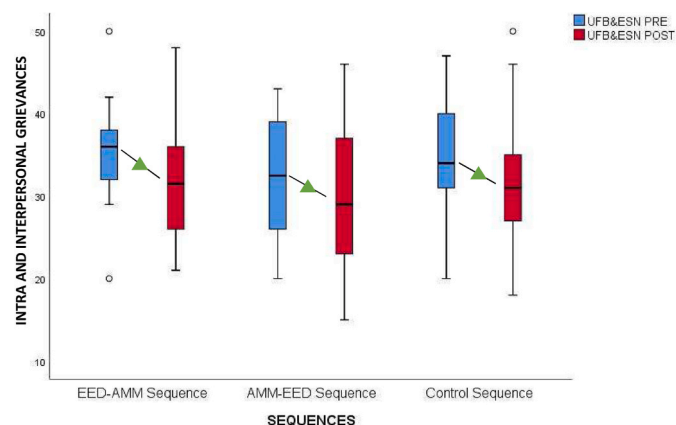| Sequence	SAM						BPRS
	Valence		Arousal		Control		Prob Act.
	Pre M (dp)	Post M (dp)	Pre M (dp)	Post M (dp)	Pre M (dp)	Post M (dp)	Post M (dp)
EED-AMM	5,23 (1,76)	5,67 (1,75)	4,93 (1,79)	4,23 (1,89)	5,13 (1,62)	5,37 (1,61)	3,97 (0,31)
AMM-EED	5,73 (1,48)	6,00 (1,66)	4,53 (1,91)	4,53 (2,08)	4,70 (2,04)	5,23 (2,06)	3,82 (0,28)
Control	5,13 (1,46)	6,27 (1,31)	5,13 (1,78)	3,47 (1,96)	4,50 (1,81)	5,47 (1,59)	3,12 (0,19)

Fig. 2. Emotional resolution scores in the pre experimental induction (blue) and post experimental induction (red). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

the Control Sequence condition (−1.133 (95% CI, −1.66 to −0.61) $p < 0.01$), the arousal dimension was only significantly decreased in the EED-AMM Sequence condition (0.700 (95% CI, 0.06 to 1.34) $p = 0.031$) and in the Control Sequence condition (1.667 (95% CI, 1.03 to 2.30) $p < 0.01$), and the control dimension was only significantly increased in the AMM-EED Sequence condition (−0.533 (95% CI, −1.05 to −0.02) $p = 0.043$) and in the Control Sequence condition (−0.967 (95% CI, −1.48 to −0.45) $p < 0.01$).

Lastly, to ascertain differences in emotional state between the study conditions, a Pairwise comparison using a Bonferroni adjustment revealed how no significant differences were found between conditions in the different dimension, both in the pre- and the post-experimental induction ($p > 0.05$). This allowed us to confirm that participants were equally emotionally active across conditions, both pre and post experimental induction.

A one-way ANOVA was used with the musical sequence (EED-AMM Sequence, AMM-EED Sequence, Control Sequence) defined as the factor, and the problem activation of the therapeutic process as dependent variable. No statistically significant effects were found, Z (2) = 2.967; $p = 0.06$; n = 90. These results show, once again, how participants were equally emotionally active across conditions.

The scores on the SAM and the Problem Activation subscale of the BPSR are presented in Table 3.

9.3. Analyses regarding emotional processing

To assess in which experimental musical sequences occurred a significant increase of the level of emotional resolution, through the reported decrease of intra or interpersonal distress, between the pre and post experimental induction periods, a repeated-measures ANOVA was used. Mauchly's test indicated that the assumption of sphericity had been violated, $\chi 2$ (3) = 0.00, $p < 0.001$. Therefore, degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = 1.00$). The results determined that mean emotional resolution differed significantly

Table 4

Bayesian analysis for the model comparison for all models under consideration for the present study's data

Model	P(M)	P (M|D)	BFm	BF₀₁	error %
ER	0.200	0.628	6.761	1.000	
ER + MS	0.200	0.335	2.013	1.877	1.537
ER + MS + ER * MS	0.200	0.037	0.153	17.048	4.620
Null model	0.200	3.073e-5	1.229e-4	20446.465	1.027
MS	0.200	1.461e-5	5.845e-5	42995.877	1.174

Note: The abbreviations "ER" and "MS" stand for Emotional Resolution and Musical Sequence type, respectively. The term "ER * MS" stands for the interaction between the two factors.

between pre-to post-test, F (1.000, 87.000) = 28.371, p (1 −*tailed*) < 0.01. However, there was no significant effect of the type of musical sequence on emotional resolution, F (2.000, 87.000) = 0.082, p (1 − *tailed*) = 0.461. That is, inversely to what was expected, a statistically significant increase in emotional resolution was observed in all the studies conditions (both the experimental and the control conditions). The scores of emotional resolution in pre and post experimental induction are shown in Fig. 2.

A Bayesian analysis was implemented to further illustrate the strength of these evidence. The primary output from the JASP repeated-measures ANOVA is presented in Table 4, which shows the support that the data offers for each model under consideration. Here we can find that the data are about 20 446 times more likely under the model with only the Emotional Resolution as a predictor than under the null model. Likewise, we can also verify that the data are about 42 995 time more likely under the model with only Emotional Resolution as a predictor than under the model with only the Musical Sequences as a predictor, this last one being the worst model for our data. In other words, the data here presented allows to strengthen the effect found of an increase in Emotional Resolution from the pre to the post experimental induction, and to also increase the confidence that this effect occurred despite the type of musical sequence presented to the participants.

The qualitative analysis of the expressive narrative task allowed to reinforce the results found in the statistical analysis. Among the 65 valid references, it was found that a majority of 38 references (58.5%) fell into the category of AMM States, which indicates that participants were able

Table 5

Frequency of words present in the participants' descriptions of emotional transformation.

Words	Count	Similar words
Felt	35	I felt, I feel
Feeling	33	Joy, calm, contentment, emotion, hope, happiness, lightness, sorrow, wanting, recognition, sensation, feelings, tranquillity, sadness
State	33	Burden, condition, confusion, consciousness, guilt, curiosity, distrust, hope, state, end, final, form, junction, improvement, level, peace, problem, relation, security, situation, transcendence, life
Calm	20	Calm, sensation, tranquil, tranquility
Modified	13	Improvement, modified, change, relaxation, successful, transformation, transform
Improvement	11	Condition, state, better, improvement, transformation

to achieve greater emotional resolution after listening to the musical sequences. A query on the frequency of words present in the descriptions of the felt transformation illustrates the referred effect. The results of this query are reported in Table 5.

Given that the main effect was not significant, our third and last hypothesis has already been somewhat answered. Although we should not follow up this effect with post hoc tests, since we have already concluded that the type of musical sequence did not have a significant effect on the achieved level of emotional resolution, pairwise comparisons using a Bonferroni adjustment were still analysed and to provide a more detailed description. The results here found for the main effect of musical sequence on emotional resolution indicated that there are no significant differences ($p > 0.05$).

A one-way ANOVA was used with the musical sequence (EED-AMM Sequence, AMM-EED Sequence, Control Sequence) defined as the factor, and the mastery experience, problem clarification and perceived usefulness subscales of the therapeutic process as dependent variables. No statistically significant effects were found (mastery experience subscale: Z (2) = 0.635; p (1 − *tailed*) = 0.27; n = 90; problem clarification subscale: Z (2) = 0.224; p (1 − *tailed*) = 0.40; n = 90; perceived usefulness subscale: Z (2) = 0.531; p (1 − *tailed*) = 0.30; n = 90). The present statistical results also do not support the third hypothesis, by showing that the referred dimensions of the therapeutic process were statistically similar between conditions.

However, when analysing the item presented immediately after the experimental induction, which asked the participants if they had felt any transformation, data was found that contradicts the results presented in the repeated-measures ANOVA. The results of this item reveal that 22 of the 30 participants (73%) in the EDD-AMM Sequence condition affirmed to have felt a transformation after listening to the musical sequences, while in the AMM-EED Sequence condition and in the Control Sequence condition only 15 participants (50%) and 8 participants (27%) also affirmed to have felt a transformation, respectively. Furthermore, by applying the chi-square test it is possible to state that the transformation reported by the participants is not independent of the musical sequence (X^2 (2) = 1.234; p = 0.029; N = 90). The results of this analysis can be found in Fig. 3.

As a follow-up to the previous item, the qualitative analysis of the expressive narrative was once again explored. The data found here also contradicts the results shown by the repeated-measures ANOVA. It was observed that in the EED-AMM Sequence condition, 21 participants voluntarily adhered to the expressive narrative task, while in the other conditions only 15 (AMM-EED condition) and 11 (Control Sequence condition) adhered to the task. It should also be noted that the EED-AMM condition presents itself as the condition with the most references inserted in the category AMM states (16 out of 38 references). The AMM-EED condition presents itself with an almost equal number of references present in the category AMM States (12 references) and references present in the category EED States (11 references). Although the Control condition presents the greatest difference between references inserted in these categories (AMM States with more 7 references in

Fig. 3. Results of the participant's reported Emotional Transformation.

Table 6
Participants' EED and AMM states references present in the Expressive Narrative task.

Emotional category references	Sequence			Total
	EED-AMM (n = 21)	AMM-EED (n = 15)	Control (n = 11)	
AMM references	16	12	10	38
EED references	13	11	3	27
Differences between AMM-EED references	3	1	7	
Total	29	23	13	65

comparison to the EED States), it is also the condition that presents the lowest total number of references in each of these categories under analysis. The results of this analysis are presented in Table 6.

10. Discussion

The present empirical study set a proposition to explore the impact of different musical sequences on emotional processes. Results demonstrated how both experimental and control musical sequences led to alterations in the emotional state of the participants, as well as allowed the participants to reach a higher emotional resolution.

The alterations in participants' emotional state, as reflected in changes in level of valence, arousal and control dimensions, was an important finding, since emotional arousal is a prerequisite for emotional processing [49]. However, this effect was extremely diversified. Namely, in EED-AMM Sequence condition there was only a significant reduction from the pre to the post experimental induction in the arousal dimension; in AMM-EED Sequence condition there was only a significant increase from the pre to the post experimental induction in the control dimension; and in Control Sequence condition there was a significant increase from the pre to the post experimental induction in the affect dimension and in the control dimension, and there was also a significant reduction from the pre to post experimental induction in the arousal dimension.

The presence of emotional arousal, regardless of the differences found within each of the three conditions, supports the emotivist position by demonstrating how music can induce emotions and generate impact on the emotional state of listeners (DeNora, 2000[13]; [1,10,14, 15]. Moreover, the use of a simple and visual self-report measure of dimensional emotional rating, presented at the pre and post experimental induction, facilitated the observation of differences in the emotional state. This methodological choice reduced the danger of interpretation biases caused by poorly worded questions that, instead of assessing the emotions induced by the music, end up assessing the perceived emotions [59,60].

Furthermore, it was also verified that emotional arousal was identical across all conditions, ensuring that differences in this parameter would not influence the results later found at the level of emotional resolution. Thus, when compared together, no significant differences in the dimensions of emotional state were found between the study conditions at the pre experimental induction, just as no significant differences were found between the study conditions at the post experimental induction. No differences were also found between the conditions regarding the level of problem activation, a dimension of the therapeutic process measure that also verifies emotional arousal, which again indicates that participants were similarly emotionally involved in the different conditions. The similarity of emotional arousal across conditions renders some validity to the methodological design of the present study. Since all musical stimuli were characterized by orchestral/instrumental excerpts, the similarity of structural features within this musical style may have enabled the activation of the brainstem reflex mechanism [14], by emotionally activating the listeners through the signalling of a potentially important event, which could explain the
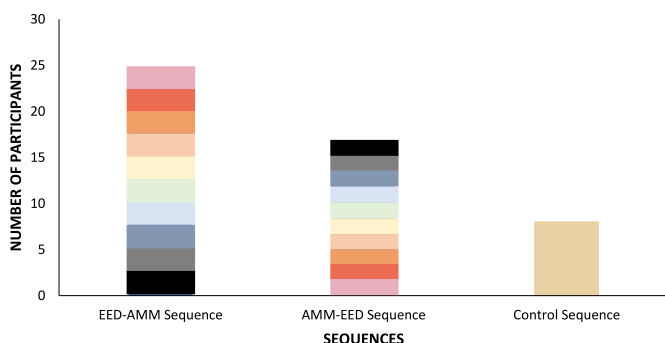
similarity of emotional involvement across conditions.

Ensuring the similarity of emotional involvement, across all conditions, both in pre and post experimental induction, allowed us to proceed with the analysis of our data. Inversely to what was hypothesised, in that we expected the experimental conditions to be the winning candidates, all musical sequences won prizes in terms of leading to higher emotional resolution. The qualitative analysis of the expressive writing task reinforces the presence of this effect, since words that fit into EED emotion states and even more words that fit into the AMM emotion states were found across all conditions. The Bayesian analysis also provides the strength of evidence regarding these findings, by concluding that the data was least likely to occur in the model that contained only the musical sequence variable.

On the one hand, the presence of this effect in the EED-AMM Sequence is extremely significant, since it shows that an emotional processing experience can occur in the presence of sequenced musical stimuli based on the sequential model. Pascual-Leone and Greenberg [43] demonstrated that the achievement of the emotional states in the AMM category proceeded in the occurrence of the emotional states present in the EED category. Also, in research using this model in a therapeutic context, the presence of sequential links between various states is demonstrated, regardless of the type of therapeutic modality applied [44,45,48,61]. Complementarily, Welling [47] reflects on the importance of the transformative emotional sequence as a common therapeutic principle of change, reinforcing the idea of the need for a prior activation of a problematic emotional state, followed by the activation of adaptive emotional states. Thus, the results found in EED-AMM Sequence condition are not surprising and align with the aforementioned research.

On the other hand, the presence of this effect in the AMM-EED Sequence also aligns with some ideas expressed in the literature. Pascual-Leone [48] stated that no study has yet been able to establish links that simultaneously unify all the emotional states present in the sequential model. Moreover, and as previously mentioned, the sequence of emotional states present in the sequential model is nonlinear, only being necessary to experience all emotional states to reach the higher level of emotional processing [43]. In the two experimental sequences of the present study, the total experience of the 10 short lived emotional states is provided, and very concrete instructions are given for participants to focus their effort on the processing of the emotional theme they had chosen to work on. Although the AMM-EED Sequence inverts the order of presentation of the referred emotional states, the participants in this inverted condition may have had the necessary and sufficient conditions for some type of emotional processing to occur, thus also leading to a higher level of emotional resolution.

Additionally, Pascual-Leone et al. [62] demonstrated how different patterns of dynamic change can be observed in the same dataset, depending on the time window and the intended goal of analysis. Thus, the authors presented a "saw-toothed"/zig-zag pattern that jointly described change within and between sessions. Pascual-Leone and Kramer [61] also noted the existence of this pattern when referring to the occurrence of emotional "collapses", where patients, when making initial attempts to move towards primary adaptive emotions, eventually regress to their initial distress expressions. Focusing on this collapse argument, two lines of thought occur to us that could explain this result. First, in the present study, one can consider that, in the AMM-EED Sequence, the first part of the music guided the participants immediately towards primary adaptive emotions, but the second part of the music quickly transported the participants to the experience of emotions related to a state of distress, which led to the referred emotional collapse. Secondly, since participants were presented with instructions to focus on their emotional distress marker, their mind/bodyset was in contact with a state of emotional suffering; thus, in turn, by being invited to immediately experience primary adaptive emotions, while focusing on the emotional distress experience, may have facilitated the occurrence of the referred emotional collapse. In other words, this

collapse could be explained by a premature and non-structured movement towards the experience of primary adaptive emotions, being difficult to sustain and susceptible to interference of the initial state of emotional suffering prompted by the study's instructions.

In regards to the Control Sequence, which also had a significant impact on emotional resolution, the result was surprising to us. Here, the presence of music alone, without specified and differentiated ingredients, is considered to have been a sufficient condition for the facilitation of emotional processing. One could admit that it is not a strange concept, since the Bonny Method of Guided Imagery and Music uses classical music to provide moments of reflection and emotional transformation [38]. Additionally, like all the other study conditions, the present condition not only provided participants with a musical sequence, but also provided specific instructions to help create a moment of focus, connection and reflection of the self. The creation of this moment or task may have also been facilitative of emotional processing. Mindfulness or focusing tasks alike are associated with emotional transformation (e.g. Refs. [63,64].

Another line of argument that could be reflected upon concerns the idiosyncrasy of the participants' emotional and psychological state [65, 66]. It is important to ponder that, although some people might be ready to engage in a full EED to AMM sequence, that would lead them to a higher and more profound level of emotional processing, other people might, indeed, not be ready for such experience. In such cases, the individuals might only make use of one segment that provides useful and adequate for them (e.g. individual that just resort to the venting of global distress). This initial step in awareness or experience might then be what the individual needs, as it provides the individual with the opportunity to think about the emotional distress in a more meaningful way [51]. In sum, considering that not everyone needs to go through a whole sequence of emotional processing in this very moment, we can better understand and postulate that, perhaps, all of the study's conditions allowed participants to enjoy some segment that facilitated a closer contact and work with one's own emotions, thus leading to a higher emotional resolution.

Following this line of argument, we can also reflect that, the people who indeed are ready to engage in a full sequence of emotional processing, will use whatever segments they can, even if a condition isn't designed to offer them that. In a clinical setting this can be observed when placebo effects occur [67,68], that is, even if an intervention is designed to not work, the patient will find a way to benefit or gain something from it, because they genuinely want the therapy to work. Thus, this effect could possibly help explain the results found in the Control Sequence, where we have a condition that wasn't designed to offer participants elements for emotional resolution, yet the participants in it were still able to reach a higher emotional resolution.

Reflecting on which musical sequence allowed to achieve a higher level of emotional resolution, quantitative and qualitative results are at least somewhat inconclusive or conflicting. On the one hand, the quantitative data concerning the scales point out that there are no differences between conditions, on emotional resolution as well as on the dimensions problem mastery and problem clarification of the therapeutic process measure. On the other hand, the quantitative data regarding the direct question about the presence of a feeling of transformation revealed that a greater number of participants in the EED-AMM Sequence condition (73%) claimed to have felt transformation. Furthermore, the qualitative data set also interestingly revealed that there was a higher number of participations in the brief expressive writing task by participants in the EED-AMM Sequence condition (also 73%). It could be hypothesised that the participants in this condition did experience a higher emotional resolution, which in turn led them to be more predisposed to generously participated in this facultative task [69].

Finally, when asked to rate the usefulness of listening the musical sequence, no differences were found between the conditions regarding the perceived usefulness of this task. Therefore, participants in all three

conditions valued and perceived it as useful task, since the mean in all conditions was higher than the midpoint of the scale. Music is commonly used in the release and regulation of emotions [1,10,13–15] and to relive valued past experiences [17], so it can be understood how the present task was perceived as useful in all three conditions. It is also considered that, in all conditions, a moment of introspection and contact with one's own emotions was provided. So, even though each sequence may have facilitated different types of experiences, overall, this was a moment that allowed participants to disconnect from their surroundings and to connect with themselves.

10.1. Limitations and future studies

The main limitation of the present study is the lack of a non-musical control condition. The main objective of the present study wasn't to analyse the difference between experiencing or not experiencing a musical sequence, but what different effects different types of musical sequences could produce. However, the inclusion of a non-musical control condition could have allowed to further understand how and if music can truly induce emotional processing. Future studies are then highly recommended to include a non-musical control condition to more clearly illustrate the power of music to affect emotional processing.

As this is an experimental study, solely conducted in an online platform and for a short period of time, there's a high risk of interference of extraneous variables [70,71]. Furthermore, considering that the present experimental study intended to induce an emotional process, we must consider that this is a very subtle process that is even more likely to be influenced and altered due to the interference of extraneous variables. Although an effort was made to ensure a standardization of experimental conditions between participants, regarding the environment and modality of listening to the musical sequences, it is not possible to fully confirm that these were ensured. However, it should be noted that, due to the current pandemic context triggered by the SARS-CoV-2 virus, it became unfeasible to carry out this study in another type of setting. If possible, futures studies are recommended to conduct trials in-person, to better control the influence of extraneous variables and to secure a more involving experience for participants.

Experimental studies on process are also a challenging task on its own because. Not only there's the interference of extraneous variables, but participants just don't follow instructions. In line with what has been mentioned above, participants have their own wishes and expectations, which may not be the same as the experimenters [65,66]. In the present study, like in most experimental research, the open-ended nature of the process tasks means that, on the side, the participants have the liberty to not follow the instructions, and, on the other side, the design cannot directly control what participants are spontaneously doing in their minds [66]. Combining these factors with the idea that participants have their own agenda, and that participants have different predispositions to receive a transforming emotional experience, one could easily understand how some participants could become more distracted in certain parts of the musical sequences. It is thus reinforced the recommendations for future studies to conduct trials in-person and it is suggested for the narrative task to be a mandatory, and not an optional task, for a more complete understanding of the type of process and transformation that participants undergo.

It can also not be forgotten that, even though the musical excerpts that integrated the final musical sequences where carefully selected with aid of Juslin and Västjfäll [14] theorical framework, the audition and interpretation of music remains as a highly idiosyncratic activity.

Besides, as the authors have pointed out, it is not possible to directly specify which mechanisms are activated during the hearing of a musical stimulus, since many of these mechanisms are activated and processed unconsciously. Even though we tried to verify them indirectly, through direct questions about the participant's contact with musical learning and appreciation, it is very likely that the activation of unwanted mechanisms occurred. Future studies are invited to deepen the type of impact that the activation of emotional contagion mechanisms and episodic memory may have on the triggering of emotional processing.

As for the statistical analysis, it is important to reflect upon the option of combining the data concerning the UFB-RS and ESN-RS scales. Both scales allowed the measuring of emotional resolution, but each scale measured this dimension regarding a different emotional marker. Although the present study did not intend to perform analyses with distinction of emotional resolution achieved between emotional markers, it may be an added value, in future studies, to perform statistical analyses separately for each emotional marker. Thus, future studies may verify if the use of musical sequences for inducing emotional processing has a greater effect depending on the type of emotional marker selected by the participants, which could allow us to refine and better understand the potentiality of the therapeutic effect of music.

Lastly, the length of the present musical sequences is not considerate a limitation, since a longer musical sequence would become unfeasible in an online setting, However, in possible future studies with trials in-person, longer musical sequences are recommended with the intent to allow participants to experience each emotional state more deeply, possibly allowing an even higher emotional resolution.

11. Conclusion

In the quest of if or how music can facilitate emotional processing, the present study opens several paths of importance. The data recorded here allows us to contribute to a gap in literature by linking musical stimuli to an empirical emotional processing model. These findings also contribute to the emotivist position by utilizing and demonstrating how different musical stimuli lead to emotional activation and processing. In conclusion, the present research demonstrates how, not only can music be described as allowing the creation of emotions, but it has the potential to be described as allowing the transformation of emotions, an important principle in working productively with emotions [72].

Author's statement

I, Marta Esteves, here by state that all authors have seen and approved the final version of the manuscript being submitted. This article is the authors' original work, hasn't received prior publication and isn't under consideration for publication elsewhere.

Appendix C. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ctcp.2022.101603.

Appendix A Music Excerpts Citation

Emotional State	Full Musical Citation
Global Distress	Albinoni, T. (2007). Adagio in G Minor [Song]. On The Prague Baroque Orchestra conducted by Trevor Pinnock. YOYO USA.
Fear	Bartók, B. (2006). Music for Strings, Percussion and Celesta, I. On The Chicago Symphony Orchestra conducted by James Levine. Polygram Records.
Shame	Albinoni, T. (2007). Adagio in G Minor [Song]. On The Prague Baroque Orchestra conducted by Trevor Pinnock. YOYO USA.
Need	Bach, J. (2006). Inventions No. 11 [Song]. On J. S. Bach: Two Part Inventions & Three Part Inventions performed by Andras Schiff. Decca.
Negative Evaluation	Schubert, F. (2013). String Quartet No. 14 in D Minor, D. 810, "Death and the Maiden": II. Andante con moto [Song]. On String Quartets No 14 D Minor Death & Maiden performed by Alban Berg Quartett. Warner Classics.
Rejecting Anger	Horner, J. (1996). Futile Escape [Song]. On Aliens conducted by Cliff Eidelman. Varese Sarabande Records.
Assertive Anger	Beethoven, L. (2010). Symphony No. 3, Eroica, 3rd movement [Song]. On The Beethoven Project conducted by Paavo Järvi. IMPORTS.
Self-Soothing	Debussy, C. (1994). Reflets dans l'eau [Song]. On Debussy: Piano Works performed by Pascal Rogé. Decca.
Grief and Hurt	Rodrigo, J. (2007). Adagio [Song]. On Joaquin Rodrigo – Concierto De Aranjuez performed by Orquesta Española de Conciertos. Tam-Tam Media.
Acceptance and Agency	Kunpu-Note (2010). Tsuki no Shizuku [Song]. On Tsukihana No Shou. Music Office Isana.

Appendix B Music Excerpts Characterization

Emotional State	Excerpt Characterization
Global Distress	Slow tempo, minor mode, firm rhythm and complex. A mixed melody of both sad and lonely emotional tones intended to induce a very vague and disruptive state, with mixed or undifferentiated feelings of hurt, pain, confusion, hopelessness, helplessness.
Fear	Slow and fast tempo, minor mode, firm rhythm and complex. A deep and profound melody with heavy chords that keep escalating, intended to induce an emotional tone of fear, of being alone and unsafe.
Shame	Slow tempo, minor mode, firm rhythm and complex. A sad melody with a low harmony and sad sounding chords, intended to induce an emotional tone of failure, of humiliation and defectiveness.
Need	Slow tempo, minor mode, flowing rhythm and simple. A gentle and comforting melody that follows darker tones, intended to induce an emotional tone of acceptance and affection towards the self.
Negative Evaluation	Slow tempo, minor mode, firm rhythm and complex. A very sad and slow melody, never evolving or growing to a major mode, intended to induce an emotional tone of negative evaluation towards the self and of hopelessness.
Rejecting Anger	Fast tempo, minor mode, firm rhythm and complex. A very angry sounding melody, with heavy drums and brass that sounds like they'll blow everything around them, intended to induce an emotional tone of anger, hate, repulsion and want for destruction.
Assertive Anger	Fast tempo, major mode, firm rhythm and complex. An angry melody, but with a strong affirming and assertive tone accentuated by the chords and the accompanying drums, intended to induce an emotional tone of self-affirmation and recognition one's rights.
Self-Soothing	Slow tempo, major mode, flowing rhythm and simple. A dreamy, sentimental, and tender melody, with a soft and bright piano, intended to induce an emotional tone of selfcare, nurture and caring.
Grief and Hurt	Slow tempo, major mode, flowing rhythm and simple. A slow and sad melody, with a soft piano accompanied by stronger chords that intended to induce an emotional tone of the sadness over a loss.
Acceptance and Agency	Slow tempo, minor mode, flowing rhythm and simple. A smooth and soothing melody, with both a unique Japanese flute and harp intended to induce an emotional tone of calm, comfort, acceptance and feeling capable/ready to move on.

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