The “Ifs” and “Hows” of the Role of Music on the Implementation of Emotional Regulation Strategies

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2021
THE “IFS” AND “HOWS” OF THE ROLE OF MUSIC ON THE IMPLEMENTATION OF EMOTIONAL REGULATION STRATEGIES

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July 2021

Dissertation submitted for the Integrated Master’s Degree in Psychology, Faculty of Psychology and Educational Sciences of the University of Porto, supervised by Doutora Susana Silva (FPCEUP).
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It really is a very odd business that all of us, to varying degrees, have music in our heads.

Oliver Sacks (2008)
Acknowledgements

As it could not be otherwise, I am grateful to my family for respecting and supporting my dreams and allowing this process of me becoming who I really am.

I am grateful to Professora Susana Silva, for all the insights, the patient and for helping me give substance to my ideas.

I am grateful to FPCEUP, and to all my college buddies, especially Esperança e Joana, for being home, for making me feel that I should not be elsewhere, doing something else.

To my friends of a lifetime, for understanding my silences and my absences during this phase.

To Ricardo, for being there from the start and for having that unending faith in me.

To Leonor, for appearing (and staying) at the craziest phase of this process.

To all the participants of this study, for their time.

Lastly, to music, for being my company in this year of isolation, for bringing meaning and motivation to this process. For being food for thought and soul.

If I could insert a song throughout this dissertation, I would.
Resumo

As pessoas investem uma parte significativa das suas vidas a ouvir música e um dos motivos pelo qual o fazem é porque acreditam que esta os ajuda a regular as suas emoções. Em oposição a esta ideia, estudos empíricos mostram resultados nulos do efeito da música na implementação de estratégias de regulação emocional, mas, para o nosso conhecimento, o potencial moderador da relação que a pessoa tem com a música (sofisticação musical) ainda não foi tido em consideração. Adicionalmente, pouco se sabe sobre a forma como a música atua e se os efeitos de ouvir música dependem das capacidades individuais de funcionamento executivo. Com o objetivo de preencher estas lacunas, desenhou-se um estudo experimental onde foram induzidos estados de raiva aos participantes (n = 48), sendo-lhes pedido depois que regulassem o seu estado emocional. Antes e depois da tarefa de regulação emocional, o seu estado de raiva foi quantificado através de medidas de autorrelato. Os participantes foram divididos em quatro grupos diferentes, que resultaram do cruzamento entre duas condições: estratégia de regulação emocional (distração vs. reavaliação) e música (com música vs. sem música). Os participantes foram caracterizados a nível da sua sofisticação musical e das suas capacidades de funcionamento executivo, preenchendo ainda um questionário sobre a sua experiência subjetiva relativamente à tarefa de regulação. Os resultados sugerem que existem efeitos da música apenas nos participantes com maior sofisticação musical, sendo que nestes a música beneficiou a reavaliação, mas prejudicou a distração. Em relação à maneira como a música atua, a experiência subjetiva dos participantes sugere que a música favorece reavaliações mais empáticas, existindo a possibilidade de estas se estenderem no tempo. Finalmente, o efeito da música, em dois domínios do funcionamento executivo – memória de trabalho e flexibilidade afetiva –, teve efeitos opostos: apenas os participantes com níveis mais elevados de memória de trabalho beneficiaram do uso da música; apenas aqueles que tinham níveis mais baixos de flexibilidade afetiva conseguiram utilizar a música a seu favor. Os nossos resultados suportam a ideia de “musical affordance” – o efeito da música depende das características do ouvinte – e levanta novas hipóteses relativamente ao papel da música na regulação emocional.

Palavras-chave: Regulação Emocional, Distração, Reavaliação, Ouvir Música, Sofisticação Musical, Funcionamento Executivo.
Abstract

People invest a significant part of their lives listening to music, and one of the reasons for doing so is that they believe music helps regulating one’s emotions. Contrasting with this idea, empirical studies have shown null results regarding the effects of music on the implementation of emotional regulation strategies, but, to our knowledge, the potential moderating role of one’s relation with music (musical sophistication) has not been considered yet. In addition, little is known on how music acts, and whether the effects of music listening depend on individual executive functioning abilities. To address these gaps, we ran an experimental study where we induced anger in a group of participants (n = 48) and then asked them to regulate their emotional state. Before and after regulation, their state of anger was quantified from self-report measures. Participants were split into four different groups, resulting from crossing two conditions: regulation strategy (distraction vs. reappraisal) and music (with music vs. without music). They were characterized for musical sophistication and executive functioning abilities, and they also filled in a questionnaire addressing their subjective experience of regulation. Results indicated music effects in higher, but not in lower musical sophistication participants. In the former, music benefitted reappraisal but impaired distraction. Regarding the way music acts, reports of subjective experiences suggested that music favors more empathic reappraisals than a non-musical context, and that these empathic reappraisals may be more long-lasting. Finally, two different executive functions – working memory and affective flexibility – had opposite effects concerning the impact of music: higher, but not lower working memory participants benefitted from music; lower, but not higher, affective flexibility participants took advantage of music. Our findings support the idea of musical affordance – music effects depend on listeners’ characteristics – and they raise new hypotheses concerning the specificity of emotional regulation helped by music.

Keywords: Emotional regulation, Distraction, Reappraisal, Music listening, Musical Sophistication, Executive Functions.
Résumé

Les gens consacrent une partie importante de leur vie à écouter de la musique, et l'une des raisons pour lesquelles ils le font est qu'ils pensent que la musique aide à réguler leurs émotions. Contrairement à cette idée, les études empiriques ont montré des résultats nuls concernant les effets de la musique sur la mise en œuvre de stratégies de régulation émotionnelle, mais, à notre connaissance, le rôle modérateur potentiel de la relation d'une personne avec la musique (sophistication musicale) n'a pas encore été considéré. De plus, on sait peu de choses sur la façon dont la musique agit et si les effets de l'écoute musicale dépendent des capacités individuelles de fonctionnement exécutif. Pour combler ces lacunes, nous avons mené une étude expérimentale dans laquelle nous avons induit la colère chez un groupe de participants (n = 48) et leur avons ensuite demandé de réguler leur état émotionnel. Avant et après la régulation, leur état de colère a été quantifié à partir de mesures d'autoévaluation. Les participants ont été répartis en quatre groupes différents, résultant du croisement de deux conditions : la stratégie de régulation (distraction vs. réappréciation) et la musique (avec musique vs. sans musique). Ils ont été caractérisés pour leur sophistication musicale et leurs capacités de fonctionnement exécutif, et ils ont également rempli un questionnaire portant sur leur expérience subjective de la régulation. Les résultats ont indiqué que la musique avait des effets sur les participants ayant un niveau de sophistication musicale élevé, mais pas sur ceux ayant un niveau inférieur. Chez les premiers, la musique a favorisé la réappréciation mais a nui à la distraction. Regarding the way music acts, reports of subjective experiences suggested that music favors more empathic reappraisals than a non-musical context, and that these empathic reappraisals may be more long-lasting. Finally, two different executive functions – working memory and affective flexibility – had opposite effects concerning the impact of music: higher, but not lower working memory participants benefitted from music; lower, but not higher affective flexibility participants used music took advantage of music. Our findings support the idea of musical affordance – music effects depend on listeners’ characteristics – and they raise new hypotheses concerning the specificity of emotional regulation helped by music.

Mots-clés : régulation émotionnelle, distraction, réévaluation, musique, sophistication musicale, fonctionnement exécutif
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Introduction

Despite the acknowledged adaptive value of emotion (e.g., preparation and direction of action, evaluation of events, see Scherer, 2005) there is still some debate about how positive it is to feel what we feel. Some defend the positive side of emotions, arguing that they work like a fuel, making them move, motivating and adding meaning to their life, being the booster and the purpose of every action; others can only see the negative side of emotions, describing them as something that paralyzes them, that inhibits their action, and something that they cannot make sense of. In our point of view, it is inadequate to look at emotions in this dichotomy (positive vs. negative), because - like every aspect of human experience - it depends. The only thing that we can say for sure is that the emotional experience is inevitable, it is what makes us humans, so the debate should not be around the pros and cons of emotions, but rather about the way we can make peace with them to try and find some control over something that, sometimes, seems so out of control. So, the good news (especially for those who advocate the abolition of emotions) is that this control can be achieved through the regulation of emotional experience (Hoeksma et al., 2004), such that our current emotional system or its expected state (e.g., feeling angry or the expectation of starting to feel angry) becomes able to match our emotional goal (e.g., do not start an argument with a loved one because you want to keep a good relation). However, knowing that it is possible to regulate our emotions does not make it simpler.

From time to time, we can feel overwhelmed by our own emotions. It is like they come and go as they please, and sometimes we only feel some relief when we can find something that can take our mind off it, distracting us, or make us see the situation with a fresh pair of eyes - something known as reappraisal. Distraction is a strategy for regulating emotions that consists of disengaging our attention from the emotional impact that an event has on us, focusing in another concurrent task (Kanske et al., 2011). Since the emotional impact that an event has on us is mediated by the way we interpret (appraise) it (Roseman et al., 1990), it makes sense that another possible strategy for regulating this emotional impact is to reinterpret the situation, changing its meaning, using reappraisal.

Facing the challenge of emotional regulation (ER), we quickly realize that the efficacy of this process does not depend exclusively on our will. Case in point, even if we want to regulate our emotions though reappraisal, we do not always have the resources for
that (e.g., time, cognitive capacity (see Barlett & Anderson, 2011). In case of distraction, it is known that this ER strategy involves more than focus on something else (Van Dillen & Koole, 2007), so even though we really want to get our mind of it, sometimes we are not able to. We get the idea that what we use to distract ourselves and to reappraise a given situation is crucial for its effective implementation (Van Dillen & Koole, 2007). Therefore, it is important to know what works for us, what can help us influence the course of our emotional experience.

One behaviour that is often credited as a powerful tool for regulating emotions is music listening (ML; see Goethem & Sloboda, 2011; Groarke & Hogan, 2018). Music is well-known by the influence it exerts in our daily emotions, their intensity, and the way we express them (Volker, 2019). People use music for many reasons, including the attempt to control, support or change the current state of experienced emotions, i.e., for emotional regulation (Thoma et al., 2012). According to the GSTM framework (see Goethem & Sloboda, 2011) ML is frequently referred as a tactic that supports the implementation of the strategy we choose to use to pursue a given goal (e.g., “when I feel angry listening to music helps to take my mind of it”, referring to distraction strategies, see Groarke & Hogan, 2018). ML seems to be particularly associated with the use of reappraisal as an ER strategy (Chin & Rickard, 2012), given that people who listen to music tend to use this strategy more often. In line with this, some studies report that the message and meaning transmitted by the lyrics of a song can allow people to “find solutions to problems and novel ways of thinking about difficult situations” (Papinczak et al., 2015, p. 1124).

Saarikallio (2010) highlighted the constructive ways – pointed in literature as having a positive impact on well-being (Chin & Rickard, 2014) – in which people use music to deal with their emotions, such as distracting and mental work/rational thinking (that sustains reappraisal). Nevertheless, potentially destructive uses of music, like ruminating (Groarke & Hogan, 2018) and immersing in negative emotions (Papinczak et al., 2015) have also been documented. Thus, ML seems to be an appropriate tool for ER, and people report using it for this purpose. However, several questions regarding the relation between ML and ER remain open.
Does ML help in implementing ER strategies?

Associations between ML and ER have been reported in empirical studies (e.g., Papinczak et al., 2015; Saarikallio & Erkkilä, 2007), but most are based on retrospective accounts. Moving from this retrospective logic, the study of Baltazar et al. (2019) focused on the efficacy of music in stress reduction when combined with an ER strategy pointed out as relevant by participants, in the context of real-time emotion regulation. This study showed that combining ML with an adequate strategy did not increase ER efficacy, when compared with music or strategy alone. However, the fact that participants were asked to choose the more adequate ER strategy raised a variety of strategies, including potentially negative ones such as rumination. In addition, the authors did not consider an important individual variable – the extent to which participants were interested in music and the significance of music in their lives. The first goal of the present study was to clarify the results obtained by Baltazar et al., (2019), allowing us to understand if music can aid the implementation of regulation strategies known to have positive results – distraction and reappraisal – and if the influence from music depends on the connection we have with it – our musical sophistication.

Does ML shape the reappraisal mode?

The possibility that music helps the implementation of ER strategies like reappraisal raises the question on how it can do so. One possibility is that music acts by increasing empathy. Listening to music has been associated with helping behaviour (Greitemeyer, 2011). Specifically, there seems to be an association between listening to music with prosocial lyrics and an increase in helping behaviour, suggesting that this kind of music can influence our cognition and affect. This is in line with the media effects theory (Rentfrow, 2012), according to which how people think and feel is congruent with the message present in the music that is being listened to. Since prosocial behaviour implies some degree of empathy (Decety et al., 2016) and empathy, in turn, engages taking the other person’s perspective, it makes sense that a prominent role of music in reappraisal relates to increased empathy. To our knowledge, this hypothesis has not yet been tested, and thus testing it was our second goal.
Is ML more useful when executive functioning is lower?

Our goal (e.g., I want to distract myself) and what we use to reach that goal (e.g., ML) are two important things in the ER process. Along with this, there are intrinsic individual characteristics that seem to influence how well we regulate our emotions. Emotional regulation involves abilities such as having a goal and keeping it in mind, controlling our impulsive behaviours, and having flexibility in choosing the most appropriate strategy given the context we are in (Gratz & Roemer, 2004). The description of these abilities matches executive functioning (EF) skills like working memory, inhibitory control, and cognitive flexibility, respectively. In the same vein, the definition of specific ER strategies, like distraction and reappraisal, refer us to the definition of some EF abilities. For us to distract from a given stimulus, we need good inhibitory abilities (Katrien et al., 2011), since those abilities consist of one’s capacity to control attention and/or thoughts, focusing on what one chooses, and suppressing attention from other things (Diamond, 2013). Working memory and cognitive flexibility seem to underlie the definition of reappraisal. Working memory refers to the ability to hold information in mind and mentally work with it (Diamond, 2013), and that is what we do when we reappraise a situation: we hold it in mind while we try to give it a new meaning. One aspect of cognitive flexibility is being able to change perspectives and the way we think about something (Diamond, 2013), things that are essential when it comes to reappraise or find new ways of looking for a situation.

The relation between EF and ER has been illustrated in some studies (e.g., Holley et al., 2015) reporting association between EF and aggressive behaviours. The urge to act in an aggressive way is more present in people who have weaker inhibiting influences. Conversely, the capacity to engage in effective problem solving instead of aggressive behavior, is associated with higher levels of EF. For example, when someone does something that makes us angry, EF gives us the capacity to inhibit saying or doing something that we might regret later and gives us room to choose another way to react, taking our goals into account. Despite this, the literature is not consensual regarding the positive relation between EF and ER, and null results have also been reported (Gyurak et al., 2012).

The possibility that good EF skills improve ER - and thus that individuals differ in their natural ER aptitudes due to different EF skills - raises one question regarding the interplay between EF skills and the use of ER tactics like ML: could it be that ML compensates for weak EF skills, in the sense that ML is more useful to individuals with
lower EF skills (weak natural tools for ER) than for those with higher skills (stronger tools, decreased need for aids)? To our knowledge, this hypothesis remains untested.

**Overview of the present study**

In face of the open questions regarding the role of ML in ER, our goal was threefold: First, given the open questions on the role of music on the implementation of ER strategies, we wanted to assess the impact of ML on the effectiveness of two different (and potentially constructive) emotional regulation strategies (distraction and reappraisal) considering the potential influences of musical sophistication. Second, we aimed to understand if music influences the type of reappraisal individuals choose to make – specifically, if music favours a reappraisal based on empathy. Finally, we wanted to clarify mixed results on the relation between some EF domains and ER performance: based on the hypothesis that executive functioning subtends effective emotional regulation, we wanted to know whether ML can compensate for low executive functioning abilities when it comes to achieve emotional regulation.

To address these goals, we conducted one study that followed a mixed 2x2x2 factorial design engaging the factors type of ER (passive and active), ER strategy (distraction and reappraisal) and ML (music and no music). Participants went through a passive ER attempt (no regulation instructions) and an active ER attempt (instructions to regulate). The two ER attempts followed an anger induction task based on autobiographical memories. Before and after recalling a situation that made them angry (anger induction), participants self-rated their anger level. In the active condition, participants were distributed by four experimental conditions resulting from the combination between regulation strategy (distraction - D; reappraisal - R) and music (with music - W; without music - Wo): D-W; D-Wo; R-W; and R-Wo. To address goal number one, we focused on participants’ success in ER during the session (success in active regulation minus passive baseline) as a function of ML, regulation strategy and musical sophistication. Success in regulation – passive and active - was measured based on anger ratings, and by self-reports of perceived success in regulation. To address goal number two, we asked participants with vs. without music to report how they reappraised the situation. To achieve goal number 3, we collected three measures of participants’ EF that have been associated with ER efficacy (inhibitory control,
working memory, cognitive flexibility) and analysed how these variables intervened in ER during the session.

We hypothesized that listening to music would lead to (H1) increased efficacy in the implementation of ER strategies (i.e., distraction and reappraisal) at least in participants with higher musical sophistication, and to (H2) a form of reappraisal different from the one used by non-listeners. Concerning our last goal, we expected that (H3) participants with lower executive functioning skills would be more sensitive to the facilitating effects of music. As a precondition to H3, we expected to see associations between executive functioning and ER.
1. Method

1.1. Participants

The required sample size for this study was estimated with a priori power analysis (with G*Power 3.1; Faul et al., 2019). To obtain a statistical power of 80% with a medium effect size ($f = .25$) and $\alpha = .05$, we had to collect data from at least 48 participants.

Forty-eight healthy participants (38 female, 10 male) aged between 19 and 33 ($M = 23.17$, $SD = 3.24$) were recruited for this study. All participants had normal hearing and normal or corrected-to-normal vision. The majority (93.8%) were college students. Participants were randomly assigned to one of the four experimental groups (Distraction With music, D-W; Distraction Without music, D-Wo; Reappraisal With music, R-W; and Reappraisal Without music, R-Wo, $n = 12$ per group). Two participants from the D-Wo group had to be reallocated at D-W because they used music to distract themselves (Appendix A).

All participants gave their informed consent (Appendix B), and experimental procedures were approved by the FPCEUP Ethics Committee (Ref.ª 2010/09-7).

1.2. Instruments

1.2.1. Emotional regulation during the session

To characterize the outcomes of participants’ emotional regulation during the session, we used the following instruments:

Self-report measure of state-anger (STAXI-2): The state-anger subscale of the State-Trait Anger Expression Inventory-2 [STAXI-2 (Spielberger, 1999); Portuguese version by Marques et al., 2007)] was used as a subjective report of the level of anger experienced by participants at different moments in the session. This instrument comprises fifteen statements (e.g., “I am furious”), and participants indicated how they identify – on a 4-point scale ranging from 1 (nothing) to 4 (extremely) – with each statement. The final score of state-anger is obtained by adding the classification assigned to each statement. Higher scores
reveal higher levels of anger. This measure provided one dependent variable in our study (changes in state-anger after regulation attempt, which we named ER intensity).

*Emotional regulation follow-up questions:* After the attempt of active regulation, participants completed a questionnaire addressing their perceptions about the emotional regulation task and the strategies that they had to implement. Participants’ answers to these questions provided a second type of outcomes, related to their perceptions of the regulation process, such as, how easy was the active emotional regulation task for them: “Did you feel difficulties in the emotional regulation task?” (Yes or no answer); what was the mode of reappraisal: “How did you reappraise the emotional situation” (open answer); projection of this emotional regulation into the future: “In the future, if you remembered that emotional situation again, the levels of anger evoked by her would be the same?” (Yes or no answer); “If no, they would be less or more intense?” (Less or more answer); “Do you think you will be able to deal better with the emotional situation?” (Yes or no answer); and, in the conditions with music (D-W and R-W): “Which features of the song did you focus on?” (Multiple choice answer: feelings evoked by the song, memories evoked by the song, rhythm and/or lyrics).

1.2.2. Individual differences in relevant dimensions

To control for individual differences in dimensions that could affect the ER task and ML effects on it, the following self-report instruments were administered:

*Sociodemographic questionnaire:* We created some questions assessing basic sociodemographic information (Appendix C) about participants.

*Regulating Emotion Systems in Everyday Life inventory [RESS-EMA (Medland et al., 2020)]*. The RESS-EMA is a self-report questionnaire designed to assess an individual’s propensity to use six strategies of emotion regulation (distraction, rumination, reappraisal, suppression, engagement, and relaxation). Participants must rate the extent to which each of twelve statements (e.g., I express my feelings) accurately describe what they usually do in response to their emotions. Responses are measured on a 5-point scale (1 = not at all; 5 = very much). The outcome variables are the strategies most frequently used by each participant. The score for each strategy may range from 2 to 10, being that each strategy is indexed by two items. Since this scale does not have a Portuguese version, we translated it
to Portuguese and then asked an English teacher to do the retroversion (Appendix D). This scale presents an excellent internal consistency (within-person: \(0.69 < \alpha < 0.79\); between-level: \(0.98 < \alpha < 0.99\)).

**Difficulties in Emotion Regulation Scale** [DERs (Gratz & Roemer, 2004); Portuguese version by Coutinho et al. (2010)]: DERs is a 36-item self-report questionnaire consisting of a global score of emotional regulation difficulties and six subscales that assess specific emotional regulation problems: (a) nonacceptance of emotional responses (6 items), (b) difficulty engaging in goal-directed behavior when distressed (5 items), (c) impulse control difficulties when distressed (6 items), (d) lack of awareness of emotions (6 items), (e) limited access to strategies for regulation (8 items), (f) lack of emotional clarity (5 items). Participants are asked how often each item (e.g., *I am clear about my feelings*) applies to them. The response is given using a 5-point scale (1 = *almost never*, 5 = *almost always*). In this scale is possible to obtain a score for each subscale, adding the items associated to it, or a total score, adding all the 36 items. Increased scores indicate increased emotional regulation difficulties.

**Goldsmiths Musical Sophistication Index** [Gold-MSI; (Müllensiefen et al., 2014); Portuguese version by Lima et al., (2020)]: Gold-MSI is a self-report measure that describes the different facets of skilled musical behavior in the general population. The facets of musical behavior are grouped in five dimensions: (1) active engagement, e.g., *Music is kind of an addiction for me - I couldn't live without it*; (2) perceptual abilities, e.g. *I can tell when people sing or play out of tune*; (3) musical training, e.g., *I can play ___ musical instruments*; (4) singing abilities, e.g. *I can sing or play music from memory*; (5) emotions, e.g., *Music can evoke my memories of past people and places*. Besides these five dimensions/subscales, the Gold-MSI also provides a General Musical Sophistication factor that incorporates some items of the scales mentioned above. The instrument has two parts: In the first part, participants rate their agreement with every statement (31 items) on a 7-point scale, anchored by 1 = *Completely Disagree* and 7 = *Completely Agree*; in the second (7 items) they indicate at which frequency they were involved in music-related activities, e.g., *I have had formal training in music theory for 0 / 0.5 / 1 / 2 / 3 / 4-6 / 7 or more years*. Increased scores indicate increased musical sophistication.

In addition, participants performed three executive-functioning-related tasks:

**Inhibitory control (IC):** Inhibitory control was assessed with the Emotional Stroop (Modified Stroop Color Naming Procedure, Martínez, 2012). Here, participants are exposed
to three sets of words (positive, negative, and neutral valence, 100 words per set), and they are asked to name the ink color of the words. Since cognitive conflict can arise from semantic-related emotional interference coming from positive or negative words, inhibitory control is required for successful task completion. The magnitude of the Emotional Stroop effect (ESE) – indicating inhibitory control deficits - is measured by the difference between the number of ink colors named of emotional words and the number of ink colors named on neutral words.

**Working Memory (WM):** The backward portion of the digit span (WAIS-III; Wechsler, 1997; 2008) was used to assess WM. Each item of this task had two sequences of numbers and participants were asked to repeat each sequence in reverse order after it was read. Participants had to be successful in both sequences to obtained 1 point. Only the backward span was applied because it is the one that is particularly dependent on working memory. WM ability is measured by the number of correct items.

**Affective Flexibility (AF):** Affective flexibility was measured using a similar design to that of Malooly et al. (2012). In this task, participants are asked to classify a series of emotional pictures based on two switching rules: a neutral rule (classify the image based on the number of human beings shown - one or fewer vs. two or more) and an affective rule (classify the image based on its valence (positive vs. negative). Rule switching is unpredictable, and participants’ ability to do the switch with little cost indicates affective flexibility. The outcomes of this task correspond to switch costs, which are obtained by comparing the reaction times (RTs) on switch trials (trials that change the rule relative to previous trial) with the RTs on repetition trials (keep the rule). Besides global switch costs, we computed specific switch costs. These included negative nonaffective switch costs, which concern switching to the nonaffective rule when the picture was negative (NA/N); positive nonaffective switch costs concern switching to a nonaffective rule when the picture was positive (NA/P); negative affective switch costs concern switching to an affective rule when the picture was negative (A/N); and positive affective switch costs switching to an affective rule when the picture was positive (A/P). For example, negative affective switch costs were calculated by subtracting RTs on trials in which the affective rule was repeated, and the picture was negative from RTs trials where participants had to switch to an affective rule and the image was negative. The reason why we consider these specific switch costs was that, in Malooly et al. (2013) study, effective reappraisal was better predicted by increased AF in switching towards the nonaffective rule in the presence of a negative picture (NA.N).
We used a selection of pictures from the Nencki Affective Picture System (NAPS; Marchewka et al., 2014). The final set of pictures consisted of 40 images, split into four groups: negative pictures with one or fewer human beings (mean valence = 1.75); negative pictures with two or more human beings (mean valence = 1.94); positive pictures with one or fewer human beings (mean valence = 8.16); positive pictures with two or more human beings (mean valence = 7.76). Pictures were presented one at a time, sequentially and randomly, with free response time and no interval between images, with two signals on the left and right sides indicating the rule to be applied (“+” and “-” to apply the affective rule; “≤ 1” and “≥ 2” to apply the neutral rule).

1.3. Procedure

Due to the pandemic context, the experiment was conducted via video call on Zoom (version 5.4.6.) with one participant at a time. The experiment followed the sequence outlined in Figure 1.

First – and after informed consent - participants answered the sociodemographic, filled in emotional-regulation-related questionnaires (RESS-EMA and DERS) and performed three executive function tasks (that measure IC, WM, and AF) in counterbalanced orders. To administer the affective flexibility task – which required precise recording of accuracy and response time, we used the OpenSesame software (version 3.3.5.) – and sent a link to participants through Mindprobe/Jatos (version 3.5.1).

The remainder of the session was structured according to two moments of anger induction - the first followed by passive regulation (common to all participants) and the second by active regulation (differing across groups). For anger induction, an autobiographical memory (AM) task was used, where participants received instructions to recall an event from their lives when they had felt “really angry”. This memory should still bring out those feelings of anger. Participants had three minutes to think about a situation and relive it with the associated feelings of anger. When evoking this memory, participants were instructed to type a narrative about it. The AM task was chosen because it is ecologically valid and shows great capacity of inducing angry mood states (changes in valence and arousal; Jallais & Gilet, 2010). Participants were asked to evoke the same episode in the two anger induction moments, being that, on the second anger induction, they
were encouraged to elaborate the previous memory. We were aware that this elaboration could lead to the decrease of anger in a second anger induction. Nevertheless, we chose this method to control for potential differences between two evoked moments and to counteract the possibility that the participant did not have more than one episode of anger to remember. Between the two core moments of anger induction plus regulation, participants filled in the Gold-MSI to help them return to baseline.

**Figure 1**

*Experimental sequence*

![Experimental sequence diagram](image)

*Note.* EF = Executive Functions; TP = Time Point; PER = Passive Emotional Regulation; AER = Active Emotional Regulation; D-W = distraction with music; D-Wo = distraction without music; R-W = reappraisal with music; R-Wo = reappraisal without music;
After the first anger induction moment, participants were told to "allow yourself to continue to feel the anger that you were feeling previously about the evoked memory, as you naturally would" (McRae et al., 2012). This was made to counteract the natural tendency that participants might have to regulate themselves. Although, strictly speaking, participants were encouraged to cancel regulation attempts, we named this a passive regulation task, to contrast with the active regulation they would do after a second moment of anger induction.

Before we move on to the description of the active regulation, it is important to note that some authors defend that the ER should be implemented at a specific time to be effective, and that some strategies should be performed at a certain point in the emotion generative process to facilitate the ER process (Gross, 1998), while others look at the ER process and emotions as continuous and accumulating processes, where ER strategies would be effective at any point from the moment that the emotion-triggering event occurs (i.e., anger-evoking memory, see Sheppes & Meiran, 2007). As we cannot say in which stage our participants were and if the negative emotion (anger) were fully developed, we adopted the second point of view of the ER process.

In the active regulation task, instructions varied according to the between-subjects condition. Two groups (D-W and D-Wo) were instructed to use distraction (D) strategies, meaning that they were encouraged to deflect their attention to something other than the anger-inducing event. In the D-Wo group (without music), they were told to engage in any activity chosen by them, while in the D-W group (with music) they should use a self-chosen song for distraction. The other two groups were instructed to use reappraisal (R), which is typically done by instructing participants to reinterpret the meaning of an emotional situation (Kanske et al., 2011). Therefore, we encouraged participants to alter the meaning of (reinterpret) the evoked situation to decrease their emotional impact. One group was told to listen to a self-chosen song to help them reinterpret the situation (R-W), while the other was only told to apply the reappraisal strategy (R-Wo). In both conditions, participants received some examples of how they could reappraise the situation (Appendix E).

Along the session, STAXI 2 was filled in six times: (1) as a first baseline; (2) after the first anger induction, indicating pre-passive-regulation anger; (3) after passive regulation (post-passive-regulation anger); (4) as a second baseline, after Gold-MSI; (5) after the second anger induction, indicating pre-active-regulation anger; (3) after active regulation (post-active-regulation anger);
Lastly, participants answered the emotional regulation follow-up questions. The entire experiment took about 50 minutes to complete.

1.4. Analysis

1.4.1. Variables and control analyses

1.4.1.1. Variables. The main dependent variable in our study was emotional regulation intensity during the session as measured by changes in anger ratings given by STAXI-2. Specifically, STAXI-2 ratings obtained after each anger induction task were subtracted to those obtained before (pre-regulation minus post-regulation, resulting in positive values if anger decreases). This provided us two indices of emotional regulation intensity: PER (passive emotion regulation, expected to be null or negative) and AER (active emotion regulation, expected to be positive; see Figure 1). Later in the analysis, we used ER type (PER vs. AER) as a within-subjects factor conveying a baseline-corrected measure of ER intensity, which we refer to hereafter as emotional regulation efficacy.

The other dependent variable corresponded to participants’ perceived success in emotional regulation, and it was obtained from one of the emotional regulation follow-up questions. Specifically, we analyze the answers (yes or no) participants gave to the question “Did you feel difficulties in the (active) emotional regulation task?”.

Having in mind the potential influence of individual differences related to emotional regulation abilities and executive functioning on emotional regulation during the session, we computed participants’ scores for DERS and RESS-EMA (emotional regulation), and IC, WM, and AF (executive functioning). Considering the potential influences of musical sophistication on the effects of music on emotional regulation, we computed Gold-MSI scores for each participant.
1.4.1.2. Control analyses. To make sure the anger induction worked, we calculated the *anger induction intensity* based on the anger ratings given by STAXI-2. Here we subtracted the STAXI-2 ratings obtained on the baselines from those obtained after the anger induction tasks (pre-passive regulation minus baseline 1 and pre-active regulation minus baseline 2). Then we ran two one-sample t tests for anger induction 1 and 2, to see if these values were significantly above zero.

In the same line of though, we checked the effectiveness of ER tasks with two one-sample t-tests against zero for both PER (expected to be null or negative) and AER (expected to be positive).

For the AF task, we eliminated outlier trials with values above and below a window defined according to the outlier labelling rule: we calculated the upper (Q3) and lower quartiles (Q1) for each participant and multiplied these two values by $g = 2.20$ (Hoaglin & Iglewicz, 1987) to establish the demarcation points of the window. We then ran a paired-sample t test comparing RTs on switch trials with RTs on repetition trials to see if there were significant switch costs in the AF task (both for global AF and specific AF).

To check whether there was a Stroop effect in the Stroop task, we ran a paired-sample t test comparing the number of ink colors named in neutral vs. emotional conditions (neutral vs. negative; neutral vs. positive).

1.4.2. HI: Effects of music x strategy x musical sophistication on emotional regulation

To test music effects on the implementation of ER strategies, we fit a linear mixed effects regression with ER intensity as the outcome variable. ER type (passive, PER vs. active, AER), music (yes vs. no) and strategy (distraction vs. regulation) were entered as fixed factors with all main effects and interactions considered (ER type*music*strategy). Participants were entered as random factors. We used the lmer function from lme4 package (Bates et al., 2015) from R (version 1.4.1106).

Along with this basic model, we ran another one adding Gold-MSI total score as a fourth fixed factor (ER type*music*strategy*Gold-MSI). The two models were compared using the *anova* function. Comparisons were made based on AIC (Akaike Information Criterion) values (Vrieze, 2012).

Significant interactions engaging ER type were broken down into further analyses by subsets. Critical alpha levels were set to .05.
In a complementary perspective on H1, and based on participants subjective experience of regulation, we analyzed the answers (yes or no) given by participants to the question “Did you feel difficulties in the (active) emotional regulation task?”. We did two chi-squares’ tests for independence to see if the answers to that question were different across conditions with distraction (D-W vs. D-Wo) and across conditions with reappraisal (R-W vs. R-WO).

1.4.3. H2: Reappraisal mode with vs. without music

Focusing on the active emotional regulation task using reappraisal, we analysed the answers to the question “How did you reappraise the emotional situation?” to find out if participants in the R-W condition reappraised the emotional situation in a different way when compared to the participants in the R-Wo condition. With this intention, we did a content analysis and count the references that were inserted in each category (R-W vs. R-Wo). The content analysis followed a deductive – based on the a priori category formulated: empathy – and an inductive logic that allow new categories to emerge from the remaining answers. Alongside, we analysed the musical features that participants had focus on during the reappraisal task (with and without music).

Lastly, and following the idea that the way participants reappraise a situation would change depending on the presence of music, we analysed if the reappraisal modes associated with ML would favour an ER that extends over time, in other words, we analyse the answers given to the question (1) “In the future, if you remember that emotional situation again, the levels of anger evoked by her would be the same?” and (2) “Do you think you will be able to deal better with the emotional situation?”.

1.4.4. H3: Examining the role of executive functions

To determine if our assumption that EFs exert an influence on the ER process was true, we calculated Pearson correlation coefficients between EF scores and ER difficulties reported by the participants (DERS). We also correlated EF scores with the most used strategies (RESS-EMA) reported by the participants, to see if increased executive functioning would relate to the choice of a given strategy.

Under H3, we hypothesized that EF differences across individuals could moderate music effects in the experimental ER task. This means that EF covariables could improve the basic 2x2x2 model if EF showed some relation to ER during the task. Therefore, if some
relation showed up (in the form of significant correlations), specific EF variables would be incorporated into our model. If these correlations were not significant, we would move on with model comparisons engaging up to two covariables to reach the best model, following the steps described in 1.4.2. Therefore, we correlated individual EF with ER efficacy (AER - PER) during the session (measured by STAXI-2 changes). The linear mixed effects model incorporating executive functioning had ER type, music, strategy and executive functioning variables as fixed factors, and participants as random intercepts. Critical alpha levels were set to .05.
2. Results

2.1. Descriptives and control analyses

2.1.1. Descriptive statistics

All descriptive statistics were calculated for every instrument and task in the present study (see Table 1).

Table 1

Descriptive statistics for study measures

| Instrument/Task | M (SD) | D-W | D-Wo | R-W | R-Wo |
|-----------------|--------|-----|------|-----|------|
| **DERS**        |        |     |      |     |      |
| Total Score     | 105(12.8) | 105 (13.1) | 105(10.8) | 102(11.2) |
| Awareness       | 17.8(3.21) | 17.8(1.78) | 17.8(2.5) | 17.7(2.56) |
| Clarity         | 9.71(1.79) | 9.71(1.35) | 10.9(1.80) | 10.1(2.02) |
| Strategies      | 19.2(3.43) | 19.8(2.04) | 18.9(2.14) | 18.3(2.58) |
| Impulse         | 12.9(4.46) | 13.2(4.46) | 12.6(2.90) | 12.6(3.48) |
| Nonacceptance   | 20.3(1.75) | 19.9(2.57) | 19.8(2.09) | 19.4(2.47) |
| Goals           | 25.4(7.92) | 25.1(7.47) | 24.9(4.96) | 24.3(6.63) |
| **RESS EMA**    |        |     |      |     |      |
| Rumination      | 6.7(1.36) | 7.86(1.49) | 7.75(1.48) | 7.83(1.62) |
| Relaxation      | 7.4(1.35) | 6.43(1.43) | 7(1.83) | 7.08(1.26) |
| Reappraisal     | 7.1(1.18) | 7.36(1.51) | 7.33(1.75) | 8.42(0.95) |
| Engagement      | 7.3(1.67) | 7.36(1.85) | 6.67(1.80) | 6.92(1.66) |
| Distraction     | 7.2(1.84) | 7.57(1.83) | 7.5(1.19) | 8(1.22) |
| Suppression     | 4.6(1.80) | 5.14(1.62) | 6.08(1.80) | 6.17(1.77) |
| **AFT**         |        |     |      |     |      |
| General         | -1189(7187) | -1632(5182) | -1689(6226) | -5550(5679) |
| NA/P            | 63.6(622) | -42.8(864) | 359(618) | -10.2(668) |
| NA/N            | -237(767) | 17.1(765) | 189(608) | -123(656) |
| A/P             | 217(475) | -239(437) | 111(786) | -106(971) |
| A/N             | -231(307) | 16.6(804) | -694(800) | -549(656) |
| **DS**          |        |     |      |     |      |
| Neutral         | 58.1(15.6) | 65.8(94) | 59.3(19.6) | 55.8(16.0) |
| Negative        | 50.5(12.2) | 54.1(12.3) | 54.9(17.6) | 49.8(16.9) |
| Positive        | 59.1(15.6) | 65.9(10.1) | 59.9(17) | 59.4(18.4) |
| **Gold-MSI**    |        |     |      |     |      |
| Total Score     | 68.7(18.3) | 57.6(16.87) | 58.25(14.75) | 72.42(16.07) |
| Emotions        | 36.2(4.33) | 36(3.55) | 35.92(3.73) | 34.83(3.87) |
Singing Abilities
Perceptual Abilities
Active Engagement
Musical Training

|                  | TP1    | TP2    | TP3    | TP4    | TP5    | TP6    | AI 1 (TP5 – TP1) | AI 2 (TP5 – TP4) | PER (TP5 – TP4) | AER (TP5 – TP6) |
|------------------|--------|--------|--------|--------|--------|--------|------------------|------------------|----------------|----------------|
| **Mean (SD)**    | 1.11   | 1.81   | 1.88   | 1.16   | 1.79   | 1.21   | .70              | .62              | -.07           | .58            |

Note. TP = time point; AI = anger induction; PER = passive emotional regulation; AER = active emotional regulation.
2.1.2.1. Was there a Stroop effect? Results of a paired sample $t$ test showed that the number of ink colors in neutral words read by participants ($M = 59.3$, $SD = 16.1$) in 45 sec was significantly higher than the number of ink colors of negative words ($M = 52.2$, $SD = 15.3$), $t (47) = 6.64$, $p < .001$, $d = .945$, this meaning that there was a significant emotional interference of negative words, describing a significant Stroop effect.

The same did not happen with positive words, where the number of ink colors of positive words named in 45 sec ($M = 60.8$, $SD = 15.7$) did not differ significantly from the number of ink colors of neutral words ($M = 59.3$; $SD = 16.1$), $t (47) = -1.39$, $p = .171$, $d = .211$.

2.1.2.2. Were there switch costs in AFT? As a result from the paired samples $t$ test, we saw that the global RTs on switch trials ($M = 2483$, $SD = 1061$) were significantly longer than the global RTs on repetition trials ($M = 2090$, $SD = 7163$), $t (935) = -18.4$, $p < .001$, $d = .077$, confirming the presence of switch costs.

2.2. H1: Effects of music x strategy x musical sophistication on ER

2.2.1. As measured by STAXI-2

The basic model (ER type*music*strategy) showed a significant main effect of ER type ($Beta = -0.68$; $CI = -1.11$ - -0.25; $p = .002$, Appendix F) pointing to a generalized success in ER (AER more successful than PER). There were no significant interactions, indicating no evidence in favour of music or strategy effects on ER intensity.

The model adding Gold-MSI as a fourth factor (ER type*music*strategy*Gold-MSI) showed improved fit compared to the basic one ($\chi^2(8) = 22.5$, $p = .004$, AIC = 161.02 vs. 167.53). Along with a main effect of ER type ($Beta = 2.37$; $CI = 1.13 – 3.60$; $p <.001$, Appendix G, Table G1), several relevant interactions showed up as significant, including the highest-level interaction ER type x music x strategy x Gold – MSI ($Beta = -0.05$; $CI = -0.09 – -0.01$; $p = .009$). We broke down the latter by analyzing high- vs. low-Gold-MSI participants, divided according to a median split.

Low-Gold-MSI participants (see Figure 2) showed a non-significant effect of ER type, but the ER type x strategy interaction was significant (Appendix G, Table G2). Further analyses considering distraction and reappraisal separately showed significant effects of ER...
type (significant ER efficacy) in reappraisal ($\beta = -1.16; \ CI = -1.84 - 0.48; \ p = .001$), but not in distraction ($\beta = -0.32; \ CI = -0.78 - 0.15; \ p = .178$). Neither of the two analyses showed significant interactions between ER type and music.

In sum, Low-Gold-MSI participants were able to achieve an effective regulation only by using reappraisal, but music was irrelevant for success.

**Figure 2**

*ER intensity according to ER type, music (y = yes, n = no) and strategy (d = distraction; r = reappraisal) for Low-Gold-MSI participants. Significant differences between active and passive regulation indicate significant ER efficacy, which was limited to reappraisal. Music had no effects.*

High-Gold-MSI participants (see Figure 3) showed a significant main effect of ER type. Unlike Low-Gold-MSI participants - all interactions were significant (Appendix G,
table G3) indicating that music was relevant. We broke down the ER type x music x strategy interaction by running four analyses, one per music x strategy condition (D-W, D-Wo, R-W, R-Wo). All four analyses showed significant effects of ER type (D-W: Beta = -0.51; CI = -0.90 – -0.13; p = .008; D-Wo: Beta = -1.51; CI = -2.87 – -0.16; p = .028; R-W: Beta = -0.68; CI = -1.12 – -0.24; p = .002; R-Wo: Beta = -0.50; CI = -.82 – -.17; p = .002). However, looking at effect sizes as indicated by estimates, we saw different patterns for distraction vs. reappraisal: in distraction, participants showed an increased effect size (Beta = -1.51) without music (vs. with music, Beta = -0.51), while in reappraisal the effect size was larger with music (Beta = -0.68, vs. without: Beta = -0.50).

Figure 3

ER intensity according to ER type, music (y = yes, n = no) and strategy (d = distraction; r = reappraisal) for High-Gold-MSI participants. Significant differences between active and passive regulation (significant ER efficacy) were observed for all four conditions, but music-induced differences in effect sizes were reversed across strategies (music benefits reappraisal, but not distraction).
To sum up, while music was irrelevant to low-Gold-MSI participants, it had some influence on those with higher musical sophistication levels. In the latter, music benefitted reappraisal but harmed distraction.

2.2.2. As measured by participants subjective experience

Chi-square tests indicated that, in the distraction condition (n = 24) participants' responses to the question “Did you feel difficulties in the (active) emotional regulation task?” did not differ as a function of listening to music, $\chi^2 (1, 24) = .098, p = .754$. The opposite was seen in the reappraisal condition (n = 24), where participants who listened to music showed a significantly larger number of "no difficulties" responses, $\chi^2 (1, 24) = 6.171, p = .013$.

2.3. H2: reappraisal mode with vs. without music

First, we tried to identify the answers that fit into our predefined category: empathy, that concerns to the attempt to understand the other person’s feelings and emotions and comprehend nonjudgmentally the negative experiences of another self (Colman, 2009; Wispé, 1986, cit. in Cuff et al., 2016). Then, with the remaining answers, four categories emerged from content analysis (see Figure 4): positive side/learning, relativization, detachment, and justification. In the positive side/learning participants tried to extract the positive aspects of the emotional situation and focus on what they learned from that. When they relativize, participants tried to introduce new elements that mitigate the importance of that situation and look at the situation in a non-absolute way. In the fourth category, participants tried to distance themselves from the emotional situation, seeing it from an outside point of view. Finally, in the fifth category participants tried to find a justification to the emotional situation.

We can see in Figure 4, in the R-W condition, participants dominantly reappraised the situation in more empathic ways. In contrast, participants in the R-Wo condition focused mainly in trying to see the positive aspects and what they had learned to reappraise the situation.
The musical features that participants focused on in each reappraisal mode can be seen in Appendix H (together with the musical features that participants focused on in the D-W).

**Figure 4**

*Number of answers for each reappraisal mode category (R-W = reappraisal with music; R-Wo = reappraisal without music)*

![Bar chart showing number of answers per category](chart)

**2.3.1. Long-term efficacy of reappraisal according to reappraisal modes**

When participants used empathy to reappraise the situation – dominant reappraisal mode under music - (n = 10), eight of them (80%) stated that, in their perspective, the levels of anger would be lower if they remembered the situation again. When they focused on the positive aspects or the things they learned – the dominant reappraisal under no music (n = 9), only five of them (55%) said that the feelings of anger would not be the same. Thus, the reappraisal mode associated with music seemed to have been perceived as having more long-lasting effects than that associated with the absence of music.

As for the other question concerning long-term efficacy of reappraisal (*Do you think you will be able to deal better with the emotional situation in the future?*), only one participant - who tried to relativize the situation – responded in a negative way. Relativization was not dominant with music nor without music.
2.4. H3: The role of executive functions

2.4.1. Correlations between individual EF abilities and ER abilities

First, regarding to ER difficulties, indexed by DERS, we did a Bonferroni correction for multiple comparisons (p < .05/56 = p =.0009). As we can see in Table 3, no significant relation was found between the difficulties reported by participants and the EF task results.

Second, we did Bonferroni correction for multiple comparison (p < .05/48 = p =.001) between the strategies most used participants, indexed by RESS EMA, and their EF task results. As we can see in table 4, no significant relation was found between the variables.

2.4.2. Correlations between individual EF abilities and ER during the session

We examined correlations between EF and effective ER during the experiment, using Bonferroni corrections for multiple comparisons (p < .05/8 = p =.0063), to see whether any EF-related variable would be a priority covariable in the model engaging EFs. As we can see in Table 5, only positive Emotional Stroop was moderately and positively correlated with ER efficacy, r (48) = .418, p < .006. However, as shown above, the positive-neutral Stroop effect was non-significant, indicating that including positive-neutral Stroop as covariable would not be adequate. For that reason, we moved on with model comparisons to choose the best model engaging EFs.
Table 3

Correlations among EF and ER difficulties (DERS)

|                  | AFT       | Stroop    | DS        |
|------------------|-----------|-----------|-----------|
|                  | Global    | NA/P      | NA/N      | A/P | A/N | Negative | Positive |
| Total Score      | .141      | .085      | -.017     | .094 | -.177 | -.218*   | -.179    | -.121    |
| Awareness        | -.028     | -.203     | -.143     | .090 | .022  | -.043    | .110     | -.027    |
| Clarity          | .057      | .187      | .083      | .033 | -.054 | -.137    | -.195    | .033     |
| Strategies       | .217*     | .114      | -.047     | -.022 | -.173 | -.077    | -.056    | -.139    |
| Impulse          | .072      | .098      | -.003     | .029 | -.119 | -.145    | -.091    | -.166    |
| Nonacceptance    | .130      | -.045     | .135      | .097 | -.135 | .009     | .003     | .236*    |
| Goals            | .075      | .096      | -.019     | .081 | -.128 | -.134    | -.135    | -.141    |

Note. AFT = affective flexibility task; NA/P = nonaffective rule + positive image; NA/N = nonaffective rule + negative image; A/P = affective rule + positive image; A/N = affective rule + negative image; DS = digit span

*p < .05; ** p < .01, *** p < .0009 (critical level after Bonferroni corrections)
Table 4

Correlations among most used strategies (RESS EMA) and EF task results

|                      | AFT                      | Stroop                  | DS  |
|----------------------|--------------------------|-------------------------|-----|
|                      | Global | NA/P | NA/N | A/P | A/N | Negative | Positive |       |
| Distraction          | .117   | .131 | .063 | -.120 | -.190 | .023 | .201 | -.121 |
| Rumination           | -.098  | -.061| .121 | .156 | -.127 | -.018 | -.217 | -.012 |
| Relaxation           | -.247* | -.256*| -.048| -.001| -.111 | .291* | .372**| .272  |
| Suppression          | -.025  | .050 | .044 | -.036| -.305*| .118  | .234* | -.144 |
| Engagement           | .065   | -.081| .120 | -.198| -.119 | .088  | -.070| .112  |
| Reappraisal          | .146   | -.226*| .008| .178 | .059  | -.071 | .269**| .082  |

Note. AFT = affective flexibility task; NA/P = nonaffective rule + positive image; NA/N = nonaffective rule + negative image; A/P = affective rule + positive image; A/N = affective rule + negative image; DS = digit span

*p < .05; ** p < .01, *** p = .0001 (critical level after Bonferroni corrections)
### Table 5

Correlations between EF tasks results and ER efficacy

|              | AFT  | Stroop | DS    |
|--------------|------|--------|-------|
|              | Global | NA/P  | NA/N  | A/P   | A/N   | Negative | Positive | DS  |
| ERE          | .039  | .101   | -.075 | -.063 | -.011 | .270     | .403**   | -.108 |

*Note. ERI = emotional regulation intensity; AFT = affective flexibility task; NA/P = nonaffective rule + positive image; NA/N = nonaffective rule + negative image; A/P = affective rule + positive image; A/N = affective rule + negative image; DS = digit span

*p < .05; **p < .01
2.4.3. Best model engaging EF variables

The best model among all comparisons engaging up to two EF variables was the one with DS and NA.N as covariates. The analysis showed a significant ER type*music*DS interaction ($Beta = -0.67, CI = -1.19 - -0.16, p = .011$, Appendix I, Table I1). Therefore, we broke down the analysis into low- vs. high DS participants (ER type*music*strategy*NA.N), based on a median split. Due to the characteristics of the scores (integers, giving rise to several instances of median = 4), two unequal groups were generated (low DS, n = 44; high DS n = 52).

Low DS participants (see Figure 5) showed a significant interaction between ER type, music and strategy ($Beta = -1.25, IC = -2.46 - -.03, p = .044$, Appendix I, Table I2). We therefore broke down the analysis further, considering distraction vs. reappraisal. For Low DS/distraction, ER type interacted significantly with music ($Beta = 1.11, IC = .20 – 2.03, p = .017$). Breaking down the analysis further, we saw significant ER intensity for both Low DS/distraction with music ($Beta = -.47, IC = -.85 - -.10, p = .013$) and Low DS/distraction without music ($Beta = -1.59, IC = -2.66 - -.51, p = .004$), but the estimate was larger for distraction without music. In contrast, Low DS/reappraisal participants showed a significant effect of ER type ($Beta = -.74, IC = -1.13 - -.36, p = <.001$) without further interactions.

Thus, for participants with low DS (low working memory resources), music seems relevant when they try to distract, but not when reappraising, and distraction seems to decrease with music.
Figure 5

ER intensity according to ER type, music (y = yes, n = no) and strategy (d = distraction; r = reappraisal) for Low DS (low working memory) participants. Significant differences between active and passive regulation (significant ER efficacy) were observed for all four conditions, but distraction was decreased by music.

High DS participants showed a significant ER type*music*NA.N interaction (Beta = -.00, IC = -.00 - -.00, p = .012, Appendix I, Table I3). We split the sample into low vs high NA.N individuals and ran the model for each group. Please note that low NA.N means lower switch costs, hence increased affective flexibility.

High DS/low NA.N (see Figure 6) participants showed a significant effect of ER type (Beta = -.77, IC = -1.50 - -1.03, p = .04) without further interactions. In contrast, the High DS/high NA.N group (see Figure 7) showed an interaction between ER type, music and strategy (Beta = .78, IC = .15 to 1.42, p = .016). We broke down the analysis further (by strategies) and found that the High DS/high NA.N/distraction group was affected by a significant ER type*music interaction (Beta = -.95, IC = -1.44 - -.45, p = .001). Splitting the analysis by music, we saw significant ER type effects in both conditions (With music: Beta = -1.10, IC = -1.68 - -1.52, p = <.001; Without music: Beta = -1.45, IC = -2.6 - -.5, p =...
.006), but an increased effect size when music was present. As for High DS/high NA.N/reappraisal, the effect of ER type was non-significant ($\beta = -.18$, $IC = -0.53 \sim 0.16$, $p = .304$) and there were no further interactions.

In sum, while music seems irrelevant for participants with high working memory (high DS) and high affective flexibility (low NA.N), it looks relevant for those with high working memory and low affective flexibility – but only in distraction, which is carried out more successfully with music.

**Figure 6**

ER intensity according to ER type, music ($y = yes$, $n = no$) and strategy ($d = distraction$; $r = reappraisal$) for High DS (high working memory)/Low NA.N (high affective flexibility) participants. Significant differences between active and passive regulation (significant ER efficacy) were observed for all four conditions, without further significant interactions.
Figure 7

ER intensity according to ER type, music (y = yes, n = no) and strategy (d = distraction; r = reappraisal) for High DS (high working memory)/High NA.N (low affective flexibility) participants. Significant differences between active and passive regulation (significant ER efficacy) were observed for distraction only, and distraction benefited from music.
3. Discussion

This study had three main objectives. First, we aimed to test if music had a facilitator effect on the implementation of two specific ER strategies - distraction and reappraisal -, and if this effect was moderated by musical sophistication. Second, we wanted to determine if listening to music would influence the way people reappraise an emotional situation. Finally, we aimed to investigate the relation between executive functioning skills and music effects on emotional regulation.

3.1. Facilitator effect: does music make it easier?

Regarding the first objective, emotional regulation based on anger reports (STAXI-2) across the experiment did not change significantly when music was added to the emotional regulation strategies, in line with the results of Baltazar et al. (2019). However, when we asked participants if they had experienced some difficulties in regulating their anger (subjective experience of emotional regulation), the ones in the reappraisal with music condition reported less difficulties than those in reappraisal without music.

There are several potential explanations for this apparent contradiction between the two measures of emotional regulation. First (1), the instrument used to measure state-anger (STAXI-2) may have failed to capture anger changes properly. For example, the instrument contained an item (“I feel bored”) that attempted to target the way participants felt at that moment due to remembering the annoying event. It is not impossible that participants reported their level of boredom resulting from participating in the experiment - not from the relived emotional situation - and that this has contaminated the ER intensity results. Second (2), the pattern of music effects associated with the subjective experience could be contaminated by biases that have been described by the Social Cognitive Theory (Rentfrow, 2012). This theory postulates that music listening is guided by listeners’ beliefs about the effects of music in their goals (e.g., emotional regulation), and these beliefs being created by experience and vicarious learning (Groarke & Hogan, 2018). Therefore, if our participants usually used music to reappraise their emotional situation (something we failed to measure), this may have resulted in a conviction that music helped in the ER task, even if
it did not. Additionally, previous research points out that music promotes insights and clarification, (Saarikallio & Erkkilä, 2007) serving as a kind of “self-therapy” that gives us space to “work through conflicts”, as this can help creating an environment that favors reappraisal, so maybe this was why, according to subjective experience, music made reappraisal seem easier to implement. Future research should consider the habits and beliefs participants have in relation to music to control these effects and maybe consider using another anger self-report measure.

When we considered the relationship participants had with music – musical sophistication (MS) – we started to see music effects on ER as measured by changes in anger across the experiment. Consistent with the idea that music is more relevant to higher than to lower MS individuals, our first finding was that music effects were restricted to the former.

Listening or not listening to music made a difference in the ER of higher MS participants for both distraction and reappraisal, but the effect of music was opposite across strategies: while music benefitted the implementation of reappraisal, it harmed the implementation of distraction. How can we account for this detrimental effect of music during distraction? One possible explanation is that, besides the need to be interesting/relevant, a distractive strategy should be complex and/or unexpected (Baddeley, 1998; Norman & Shallice, 1980 cit. in Van Dillen & Koole, 2007). Bearing in mind that music is a customary activity for people with higher MS, they end up relying on more habitual processes (Van Dillen & Koole, 2007), leaving more “cognitive room” for the emotional information and reducing their sensitivity to the musical stimulus. A different – and even contradictory - explanation may relate to the fact that music is an emotional stimulus that is capable of induce emotion states (Ribeiro et al., 2019) especially in higher MS people, and that listening to music chosen by us is almost never destitute from emotions. This could have led higher MS participants to an emotional overload that made the distraction task harder. In line with this idea of trade-off between cognitive processing and emotionality, it has been shown that increases in cognitive load (as when one engages in a distractive activity) associates with decreased activation of the emotional system, and vice versa (Hariri et al., 2000; Northoff et al., 2004 cit. in Van Dillen & Koole, 2007).
3.2. Reappraisal mode: does music make it different?

Regarding the second objective of this study, we saw a difference between conditions in the way participants reappraise the emotional situation. Empathy-based reinterpretations were the most common between participants in the R-W condition. It is known (e.g. Greitemeyer, 2011) that pro-social songs exert an influence on participants' feelings and thoughts, leading to increased empathy. The interesting finding in our study was that the musical features participants attended to when using reappraisal were – not the lyrics – but mostly the feelings and memories evoked by the song (Appendix H).

How could music per se, without words, be able to generate empathy? Empathy can be seen as a process and not so much as an emotional state, meaning that there are various components in music that may lead to a greater sense of empathy, such as mimicry and cognitive processes (Thompson et al., 2019). Mimicry concerns the predisposition to mimic the (perceived) emotional states of others, giving that this will increase the predisposition to empathize with them. When listening to music, we tend to do the same - we mimic the emotional state expressed by the song (Juslin & Västfjäll, 2008). So, taking into account that this mimic-related process is something that happens automatically and with no need of higher-order cognitive processes (Thompson et al., 2019), it makes sense that a transference of mimicked emotions occurs: if we are listening to music while we are thinking about the emotional event, the mimicked musical emotions can be transferred to the features of this emotional event, leading to an increase sense of empathy towards them. Another possible explanation is that music increases the capacity of cognitive processing that underlies the empathy process – the ability to take perspective of the other based on the inferences we do about their mental state/intentions. Through visual imagery, music can lead to the creation of scenarios that make the emotional situation more liable of being reappraised and, since "listeners respond to mental images much in the same way as they would to the corresponding stimuli in the real world" (Thompson et al., 2019, p. 566), this could lead to an increase sense of empathy. This visual imagery can co-occur with episodic memory, so, instead of creating scenarios, people could just visualize a specific event of their lives. These specific events, evoked by music, are usually related with social relationships and can serve a nostalgic function (Thompson et al., 2019). Therefore, this could lead to the remembering of positive events with the person that is now involved in the anger emotional situation, leading to a better understanding of the situation and the way things happen the way they
did. Future research could investigate work on these hypotheses, contributing to understand how this empathic way of giving meaning emerges from music.

Given that the capacity to understand others’ minds is positively correlated with the capacity to use reappraisal in an effective way (Thompson et al., 2019), and that the way we look and interpret one's’ feelings help us regulate our emotional experience, it makes sense that the participants in this condition felt like (subjective experience) they had less difficulties in regulating their emotions.

Participants that had reappraised the situation in an empathic way were the ones that answered yes more frequently to the questions “In the future, if you remember that emotional situation again, the levels of anger evoked by her would be the same?”. Future research could test further these preliminary results by investigating if this effect does extend in time and if the reappraise of that situation worked upon integration of participants’ life narratives, or, on the contrary, these feelings of empathy and understanding are only evoked when listening to music. Even if participants who reappraised the situation in a more emphatic were those that listened to music, this does not mean that there is a correlation.

3.3. The role of executive functions

Regarding the assumption that EF abilities were related to ER performance, i.e., lower results on DERS and higher levels on effective ER, we saw no evidence in favour of this association in our study, meaning that different levels of EF did not relate to how participants regulate themselves. These results are congruent with previous research showing that EF skills (i.e., WM and IC) do not predict ER performance (Gyurak et al., 2012). Concerning the other EF domain (AF), previous research (Malooly et al., 2013) found that increased AF predicted the ability to down-regulate sad emotions. Our results do not support this finding, however there are some facts that can explain this. First, we tested the regulation of anger feelings and not sad feelings. Second, we used images from a different database and in a smaller number. Finally although ER relies partly on EF capacities, ER is a much wider construct (Holley et al., 2015) and, from this viewpoint EF effects on ER may have remained hidden in our study.

When it comes to the results of the best model containing EF factors, we saw that two EF domains (WM (DS) and a specific domain of AF (NA.N)) moderated the effects of
music. Staring with WM, participants with lower WM showed detrimental effects of music, while those with higher WM showed benefits. These results go against our hypothesis, in that the group with higher executive functioning – not that with lower – that used music in increase emotional regulation.

In lower WM participants, music only influenced distraction, making it more difficult than without music. What may explain this? WM capacity involves holding information in mind and mentally working with it, and the more we focus on that information, the greater will be the probability that this information will guide our behavior (Diamond, 2013). In our case, distracting instructions (information) had to be kept in mind to guide participants behaviors while they were listening to music. Additionally, for distraction to be successful, there is a need to change people’s feelings and thoughts by something else, and an optimal task for this purpose should not elicit feelings by itself (Van Dillen & Koole, 2007). In our case, music (emotional stimulus) would not be optimal from this viewpoint. Adding up these two ideas, when we use an emotional stimulus, i.e., music, in people who have more difficulties in keep a goal in mind, i.e., low WM, this could lead to, for example, some mind-wandering. Considering the fact that the stimulus itself can be the driver of mind wandering (Faber & D’Mello, 2018), and that this stimulus is emotional, it could have redirect participants attention to the emotional event that they were trying to distract.

In contrast, music was either irrelevant or beneficial for distracting participants with higher WM abilities. These different effects depended on another executive functioning ability – affective flexibility (AF), specifically (NA.N). When AF was high, music was irrelevant; when low, it was beneficial. Unlike the previous moderating effect (WM), the moderating effect of AF is in line with our hypothesis: when both WM and AF were high, music was irrelevant, maybe because participants had all the conditions to distract themselves not needing extra tools, i.e., music. In contrast, when participants had greater difficulties in changing for a nonaffective rule (that implied focusing on the neutral features of the stimulus) in the presence of a negative stimulus (NA.N), they were able to distract themselves better in the presence of music. But why would music compensate for the lack of this particular EF skill? One possible explanation is that the difficulty to focus on the neutral features within the negative stimulus (problems in AF, NA.N) can be overcome by focusing on the neutral features of another stimulus, i.e., music. Supporting this, we could see those participants, in the D-W condition, focused on the more neutral aspects of music, like rhythm.
In sum, we found evidence against, but also in favour of our hypothesis: while low levels of WM do not seem to make participants use music as a support tool (on the contrary, they need WM to use music), low levels of affective flexibility in a specific domain have the effect we predicted, provided that higher levels of WM are available. These results should be investigated further with larger and more controlled samples regarding executive functioning.

### 3.3. Other limitations and prospects

Besides the potential limitations in our study that we already highlighted in the discussion, we would like to emphasize three additional methodological weaknesses: first, it was impossible (due to the pandemic situation) to measure the participant’s psychophysiological response (e.g., heart rate) after the anger inductions, and thus we only relied on self-reports of anger. Self-report measures may be biased by social desirability or demand effects (Lobbestael et al., 2008), so future studies should include psychophysiological variables in their experimental procedure.

Along with this, we did not control for the possibility that some participants did not have enough memory skills to evoke the feelings of anger, resulting in lower self-reported anger, and lower ER intensity. Even when participants had a personal situation to recall, the fact that they had to recall it twice could have led to a decrease in their emotional impact, resulting in a contamination on ER intensity. These two limitations can be avoided in the future by using non-personal stimulus to induce emotions, such as emotional pictures or/and films.

Finally, although we have explicitly asked participants to recall an event that made them feel angry, those events could have elicited other emotions that were not covered by the STAXI-2, leaving some emotional experiences unnoticed. So, future research could include self-reported measures that can evaluate a more diverse spectrum of emotions.
4. Conclusion

We are very susceptible to music (James, W., 1890 cit in Sacks, O. 2008), and the power it exerts on us is undeniable. The way music is described by lay people and experts, makes us believe that it is like an omnipotent entity, capable of cheering us up, calming us down, acting like a comforting friend (Saarikallio, 2011), and giving us chills (Grewe, 2005). That said, it is normal for this power to be subject of investigation.

The present study adds to a growing literature on the influence of music in our emotional experience, especially when it comes to regulate it. Our main goal was trying to understand if this powerful and accessible stimulus that elicits so many emotions could be used to influence them.

Our findings seem to meet the “musical affordance” idea of Krueger (2011), where the power of music does not come from music itself, but rather from the dynamic interactions between music and the listener. This author also postulates that, for music to be perceived as something we can make things with, i.e., regulate our emotions, the listener should have some appropriate skills (e.g., perceptual, and affective sensitivities). So, maybe ER strategies are like a cognitive way of dealing with emotional events, and maybe music can be used as a tactic when there are cognitive resources that allow it, or/and when there is a special relationship between us and music. In line with these ideas, our findings showed that music was an useful tactic only for those who are more musical and capable to engage with music in a flexible and effective way (Müllensiefen et al., 2014), and for those who have trouble in changing for a nonaffective rule in the presence of a negative stimulus (NA.N) but have the cognitive abilities (WM) to use music to mitigate this. Another important aspect of our study is the empathic way participants found to reappraise the emotional situation in the presence of music. So, maybe music does not necessarily influence the reduction of emotional activation caused by anger, but maybe it plays an important role in providing us the context that allow us to find a more meaningful interpretation, that suits us, leaving us with the feeling (subjective experience) that maybe we were more successful in regulating our emotions.

Hereupon, it is important to consider that music is an emotional stimulus that, usually, makes us more emotional (what can become an obstacle when the goal is to be less emotional). So, in our point of view, when our goal is to manage/regulate an emotional
situation by down-regulating their intensity, using an emotional stimulus may not be a good idea, since it can lead to an emotional overload.

Finally, if we adopt a broader perspective of ER, what we might conclude from participants reports of their subjective experience and the way they reappraise the emotional situation is that, as important as the punctual decrease of a given emotion, is what we do with that emotion and with the situation that generate it. As we saw, music seems to lead to a better resolution of the emotional situation, bringing the feeling that, in the future, it will have a lower affective resonance, especially when the new meaning assigned involves put us in contact with our emotional side, understanding and forgiving others. So, maybe the best use of music does not involve the containment and the decrease of our emotional experience *per se*, but the creation of an ideal atmosphere that allow us to integrate this emotional experience in our life narrative.
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Appendices
Appendix A

The way participants distract themselves in the D-Wo (distraction without music) condition

Distração sem Música (D-Wo)

- Meti uma música alegre e brinquei com o meu animal (a minha gata).
- Festas à gata
- Falei com a minha mãe
- Fui ajudar o meu irmão com os trabalhos de casa
- Vi um vídeo de xadrez no youtube e liguei o computador ao telemóvel porque a internet foi abaixo.
- Liguei a internet do telemóvel e fui para o Instagram.
- Organizar a secretária
- Jogar um jogo de telemóvel
- Pensar no que vou fazer o resto do dia; cantar alguma música na minha cabeça; pensar no que quero fazer no fim do confinamento...
- Audição de uma música que gosto no Youtube
- Fui para redes sociais
- Ouvi música
Informação sobre o Estudo

Antes de mais, agradecemos a disponibilidade e interesse em participar neste estudo. No âmbito de um projeto de Dissertação de Mestrado em Psicologia Clínica e da Saúde, pela Faculdade de Psicologia e de Ciências da Educação da Universidade do Porto (FPCEUP), vimos solicitar o preenchimento do seguinte questionário.

Objetivo: Investigar a relação entre a audição musical, a gestão emocional e outras competências mentais.

Quem pode participar: Todos os sujeitos com mais de 18 anos.

Esta experiência envolve dois momentos: No primeiro (1), será convidado/a a preencher questionários curtos e a realizar tarefas de memória e atenção. No segundo (2), receberá instruções para que recorde alguns eventos da sua vida (sem nos dizer quais) e para que lide com essas memórias durante alguns minutos de acordo com instruções que serão dadas.

Este estudo foi aprovado pela Comissão de Ética da Faculdade de Psicologia e de Ciências da Educação da Universidade do Porto (FPCEUP). Os dados pessoais que nos facultar serão confidenciais e os resultados obtidos neste estudo serão utilizados apenas para alcançar os objetivos da investigação.

A sua participação é voluntária e pode ser interrompida a qualquer momento.

Os resultados do estudo poderão ser solicitados à responsável que lhe está a dar as instruções ou então por contacto direto com as responsáveis pelo estudo:

Declaro que tenho mais de 18 anos e aceito participar neste estudo de investigação. Compreendo a natureza e o objetivo do estudo. Sei que posso suspender o preenchimento deste questionário online a qualquer momento, sem que isso me cause qualquer tipo de prejuízo e que os meus dados são confidenciais e serão usados apenas para fins de investigação científica. No final do inquérito ser-me-á solicitado um contacto e-mail para que ser contactado para atender à segunda fase do estudo, sendo que essa informação será armazenada num local separado dos meus dados de participação, ao qual apenas os investigadores deste projeto terão acesso. Foi-me comunicado que poderei aceder aos resultados do estudo se o solicitar.
• Sim, pretendo prosseguir e participar neste estudo □
• Não quero participar neste estudo □
Appendix C
Sociodemographic questions

Idade: __________

Género:
- Feminino
- Masculino
- Outro/Prefiro não dizer

Habilitações literárias:
- Sem estudos
- 1º ciclo (1º, 2º, 3º e 4º anos)
- 2º ciclo (5º e 6º anos)
- 3º ciclo (7º, 8º e 9º anos)
- Ensino Secundário (10º, 11º e 12º anos)
- Licenciatura
- Mestrado
- Doutoramento

Profissão/ocupação:
- Empregado(a)
- Desempregado(a)
- Estudante
- Reformado(a)

Se você encontra a estudar, estabelecimento de ensino: ______________

Nacionalidade: __________
Appendix D
Suggestion of Portuguese translation of RESS EMA

Em resposta às minhas emoções eu...

1. Envolvo-me noutra coisa para me manter ocupado(a).
2. Faço de conta que não estou chateado(a).
3. Penso continuamente naquilo que me está a aborrecer.
4. Penso várias vezes no evento emocional.
5. Faço um esforço para esconder os meus sentimentos.
6. Demonstro aquilo que estou a sentir.
7. Olho para a situação de diferentes ângulos/pontos de vista.
8. Respiro fundo várias vezes.
9. Penso noutras formas de interpretar a situação.
10. Envolvo-me em atividades para me distrair.
11. Tento diminuir o meu ritmo cardíaco e respirar.
12. Expresso os meus sentimentos.
Appendix E
Reappraisal Instructions

“Muitas vezes, quando estamos a pensar em algo que nos causa raiva, tentamos reavaliar a situação para que a raiva sentida diminua. A reavaliação consiste numa interpretação do evento/estímulo emocional de maneira a diminuir o seu impacto emocional. Podemos reinterpretar de maneira neutra ou de maneira positiva. Por exemplo, podemos pensar que o nosso amigo não se lembrou do nosso aniversário porque podia estar com alguns problemas pessoais que o estão a deixar sem cabeça para outras coisas ou, apesar de ele se ter esquecido do nosso aniversário, tivemos um dia excelente e divertimo-nos muito.” Apenas na condição com música, acrescentar: “Agora vou pedir-lhe que escolha uma música que ache que o/a ajudaria a reavaliar a situação”
### Appendix F

**Table of results of the effects of ER type, music, and strategies on emotional regulation intensity**

| Predictors                                      | Estimates | CI       | p     |
|-------------------------------------------------|-----------|----------|-------|
| (Intercept)                                     | 0.72      | 0.40 – 1.05 | <0.001|
| ER type [passive]                               | -0.68     | -1.11 – -0.25 | **0.002**|
| strategy [R]                                    | -0.20     | -0.64 – 0.24 | 0.369 |
| music [Y]                                       | -0.20     | -0.63 – 0.22 | 0.355 |
| ER type [passive] * strategy [R]                | 0.02      | -0.57 – 0.60 | 0.957 |
| ER type [passive] * music [Y]                   | 0.14      | -0.42 – 0.71 | 0.617 |
| strategy [R] * music [Y]                        | 0.26      | -0.34 – 0.86 | 0.391 |
| (ER type [passive] * strategy [R]) * music [Y] | -0.20     | -0.99 – 0.59 | 0.622 |

| SD (Intercept)                                  | 0.18      |          |       |
| SD (Observations)                               | 0.70      |          |       |

**Random Effects**

| Parameter | Estimate |
|-----------|----------|
| $\sigma^2$ | 0.24     |
| $\tau_{00}$ | 0.03    |
| ICC       | 0.12     |
| $N_{ID}$  | 48       |

| Observations | 96      |
| Marginal R2 / Conditional R2 | 0.286 / 0.370 |

*Note. Marginal R² = variance explained by fixed factors; Conditional R² = variance explained by fixed and random marginal factors; bold = p <.05*
Appendix G

Table of results of effects of ER type, music, strategies and Gold-MSI on emotional regulation

**Table G1**

*Effects of ER type, music, strategies and Gold-MSI on emotional regulation intensity*

| Predictors                          | Estimates | CI          | p    |
|-------------------------------------|-----------|-------------|------|
| (Intercept)                         | -1.33     | -2.38 – -0.28 | 0.013 |
| ER type [passive]                   | 2.37      | 1.13 – 3.60  | <0.001|
| strategy [R]                        | 2.12      | 0.49 – 3.74  | 0.011 |
| music [Y]                           | 1.87      | 0.44 – 3.30  | 0.010 |
| GoldMSI                             | 0.04      | 0.02 – 0.05  | <0.001|
| ER type [passive] * strategy [R]    | -3.46     | -5.37 – -1.55 | <0.001|
| ER type [passive] * music [Y]       | -2.92     | -4.60 – -1.24 | 0.001 |
| strategy [R] * music [Y]            | -1.91     | -4.10 – 0.28 | 0.087 |
| ER type [passive] * GoldMSI         | -0.05     | -0.07 – -0.03 | <0.001|
| strategy [R] * GoldMSI              | -0.04     | -0.06 – -0.02 | 0.001 |
| music [Y] * GoldMSI                 | -0.04     | -0.06 – -0.01 | 0.002 |
| (ER type [passive] * strategy [R]) * music [Y] | 2.88     | 0.31 – 5.45  | 0.028 |
| (ER type [passive] * strategy [R]) * GoldMSI | 0.06     | 0.03 – 0.09  | <0.001|
| (ER type [passive] * music [Y]) *GoldMSI | 0.05     | 0.03 – 0.08  | <0.001|
| (Strategy [R] * music [Y]) * GoldMSI | 0.04     | 0.00 – 0.07  | 0.030 |
| (ER type [passive] * strategy [R] * music [Y]) * GoldMSI | -0.05 | -0.09 – -0.01 | 0.009 |

|                  |          |        |
|------------------|----------|--------|
| SD (Intercept)   | 0.26     |        |
| SD (Observations)| 0.63     |        |

**Random Effects**

| Parameter | Estimate |
|-----------|----------|
| $\sigma^2$ | 0.16     |
| $\tau_{00 ID}$ | 0.07     |
| ICC       | 0.31     |
| $N_{ID}$  | 48       |

| Observations | 96 |
| Marginal R2 / Conditional R2 | 0.411 / 0.593 |

*Note.* Marginal $R^2 =$ variance explained by fixed factors; Conditional $R^2 =$ variance explained by fixed and random factors; bold = $p < .05$

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**Table G2**

*Participants with lower musical sophistication (Gold-MSI)*

| Predictors                        | Estimates | CI        | p       |
|-----------------------------------|-----------|-----------|---------|
| (Intercept)                       | 0.44      | 0.09 – 0.80 | 0.014   |
| ER type [passive]                 | -0.32     | -0.78 – 0.14 | 0.171   |
| Strategy [R]                      | 0.38      | -0.27 – 1.03 | 0.249   |
| Music [Y]                         | 0.08      | -0.42 – 0.58 | 0.752   |
| ER type [passive] * Strategy [R]  | -0.84     | -1.67 – 0.00 | 0.049   |
| ER type [passive] * Music [Y]     | -0.23     | -0.88 – 0.41 | 0.479   |
| Strategy [R] * Music [Y]          | -0.29     | -1.10 – 0.53 | 0.494   |
| ER type [passive] * Strategy [R]  * Music [Y] | 0.65 | -0.41 – 1.70 | 0.229   |
SD (Intercept) 0.20
SD (Observations) 0.66

**Random Effects**

|                |       |
|----------------|-------|
| \( \sigma^2 \) | 0.19  |
| \( \tau_{00 \, ID} \) | 0.04  |
| ICC            | 0.17  |
| N_{ID}         | 24    |

Observations 48
Marginal R\(^2\) / Conditional R\(^2\) 0.333 / 0.446

*Note.* Marginal R\(^2\) = variance explained by fixed factors; Conditional R\(^2\) = variance explained by fixed and random factors; bold = \( p < .05 \)

**Table G3**

*Participants with higher musical sophistication (Gold-MSI)*

| Predictors                      | Estimates | CI       | \( p \)   |
|---------------------------------|-----------|----------|-----------|
| (Intercept)                     | 1.38      | 0.80 – 1.96 | <0.001    |
| ER type [passive]               | -1.51     | -2.25 – -0.78 | <0.001    |
| Strategy [R]                    | -0.96     | -1.63 – -0.28 | 0.005     |
| Music [Y]                       | -0.86     | -1.56 – -0.16 | 0.016     |
| ER type [passive] * strategy [R]| 1.02      | 0.17 – 1.86 | 0.019     |
| ER type [passive] * Music [Y]   | 1.00      | 0.12 – 1.88 | 0.025     |
| strategy [R] * Music [Y]        | 0.97      | 0.07 – 1.87 | 0.035     |
| Term                                      | Estimate | Lower Bound | Upper Bound | p Value |
|-------------------------------------------|----------|-------------|-------------|---------|
|(ER type [passive] * strategy [R]) * Music [Y]| -1.18    | -2.31       | -0.06       | **0.040** |
| SD (Intercept)                            | 0.24     |             |             |         |
| SD (Observations)                         | 0.68     |             |             |         |

**Random Effects**

| Term   | Estimate |
|--------|----------|
| $\sigma^2$ | 0.21     |
| $\tau_{00}$ | 0.06   |
| ICC    | 0.21     |
| $N_{ID}$ | 24       |

| Term                  | Value |
|-----------------------|-------|
| Observations          | 48    |
| Marginal R$^2$ / Conditional R$^2$ | 0.378 / 0.509 |

*Note.* Marginal R$^2$ = variance explained by fixed factors; Conditional R$^2$ = variance explained by fixed and random factors; bold = $p < .05$
Appendix H
The way participants reappraised the emotional situation – with and without music - and the music features that they have focused on – both in distraction and reappraisal with music

Reavaliação com música (R-W)

- Tentei relativizar a situação (Letra da música, Ritmo da música, Sentimentos evocados pela música) – Relativization
- Tentei olhar para a situação de outra forma, pensando que todos erram e que nem sempre as pessoas sabem resolver o conflito de uma forma calma e apaziguadora (Letra da música, Ritmo da música, Sentimentos evocados pela música) – Empathy
- Tentei não dar tanta importância à situação (Letra da música, Sentimentos evocados pela música) – Relativization
- Olhar para o acontecimento de uma forma mais positiva, focando-me nos bons momentos (Memórias evocadas pela música) – Positive side, Learning
- Tentei olhar para a situação de outra maneira e entender que às vezes são necessários momentos como aqueles para nos ensinarem que o caminho nem sempre é certo (Letra da música, Memórias evocadas pela música, Sentimentos evocados pela música) - Positive side, Learning
- Tentei colocar-me no lugar da outra pessoa, e entender que a situação também era difícil para ela e que eu também tinha um pouco de responsabilidade no resultado que levou ao desentendimento (Ritmo da música, Sentimentos evocados pela música) – Empathy
- Tentei ver a situação de outra forma, incluindo do ponto de vistas das outras pessoas envolvidas (Ritmo da música, Sentimentos evocados pela música) - Empathy
- Tentei compreender o ponto de vista da outra pessoa (Letra da música, Ritmo da música, Sentimentos evocados pela música) - Empathy
- Tentei pensar em como seria se fosse e no papel do outro e se, muito provavelmente, também não teria feito igual (Memórias evocadas pela música, Sentimentos evocados pela música) - Empathy
- Tentei sentir amor e perdoar (Sentimentos evocados pela música) - Empathy
Tentei adotar o ponto de vista de outra pessoa e o que, provavelmente, iria sentir, se me encontrasse na exata situação que a mesma estaria a vivenciar (Ritmo da música, Memórias evocadas pela música, Sentimentos evocados pela música) - *Empathy*

Entender, a execução da situação tendo em conta o contexto, mentalidade e emoções daquela pessoa (Letra da música, Sentimentos evocados pela música) – *Empathy.*

*Reavaliação Sem Música (R-Wo)*

Tirei a situação do passado já que la eu não tinha nenhum controle. A única coisa que eu poderia fazer em relação a ela é me preparar e estar a altura de para uma nova situação parecida - *Positive side, Learning*

Não era possível tentar adotar o ponto de vista da outra pessoa, mas tentei pensar que não sou a única a passar por situações idênticas e o facto de encarar a situação como uma aprendizagem permitiu-me controlar a raiva - *Positive side, Learning*

Tentei adotar o ponto de vista da outra pessoa – *Empathy*

Tentei avaliar a situação de maneira a perceber o que isso me trouxe de bom e de que forma me ajudou - *Positive side, Learning*

Tentei pensar nas consequências que a situação tem em termos práticos (que não é nenhum). Pensar nas razões da situação (que não são da minha responsabilidade). Pensar que a pessoa age dessa maneira com toda a gente e que não é nada contra mim. – *Relativization*

Valorizando o ponto de vista externo – *Detachment*

Tentei pensar que a pessoa quando age assim não o faz mal, não tem a intenção de fazer o que faz, simplesmente não tem cuidado suficiente. Que se calhar eu às vezes também não tenho esse cuidado, somos todos humanos e todos cometemos erros egocêntricos. – *Empathy*

Tentei avaliar os benefícios da situação - *Positive side, Learning*

Tentei perceber aquilo que aprendi com a situação, o quanto cresci com ela e o que, apesar de tudo, me acrescentou de bom - *Positive side, Learning*

Tentei pensar noutras razões mais positivas para aquela situação ter acontecido - *Positive side, Learning*

Tentei colocar-me no lugar da outra pessoa e tentar compreender as suas atitudes – *Empathy*
• Procurei tentar encontrar justificativas para que a pessoa tenha se comportado daquela forma comigo – *Justification*

*Características da música em que os participantes se focaram durante a condição D-W (distração com música)*

• Letra da música, Ritmo da música, Memórias evocadas pela música
• Letra da música, Ritmo da música, Memórias evocadas pela música
• Ritmo da música, Sentimentos evocados pela música
• Letra da música
• Letra da música, Ritmo da música, Letra da música, Sentimentos evocados pela música, Planos para o futuro (nomeadamente quando puder sair de casa após a pandemia)
• Letra da música, Ritmo da música, Memórias evocadas pela música, Sentimentos evocados pela música
• Letra da música, Ritmo da música, Sentimentos evocados pela música
• Letra da música, Ritmo da música
• Letra da música, Ritmo da música
Appendix I
Best model engaging EF

Table I
Effects of music, strategies, ER type, NA.N and DS (working memory) on emotional regulation intensity

| Predictors                          | Estimates | CI        | p     |
|-------------------------------------|-----------|-----------|-------|
| (Intercept)                         | 2.15      | 0.87 – 3.43 | 0.001 |
| ER type [passive]                   | -2.49     | -4.30 – -0.68 | 0.007 |
| strategy [R]                        | -0.00     | -1.58 – 1.58 | 0.999 |
| music [Y]                           | -1.78     | -3.21 – -0.36 | 0.014 |
| DS                                  | -0.37     | -0.70 – -0.05 | 0.024 |
| NA.N                                | -0.00     | -0.00 – -0.00 | 0.032 |
| ER type [passive] * strategy [R]    | 0.41      | -1.82 – 2.64 | 0.719 |
| ER type [passive] * music [Y]       | 2.66      | 0.65 – 4.67 | 0.010 |
| strategy [R] * music [Y]            | 0.37      | -1.87 – 2.61 | 0.746 |
| ER type [passive] * DS              | 0.45      | -0.01 – 0.91 | 0.055 |
| strategy [R] * DS                   | -0.10     | -0.51 – 0.31 | 0.641 |
| Music [Y] * DS                      | 0.43      | 0.07 – 0.80 | 0.020 |
| ER type [passive] * NA.N            | -0.00     | -0.00 – 0.00 | 0.640 |
| strategy [R] * NA.N                 | 0.00      | 0.00 – 0.00 | 0.030 |
| Music [Y] * NA.N                    | 0.00      | -0.00 – 0.00 | 0.371 |
| DS * NA.N                           | 0.00      | -0.00 – 0.00 | 0.145 |
| (ER type [passive] * strategy [R]) * music [Y] | -2.01    | -5.17 – 1.16 | 0.214 |
| (ER type [passive] * strategy [R]) * DS | -0.04    | -0.62 – 0.54 | 0.901 |
| (ER type [passive] * music [Y]) * DS | -0.67    | -1.19 – -0.16 | 0.011 |
| (strategy [R] * music [Y]) * DS     | 0.02      | -0.57 – 0.62 | 0.937 |
| Term                                          | Coefficient | 95% CI     | p   |
|-----------------------------------------------|-------------|------------|-----|
| (ER type [passive] * strategy [R]) *         | 0.00        | -0.00 – 0.00 | 0.914 |
| NA.N                                          |             |            |     |
| (ER type [passive] * music [Y]) * NA.N       | 0.00        | -0.00 – 0.00 | 0.367 |
| (strategy [R] * music [Y]) * NA.N            | 0.00        | -0.00 – 0.00 | 0.934 |
| (ER type [passive] * DS) * NA.N              | 0.00        | -0.00 – 0.00 | 0.764 |
| (strategy [R] * DS) * NA.N                   | -0.00       | -0.00 – -0.00 | 0.018 |
| (Music [Y] * DS) * NA.N                      | -0.00       | -0.00 – 0.00 | 0.801 |
| (ER type [passive] * strategy [R] *         | 0.43        | -0.41 – 1.28  | 0.317 |
| music [Y]) * DS                             |             |            |     |
| (ER type [passive] * strategy [R] *         | -0.00       | -0.00 – 0.00 | 0.746 |
| music [Y]) * NA.N                           |             |            |     |
| (ER type [passive] * strategy [R] *         | 0.00        | -0.00 – 0.00 | 0.586 |
| DS) * NA.N                                   |             |            |     |
| (ER type [passive] * music [Y] * DS) *       | -0.00       | -0.00 – 0.00 | 0.323 |
| NA.N                                         |             |            |     |
| (strategy [R] * music [Y] * DS) * NA.N       | 0.00        | -0.00 – 0.00 | 0.973 |
| (ER type [passive] * strategy [R] *         | 0.00        | -0.00 – 0.00 | 0.938 |
| music [Y] * DS) * NA.N                      |             |            |     |

**Random Effects**

| Term                              | Coefficient |
|-----------------------------------|-------------|
| $\sigma^2$                       | 0.16        |
| $\tau_{ID}$                      | 0.00        |
| N $\_ID$                         | 48          |

| Observations | 96 |
| Marginal R$^2$ / Conditional R$^2$ | 0.596 / NA |

**Note.** Marginal $R^2$ = variance explained by fixed factors; Conditional $R^2$ = variance explained by fixed and random factors; bold = $p < .05$
Table I2

Lower DS (lower working memory)

| Predictors                                | Estimates | CI          | p    |
|--------------------------------------------|-----------|-------------|------|
| (Intercept)                                | 1.16      | 0.60 – 1.72 | <0.001 |
| ER type [passive]                          | -1.59     | -2.38 – 0.80 | <0.001 |
| Music [Y]                                  | -0.61     | -1.25 – 0.02 | 0.059 |
| Strategy [R]                               | -0.49     | -1.18 – 0.21 | 0.171 |
| NA.N                                       | -0.00     | -0.00 – 0.00 | 0.106 |
| ER type [passive] * music [Y]              | 1.11      | 0.22 – 2.01  | 0.015 |
| ER type [passive] * strategy [R]           | 0.84      | -0.14 – 1.83 | 0.093 |
| Music [Y] * strategy [R]                   | 0.66      | -0.20 – 1.52 | 0.130 |
| Retype [passive] * NA.N                    | -0.00     | -0.00 – 0.00 | 0.056 |
| Music [Y] * NA.N                           | 0.00      | -0.00 – 0.00 | 0.343 |
| Strategy [R] * NA.N                        | 0.00      | -0.00 – 0.00 | 0.298 |
| (ER type [passive] *music [Y]) * strategy [R] | -1.25   | -2.46 – 0.03 | 0.044 |
| (ER type [passive] * music [Y]) * NA.N    | 0.00      | -0.00 – 0.00 | 0.169 |
| (ER type [passive] *strategy [R]) * NA.N  | 0.00      | -0.00 – 0.00 | 0.201 |
| (music [Y] * strategy [R]) * NA.N         | 0.00      | -0.00 – 0.00 | 0.620 |
| (ER type [passive] *music [Y] * strategy [R]) * NA.N | -0.00 | -0.00 – 0.00 | 0.402 |
| SD (Intercept)                             | 0.00      |             |      |
| SD (Observations)                          | 0.68      |             |      |

Random Effects

| σ²  | 0.21 |
| τ₀₀ ID | 0.00 |
| N ID  | 22   |

Observations 44

Marginal R² / Conditional R² 0.601 / NA

Note. Marginal R² = variance explained by fixed factors; Conditional R² = variance explained by fixed and random factors; bold = p < .05
Table I3

Higher DS (higher working memory)

| Predictors | Estimates | CI         | p     |
|------------|-----------|------------|-------|
| (Intercept) | 0.57      | 0.32 – 0.82 | <0.001 |
| ER type [passive] | -0.52     | -0.87 – -0.17 | 0.004  |
| music [Y] | 0.17      | -0.27 – 0.61 | 0.453  |
| Strategy [R] | -0.40     | -0.77 – -0.03 | 0.035  |
| NA.N | -0.00     | -0.00 – -0.00 | 0.008  |
| ER type [passive] * music [Y] | -0.44     | -1.07 – 0.19 | 0.172  |
| ER type [passive] * strategy [R] | 0.23      | -0.29 – 0.75 | 0.392  |
| Music [Y] * strategy [R] | 0.23      | -0.35 – 0.81 | 0.442  |
| ER type [passive] * NA.N | 0.00       | -0.00 – 0.00 | 0.075  |
| Music [Y] * NA.N | 0.00       | 0.00 – 0.00  | 0.001  |
| Strategy [R] * NA.N | -0.00     | -0.00 – -0.00 | 0.611  |
| (ER type [passive] * music [Y]) * strategy [R] | 0.03      | -0.79 – 0.85 | 0.948  |
| (ER type [passive] * music [Y]) * NA.N | -0.00     | -0.00 – -0.00 | 0.012  |
| (ER type [passive] * strategy [R]) * NA.N | 0.00      | -0.00 – 0.00 | 0.339  |
| (music [Y] * strategy [R]) * NA.N | -0.00     | -0.00 – -0.00 | 0.028  |
| (ER type [passive] * music [Y] * strategy [R]) * NA.N | 0.00      | -0.00 – 0.00 | 0.307  |
| SD (Intercept) | 0.00      |             |       |
| SD (Observations) | 0.56      |             |       |

Random Effects

|            |          |
|------------|----------|
| $\sigma^2$ | 0.10     |
| $\tau_{00}$ | 0.00    |
| $N_{ID}$   | 26       |
| Observations | 52       |
| Marginal $R^2$ / Conditional $R^2$ | 0.603 / NA |

*Note. Marginal $R^2 =$ variance explained by fixed factors; Conditional $R^2 =$ variance explained by fixed and random factors; bold = $p < .05$*