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## Depression, Music Choice, and Affective Outcomes in Daily Life

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Depression, Music Choice, and Affective Outcomes in Daily Life

by

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A dissertation submitted in partial fulfillment  
of the requirements for the degree of  
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## ABSTRACT

Persons with depression consistently report a preference for sad music. Are such preferences maladaptive or beneficial? We tested this question in a 3-part study that examined 77 participants' (39 with and 38 without clinical depression) music choice in daily life, affective outcomes, and the reasons for music choice. During a 3-day ecological momentary assessment (EMA), participants chose a song from a pre-set music library of happy and sad songs and rated their affect before and after hearing the chosen song. In addition, we analyzed the characteristics (e.g., tempo) of participants' free song choices over 7 days (from participants' *Spotify* music streaming accounts). Finally, we analyzed the reasons participants reported for why they listened to music when feeling happy and sad. Unlike nondepressed persons, persons with depression lacked a preference for happy over sad songs; further, depressed persons' favorite freely chosen songs had a slower tempo than nondepressed persons' freely chosen songs. Notably, both groups reported increased relaxedness as well as decreased happiness after hearing sad songs and did not differ in these reports. When feeling sad, participants in both groups did not indicate that they listened to music to increase high arousal positive affect. Depressed persons' music choices may reflect a desire to feel calm rather than a desire to upregulate feeling distressed.

## **CHAPTER ONE: DEPRESSION AND CHOICE OF EMOTIONAL STIMULI**

In daily life, we are surrounded by various stimuli, including stimuli that have the potential to alter affective experience. When navigating the environment, we often choose stimuli that we prefer to engage with (or avoid) (e.g., Schäfer, Sedlmeier, Städtler, & Huron, 2013). For example, imagine that you want to listen to music while driving. You decide to turn on a radio. You may like the first channel you tuned to because the music is your taste, or, you might change the channel because you do not like the music.

Researchers have been trying to understand why people choose or avoid emotional stimuli, as well as the consequences of these choices (i.e., Gross, 1998; Schellenberg, Peretz, & Vieillard, 2008; Zillmann, 1988). One motivation for emotion stimulus choice is to alter emotion experience (Gross, 1998; Zillmann, 1988). Although depression has been considered as a disorder of emotion regulation (Gross & Muñoz, 1995), and numerous studies have examined emotion regulation difficulties in depression (e.g., Garnefski & Kraaij, 2006; Joormann & Gotlib, 2010), relatively little is known about emotional stimulus choice in people with depression (for initial work see, Millgram, Joormann, Huppert, & Tamir, 2015; Punkanen, Eerola, & Erkkilä, 2011b; Yoon, Verona, Schlauch, Schneider, & Rottenberg, 2019). This project investigated the pattern of emotional stimulus choice and its affective consequences among individuals with depressive disorders.

There are two conflicting hypotheses concerning depressed persons' emotional stimulus choice. The first hypothesis is that persons with depression engage in maladaptive emotional

stimulus choice, and prefer negative stimuli that ultimately make them feel worse and more depressed (Millgram et al., 2015), such as maintaining deactivated and lethargic states. An alternative second hypothesis is that depressed persons may indeed prefer sad stimuli, but such choices ultimately lead them to feeling increased positive affect (Yoon et al., 2019). To determine which hypothesis is supported, we carefully examined the characteristics of music stimuli depressed people want to engage with, in their daily life contexts, including data collected on the affective outcomes of, and the reasons for particular music choices.

Before proposing our study design, we review evidence supporting each hypothesis. A few studies have suggested emotional stimulus choice is problematic in depression. For example, Punkanen et al (2011) examined whether patients with major depressive disorder (MDD) and healthy controls might show different patterns of liking various emotional music excerpts (i.e., positively and negatively-valenced, high and low energetic, and anger, sadness, and happiness inducing music excerpts). The researchers found that patients with MDD were less likely to prefer highly energetic and anger-inducing music excerpts, compared to control participants. The researchers interpreted the results in terms of depression-related impairment. For example, they claimed that depressed patients' reduced preference for highly energetic music reflected an impaired approach motivation system. In a multi-study sequence, Millgram et al. (2015) found that a depression group more often chose sad images to watch and more often selected sad music clips to listen than did a healthy control group. In another experiment, participants were trained to increase and decrease their emotional reactivity, and then were presented with happy, sad, and neutral images. While watching each image, participants selected whether they wanted to increase or decrease their emotional reactivity to each image. Persons with depression selected to increase their emotional reactions to sad images more often than did healthy controls. The

researchers interpreted these results as meaning that depressed people prefer sad stimuli because they want to feel more sadness, presumably a maladaptive emotion regulation goal.

Logically, to confirm that depressed persons' emotional stimulus choice reflects a maladaptive emotion regulation goal, it would be necessary to closely examine the affective consequences of these choices. For example, even music pretested to engender reports of sadness in healthy populations exhibits complex affective responses in practice (e.g., Juslin & Laukka, 2004). For example, sad music tends to have slow tempo and minor key which may elicit not only reports of sad feelings, but also relaxing feelings (Juslin & Laukka, 2004; Khalfa, Roy, Rainville, Dalla Bella, & Peretz, 2008). Even if a depressed person prefers 'sad music', as found in previous studies (Millgram et al., 2015; Yoon et al., 2019), it remains unclear whether the person likes the 'sadness' of the music, or 'calmness' of the music. This lack of clarity leads to the difficulty in interpreting the results. Thus, musical features of stimuli (e.g., tempo and mode) as well as its affective characteristics (i.e., how the music sounds) should be more thoroughly examined to better understand depressed persons' music preferences.

Further, it is necessary to examine reports of affective experience. Without the direct examination of these affective outcomes, it is uncertain whether choice of sad stimuli is a "maladaptive" strategy that makes depressed persons sadder or more distressed. Unfortunately, previous studies on depression have neglected to test this assumption. Elsewhere, previous works questioned the idea of a one-to-one correspondence between the selection of an emotional stimulus and a change in feeling state (Garrido & Schubert, 2011; Vuoskoski, Thompson, McIlwain, & Eerola, 2012). It was found that the emotions are perceived in a song can differ from the emotions that are induced by the stimulus (see Juslin & Laukka, 2004 for review). For example, engagement with a normative "sad" stimulus make people feel not only sad, but also

positive emotions such as empathy or peacefulness (Garrido & Schubert, 2011; Vuoskoski et al., 2012). Thus, it is possible that depressed persons might feel more positive affect after engaging with normatively sad stimuli.

Finally, to support arguments that depressed persons prefer sad stimuli because they ‘want to’ feel sad or remain lethargic (i.e., maladaptive choices), it is crucial to directly investigate the reasons that people offer for their preferences. Even granting that participants’ stated reasons for choice may also reflect some degree of bias or error (e.g., Nisbett & Wilson, 1977), they remain a critical piece of data to understand preference. Examining stated reasons for music choice would help us understand the manifest intentions behind depressed persons’ choices, including whether the intentions are potentially harmful (i.e., want to feel sadder) or beneficial (i.e., to feel increased positive affect).

More recently, I found evidence that undercuts the idea that depressed persons hold a maladaptive pattern of emotional stimulus choice (Yoon et al., 2019). This study investigated 1) whether people with MDD show a distinct pattern of choice, namely the increased preference for sad stimuli as shown in Millgram et al. (2015), and 2) whether the choice reflects maladaptive emotion regulation. To examine the pattern of music choice, we used two tasks. In the first task, we attempted to replicate Millgram et al.(2015)’s music study using the same sad, happy and neutral music excerpts. In the second task, we used a new emotional stimuli selection task (ESST) to examine both emotion and energy levels (i.e., energy levels for music), making 7 different types of stimuli (happy/high energy, happy/low energy, sad/high, sad/low, fear/high, fear/low, and neutral music). Participants listened to 84 unique pairs of music excerpts, and for each pair chose an excerpt they preferred to hear.

In the first task, we replicated Millgram et al. (2015)'s finding that a depression group chose more sad and less happy music excerpts, compared to a non-depression group. In addition, we found that a depression group's chosen music was not only sadder and less happy, but also less energetic, compared to a non-depression groups' music. Results from the paired choice task (ESST) were similar: the depression group chose sad and less energetic music excerpts more than non-depressed controls. However, when looking at preferences within group, the depression group did not prefer sad to happy music; instead, they evidenced an equal preference for happy and sad, and high and low energetic music. By contrast, non-depressed controls showed a clear preference for happy over sad and for high over low energetic music. Across two tasks, then, the depression group lacked the pattern of preference for happy and energetic music that was evidenced by the non-depression group.

The key part of the study was to provide an initial test of whether these choices might reflect maladaptive emotion regulation. As such, we measured participants' affective states prior to and after listening to their chosen music in the first task. In addition, participants freely reported their reasons for their choice. We found that the most frequently reported reasons for sad music choice among persons with depression was related to the energy levels of the music (i.e., the music is calm). Notably, compared to affective states prior to music listening, persons with depression reported feeling more happiness and less sadness after listening to their chosen music, even though more than half the depression group chose sad music ( $n = 21$  out of 38). Based on these results, we concluded that individuals with depression's preference for sad music may be related to wanting to feel relaxed rather than wanting to feel sad. If so, increased engagement in sad music may not be harmful, and might even be helpful, as there is some evidence that relaxing music can positively affect psychological health (Nilsson, 2008). In sum,

our data appeared to directly contradict the hypothesis that depressed person's emotion stimulus choice is maladaptive.

Although this study shed light on the pattern of music choice in depressed people and affective outcomes (Yoon et al., 2019), there remain unresolved questions. First, our study examined emotional stimulus choice in a laboratory setting in which we forced participants to choose one among the prepared set of music. It is possible that depressed persons might show different effects in everyday life contexts, especially when they have a greater array of stimuli to choose from. Second, limitations in our study design did not allow us to fully resolve the affective outcomes of depressed person's emotional stimulus choice. In our study, we collected information on affective states only once, to each participant's most preferred music excerpt. Thus, whether the results will remain consistent over more trials (reliability) and in different contexts (generalizability) is uncertain. Third, our lab study provided only a snapshot of reasons for emotional music choice. We could not examine, for example, why persons with and without depression might want to engage with distinct music choices while in different emotional states (i.e., when feeling sad or happy). This contextual information can be valuable for understanding depression. For example, individuals with depression might not want to listen to music to feel better when they are feeling positive affect; and, when feeling sad, they may want to listen to music that helps them feel more relaxed, such as sad and slow songs.

To address these issues, the present study aimed to examine the characteristics of emotional stimuli chosen by persons with depression in daily life. Furthermore, we assessed the affective outcomes of these choices using an ecological momentary assessment design (EMA; Shiffman, Stone, & Hufford, 2008). EMA design is a logical next step for the following reasons. The repeated assessments in an EMA design enables us to examine affective consequences of

engagement with multiple chosen stimuli. It might take a number of lab studies to investigate the effect of multiple emotional stimuli on affective states, as participants have to wait in the lab to engage in the next stimulus until a certain time passes after the first stimulus. In the EMA design, affective states can be measured multiple times throughout a day without restricting daily activity. In addition, an EMA study by its very nature has greater ecological validity than a laboratory study. This design makes it possible to measure choice of emotional stimuli in persons with depression across various contexts, rather than a single laboratory context.

In this study, we focused on music stimuli. There are several advantages of using music. First, focusing on music enables greater continuity with Yoon et al. (2019) to directly compare what we found in the lab to an everyday life context. Second, music is a universal (McDermott & Hauser, 2005) and ubiquitous emotional stimulus; approximately 50% of people in the U.S.A. listen to music at least once a day (North, Hargreaves, & Hargreaves, 2004). Third, one of the major reasons why people listen to music is to regulate emotions, which makes it germane for examining emotion regulatory consequences (e.g., Saarikallio, 2011; Schäfer et al., 2013; Van Goethem & Sloboda, 2011). Finally, it would be virtually impossible to track all emotional stimuli people are using or choosing in daily life. Focusing on music makes our study relatively feasible.

Therefore, the current study examined the characteristics of depressed and non-depressed persons' music choices in daily life as well as the affective outcomes of their choice and reasons for music listening. To elaborate on the aim, this study consists of three sub-studies: 1) the EMA study, 2) the song analysis study, and 3) the exploratory reason study.

Firstly, the EMA study was conducted to examine whether the people with depression's increased choice of 'sad' pre-selected music would be exhibited in daily life contexts. For the 3-day EMA study, participants were given 4 choices of pre-selected instrumental music (i.e., 2 happy and 2 sad songs). Participants listened to 5 second excerpts of each music to gauge the emotional tone of each, and then made a choice on which one they wanted to hear in the full length (emotional music choice). In addition, participants gave affective ratings of their mood before and after listening to the chosen song (affective outcomes). Although the use of a pre-set library constrained the ecological validity of our assessment of music listening behavior, it also allowed us to reduce heterogeneity in music genre, lyrics, or length, affording us to control for those third variables than emotionality (i.e., happy vs sad).

Secondly, in the song analysis study, the list of music freely chosen by each participant for 7 days was collected, and then the repeatedly chosen songs were extracted and analyzed. With the repeatedly chosen songs, we examined if participants with depression listened to music with a different tempo or main key (mode) than nondepressed persons. Tempo and mode were chosen because these characteristics were found to distinguish sad, happy, more and less energetic music (Dalla Bella, Peretz, Rousseau, & Gosselin, 2001; Gagnon & Peretz, 2003; Robb, Nichols, Rutan, Bishop, & Parker, 1995). In addition, an independent group of judges assessed perceived emotions portrayed by the repeatedly chosen songs (i.e., how happy/sad/energetic a song sounds). This study was novel in collecting freely chosen songs, which likely represents a person's true music preference better than choices drawn from a pre-set music library. This was the first to demonstrate whether persons with depression's freely chosen music in daily life contexts is indeed perceived as normatively less happy and energetic, or

sadder compared to non-depressed persons’, as well as the first to explore whether the depressed persons’ preferred music has particular musical features, such as slow tempo and minor mode.

To realize these aims, we used *Last.Fm* online music database to collect the list of music played by each participant. The *Last.Fm* was linked to a participants’ *Spotify* accounts, a popular music streaming application, and it records the list of music heard (for songs that are at least half way listened) for the study period. To capture as much of the participants music listening as possible, participants were asked to use only *Spotify* when playing songs during the 7-day study period.

Lastly, “the reason study” aimed to explore participants’ reasons for music choices in different feeling states. As the final measures, participants completed questionnaires regarding the reasons why they wanted to hear music when feeling sad and happy over the past study week .

### **Hypotheses.**

Based on previous research (Yoon et al., 2019), I hypothesized as follows:

H1: In the EMA study with choices drawn from a pre-set music library, it was predicted that the pattern of emotional music choice would mirror lab findings (Yoon et al., 2019): the depression group would choose sad music more often than non-depressed group.

H2: Yoon et al. (2019) showed that engagement in chosen music excerpts was associated with increased happiness and decreased sadness in the depression group but not in the healthy control group. In the EMA study, we expected results would mirror what was found in the lab study: the depression group would report larger decreases in reported sadness and increases in

reported happiness and relaxedness after listening to their chosen music, compared to non-depressed group, regardless of their song choice.

H3: In the song analysis study, when an independent group of raters evaluates the free list of repeatedly played music, it was predicted that the depression group's list would be judged to be sadder and less happy and energetic, compared to the non-depression group's list.

Exploratory H4: The current study also had exploratory aims.

H4-1) In the song analysis study, we explored whether depressed persons' preferred music differed from the non-depressed controls' ones in tempo and mode.

H4-2) In the reason study, we explored possible group difference in the reasons for music listening when feeling sad and happy.

## CHAPTER TWO: METHOD

### **Participants.**

A total of 77 female undergraduate participants (39 depressed and 38 age-and gender matched non-depressed individuals) were recruited through an online research participation pool system, or by flyers posted online/on campus. For the depression group, participants were included when they met the criteria for current MDD or persistent depressive disorder. For the non-depression group, participants were required to have no lifetime history of MDD and persistent depressive disorder and were included only when they had a total BDI-II score below 14. For both groups, participants were excluded if listened to music less than 6 days a week, were unfamiliar with use of the *Spotify* music app, or had a history of serious brain injury or other neurological disorders, alcohol or substance dependence or abuse within the past 6 months, a lifetime history of bipolar disorder or psychotic disorders. In addition, previous studies found that musicians may react differently to music, compared to non-musicians (e.g., VanderArk & Ely, 1992). Thus, we enrolled only non-musicians (i.e., those who do not major or minor in music, and have not received sustained musical and instrumental training for more than 10 years; Bigand & Poulin-Charronnat, 2006).

The recruitment process had two phases: online/phone screening and in-person clinical interview. For participants collected through an online research participation pool system, they were pre-screened on the system using five questions: 1) ‘during the past two weeks, how often have you felt sad, down, or depressed?’ and 2) ‘during the past two weeks, how often have you been less interested in your usual activities?’ with 4 answers (a, Not at all; b, Some of the time; c,

More than half the time; d, All the time), 3) ‘how often do you listen to music’ (a, Almost daily (6-7 days a week); b, Sometimes (3-4 days a week); c, Less than 3 times a week), 4) ‘Do you major or minor in music, or have you received sustained musical and instrumental training for more than 10 years’ (a, Yes; b, No), and 5) ‘How familiar are you with using *Spotify*?’ (a, Very familiar; b, Quite familiar; c, Not familiar, but I think I can easily learn how to use it; d, Not familiar and I would have difficulty leaning how to use it). To recruit the depression group, only those who responded ‘c’ or d to questions 1(i.e., sad mood) or 2 (i.e., lack of motivation), and for the HC group, only those who chose ‘a’ to both questions were invited. In addition, for both groups, only those who responded ‘a’ to question 3 (i.e., daily music listening), ‘b’ to question 4 (i.e., non-significant training in music), and ‘a’ or ‘b’ to question 5 (i.e., familiarity with *Spotify*) were invited.

Those who were recruited through flyers were asked the same 5 questions over the telephone. In addition, to increase the chance to invite eligible participants, we briefly asked pre-screening questions regarding inclusion and exclusion criteria using the shortened and revised items from SCID (the Structured Clinical Interview for DSM-V Axis I Disorders; First, 2014) and MINI (the Mini-International Neuropsychiatric Interview; Sheehan et al., 1998). Participants who did not meet the exclusion criteria and satisfied the 5 questions were invited.

In total, 182 students were invited to an in-person clinical interview and consented to participate in the current study. They were compensated \$25 if recruited from a flyer or with corresponding course credits for participants recruited through a research participation pool system. In the clinical interview, the mood module of SCID was used to diagnose MDD and persistent depressive disorder. The MINI was used to examine exclusion criteria. The first author, an advanced doctoral student in clinical psychology, and three trained undergraduate

psychology majoring research assistants conducted the clinical interview. The first author had several years of clinical interview experiences. Three undergraduate research assistants were trained by the first author for two months prior to the study administration, which includes three seminars on screened mental disorders and clinical interview, role plays, and three mock interviews and feedback. Two of them had prior experiences with conducting psychosocial interviews in a private psychiatric hospital. During the study administration, the first author and each undergraduate research assistant assessed the first five participants together (i.e., research assistants observed two cases and the first author observed three cases), compared clinical decisions, and reached an agreement regarding the diagnosis in all cases. After the interview, 39 depressed and 38 non-depressed participants met the inclusion criteria and were included for the study. The recruitment flow chart is presented in Figure 1.

### **Pre-set music library.**

**Pilot study.** Nine songs (4 happy and 5 sad) whose duration was around 2 to 3 minutes were chosen from Eerola and Vuoskosk (2011)'s list of standardized emotional music, based on the selection criteria used in Yoon et al. (2019). Five second excerpts were extracted from each song. To provide initial validity data, twenty-five female university students were recruited from a psychology research participation pool. The mean age of the participants was 22.24 ( $SD = 3.31$ ) and 36% identified themselves as Caucasian. Participants gave ratings of how happy/sad/energetic the music sounds on a 9-point scale (0 = not at all, 8 = extremely) after hearing each song and excerpt. Among them, 6 songs (3 per emotion) were selected based on the following criteria: ratings above 4 on a target emotion and below 2 on a non-target emotion. Ratings of target emotion were significantly higher in the matching songs (e.g., happy songs sounded significantly happier than sad songs) and excerpts (see Appendix G for statistical details

and the information about songs). In the EMA study, participants were presented with 4 songs to choose from (2 happy and 2 sad songs) at any given survey. Each song was offered as a choice 10 times in total.

### **Other measures.**

**Demographic characteristics.** Information regarding age, education (i.e., how many years of education completed: 12 years for freshmen), and the current medication usage were measured.

**Depression and anxiety symptom severity.** Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996) and Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988) were used to measure depression and anxiety symptom severity. Both questionnaires have 21 items on a 4-point Likert scale ranging from 0 to 3. In the current sample, Cronbach's alpha was .95 for both questionnaires.

**Affective outcomes ratings.** Self-reported affective experiences were measured using a visual analog scale (VAS) with 0 (none) to 8 (a lot). Participants reported how much they feel each emotion before and after music listening. The following affective states were measured: happiness (joyful, happy), sadness (sad, downhearted), and relaxedness (relaxed). For happiness and sadness, average scores were used for analyses.

**Reasons for music listening.** In the reasons for listening study, participants were showed a list of six songs they heard when feeling sad and happy over the past week, respectively (3 songs for each emotion). These songs were reported to help participants recall their music behaviors of the past 7 days. After listing each song, they chose the reasons why they wanted to hear it, with multiple choices allowed. Based on previous research (Linnemann, Ditzen, Strahler,

Doerr, & Nater, 2015; Van den Tol & Edwards, 2015; Wilhelm, Gillis, Schubert, & Whittle, 2013), the following choices were provided: 1) to relax 2) to get energy, 3) to lift my mood, 4) to distract myself from unwanted thoughts or feelings, 5) to express, experience or understand emotion in music, and 6) to think or process thoughts.

### **Procedure.**

The current study consisted of three phases (Time 1, Time 2, Time 3). Participants were informed that they are invited to take part in a study regarding college students' music listening. At Time 1, participants were screened using the SCID-I, completed the BDI-II, BAI and provided demographic information. Then, they were informed about the EMA study. Each participant's *Spotify* account was connected to the lab's *Last.Fm* database. For those who did not have their own premium account, a premium account was provided (which allowed a wider array of song choices). Participants were informed that they should listen to music as usual; however, they were to use only *Spotify* whenever they wanted to hear music for the 7 days. For the participants not knowledgeable about how to use the *Spotify* app, instructions were provided. Participants played 5 songs using their *Spotify* to check whether their account was linked well to the database. Participants were trained on how to answer each EMA question and performed one example of completing EMA survey. All participants reported that they fully understood the EMA survey after one example.

Time 2 (the EMA study) lasted 3 days, including two days of weekend and one weekday (i.e., either Monday or Friday). Participants were advised to carry their earphones/headphones for the 3 days in case they went outside. A reminder text message was sent to participants one day prior to the beginning of Time 2 and each morning for the 3 EMA days. At each response,

participants received a text message with a survey link. Using a Qualtrics software, a survey containing a series of EMA questions were sent 5 times a day (with a 2-4hr gap between responses at semi-random schedule between 10:00am-10:30pm). Participants were instructed to complete the survey within 1 hour of receiving the text message and were informed that any completed survey after 1 hour would not count. Participants received one reminder text message if they did not complete the survey within 30 min. At each text prompt, participants first completed their current affective rating. Then, they listened to 4 5-second song excerpts (2 happy and 2 sad excerpts; 25 seconds) in a random order and were asked to choose one song to listen for its entire duration. As a check that participants were on task, at the end of the choices, an instruction message told them to choose a certain letter to move on (i.e., choose 'C'). If a wrong letter was chosen, the survey became closed and invalid. For valid trials, participants were presented with their chosen song in its full duration (i.e., 2.19- 2.48 minutes long). Again, as an attention check, participants heard an instruction message telling them to select a certain letter to move on. After correct letter responses, participants rated their current affective states again. Participants were informed that they would receive the full compensation only if they complete 90% of valid surveys. In the analysis, we included the responses started within 1 hour of the text sent.

Time 3 (the reason study) occurred online after 7 days since Time 1. On the 7<sup>th</sup> day, participants received a survey link using a Qualtrics software via text. In the survey, participants were asked to report three songs they wanted to hear when feeling happy and sad over the past week, respectively. This procedure was used to help participants recall what they heard. After reporting a title of each song, they were instructed to choose reasons why they wanted to hear it.

### **The song analysis study.**

To enable us to test that the depression group's most played music over a week would be sadder, less happy and energetic, and have slower tempo and more minor keys, compared to the non-depression group's, we extracted the list of songs repeatedly chosen by participants over the 7-day-study period. Repeatedly chosen songs were examined because these songs can reasonably be assumed to reflect a strong music preference, which is our interest. Repeatedly chosen songs were defined as songs played at least 5 times. We chose 5 times as a criterion value because 1) analysis were feasible with a tractable sample size and 2) it is reasonable to assume that a song is liked by a listener when it is played at least 5 times.

For tempo and mode analyses, we used repeatedly chosen songs. We manually extracted information about main key (i.e., mode) and beats per minute (BPM; tempo) of each song from an online website (i.e., <http://tunebat.com>) where users can search such information provided by *Spotify* using its own estimation algorithms. With the extracted information, we compared the key and BPM of repeatedly chosen songs between groups.

Furthermore, to examine possible group differences in the judged affective characteristics of preferred songs (i.e., how happy/sad/energetic a song sounds), we had strongly preferred songs rated by 3 independent raters on a 9 Likert scale (i.e., 0 = none to 8 = a lot). Ratings were made of the levels of happiness, sadness and energy of each song. We extracted strongly preferred songs from the repeatedly played songs in order to have a more manageable database. We used following criterion: 1) two to three songs per participant, 2) songs heard greater than or equal to 5 times, AND 3) heard at least one more time than the other songs. Five

research assistants served as raters. Each heard different sub-sets of the strongly preferred songs and completed the ratings after hearing each song. Each song was rated by 3 research assistants.

### **Statistical analyses.**

Firstly, group differences in demographic characteristics, clinical symptoms, and survey completion rates were tested using t-tests for continuous dependent variables and a chi-square test for categorical dependent variables, such as ethnicity.

To examine that the depression group would choose sad music more often than non-depression group in the EMA study (H1), the proportion of which a participant chose sad songs over the total completed choices was calculated per participant. An independent t-test was conducted with the sad song proportion score as a dependent variable and Group (depression, non-depression) was a grouping variable.

Given the nested structure of our data (i.e., time-related responses nested within a participant), hierarchical linear modeling (HLM) was appropriate to test many of our hypotheses. To test whether group predicts mood change after listening (H2), a series of HLM were conducted with affect (happy/sad/relaxed, respectively) as an outcome variable, a grand-mean centered dummy coded time (before listening:0, after:1) as a level 1 predictor, a grand-mean centered time of the day (first survey of a day:1, second:2, third:3, fourth:4, final survey of a day:5), a grand-mean centered dummy coded song-choice (sad song choice=1, happy =0) and an uncentered interaction term of song choice and time as covariates, and group as a level 2 predictor. The final equations used are presented below. In the equation below, we are particularly interested in the main effects of time, and the interactions of time\*group, song choice\*time, and song choice\*time\*group. When the three-way interaction of song

choice\*time\*group was not significant in the model, we removed the interaction from the model.

To further decompose within or between level interactions, we used JavaScript programs at <http://www.quantpsy.org> based on formulas/calculations created by Bauer & Curran (2005).

### **Level-1 Model**

$$Affect_{ij} = \beta_{0j} + \beta_{1j}*(Song\ choice_{ij}) + \beta_{2j}*(Time_{ij}) + \beta_{3j}*(Interaction_{ij}) + \beta_{4j}*(Time\ of\ day_{ij}) + r_{ij}$$

### **Level-2 Model**

$$\beta_{0j} = \gamma_{00} + \gamma_{01}*(GROUP_j) + u_{0j}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}*(GROUP_j) + u_{1j}$$

$$\beta_{2j} = \gamma_{20} + \gamma_{21}*(GROUP_j) + u_{2j}$$

$$\beta_{3j} = \gamma_{30} + u_{3j}$$

$$\beta_{4j} = \gamma_{40} + u_{4j}$$

To examine group differences in affective and musical characteristics of freely chosen songs (H3 and H4-1), a series of HLM analyses were conducted with mode/tempo (i.e., dummy coded; major =1, minor =0)/affective characteristics as outcome variables and an uncentered group (dummy coded) as a level 2 predictor. Due to any possible individual differences, the model allows both intercept and slope to vary for Level 1 predictors.

**Level-1 Model:** *Mode/Tempo/ Affective characteristics* =  $\beta_{0j} + r_{ij}$

**Level-2 Model:**  $\beta_{0j} = \gamma_{00} + \gamma_{01}*(GROUP_j) + u_{0j}$

Finally, for testing the exploratory H4 of music listening reasons, we computed the number of each reason endorsed by each participant (i.e., 0 -3times) separately for feeling sad and happy. For example, if a person chose “to lift mood” for all three songs chosen for a feeling sadness

condition, the score “to lift mood” would be 3. If the person chose “lift mood” for one song, the score is 1. The larger score indicates a stronger endorsement of the reason for music listening. Using the endorsement scores as a dependent measure, a repeated measures analysis of variance (ANOVA) was conducted where Feeling states (sad, happy), Reasons (to relax, to get energy, to lift mood, to distract, to express, to process) were within-subject variables, and Group (depression, non-depression) was a between-subject variable. When sphericity test was violated, Huynh-Feidt scores were used.

Throughout analyses, HLM was conducted using HLM statistical software version 7.03 (Raudenbush, Bryk, Cheong, Congdon, & Du Toit, 2011). The rest of statistical tests were conducted using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp, Armonk, N.Y., USA).

## CHAPTER THREE: RESULTS

### **Demographic and clinical characteristics.**

Consistent with a college sample, mean age was 19.92 years for the depression group and 19.71 years for the non-depression group. The average education was the second year in college and about half the participants in each group identified themselves as Caucasian. No significant group difference was found for age, education or ethnic background. For clinical symptoms, as expected, the depression group reported higher scores for depression and anxiety, compared to the non-depression group. Among the depression group, 5 participants were on antidepressants: selective serotonin reuptake inhibitors ( $n=3$ ), serotonin and norepinephrine reuptake inhibitors (SNRI;  $n=1$ ), and SNRI and benzodiazepine ( $n=1$ ). Demographic characteristics, clinical symptoms and statistical results are displayed in Table 1.

### **Song choice and its affective consequences: the EMA study.**

To analyze song choice difference between groups, we excluded late responses that began after 1 hour of a text survey sent ( $n=15$ ). In addition, trials where participants failed the attention check ( $n = 14$ ) were excluded. In total, 1057 analyzable responses were collected from the 3-day EMA study. On average, participants completed 91.5% of surveys within an hour of receiving a text survey, with completion rates ranging from 46.7% to 100%. There was no significant difference in the completion rate between depressed and control participants,  $t(75)=.71, p =.483$ .

For the analysis of mood change after listening, we excluded suspect datapoints when it was not clear that participants actually heard the entire length of a chosen music as well as rated their emotions after hearing the chosen music as instructed, including: any response in which participants spent too little time on a response ( $n = 28$ ; i.e., below the minimum length of time needed to complete a survey, 169 seconds; the sum of 4 music excerpts (25 sec; seconds), the shortest music (139 sec), and completing self-report measures (estimated as 5 sec) and in which participants spent too long completing a survey ( $n = 19$ ; i.e., above 2 SDs of mean survey duration, 788 seconds). Finally, responses were excluded when participants failed attention checks ( $n = 4$ ) or participants did not complete mood ratings after hearing their chosen music ( $n = 5$ ). In total, 1001 responses remained in the analysis of the mood change. On average, 86.9% of participants' responses were valid, ranging from 40% to 100%. Again, there was no group difference in proportion of valid responses,  $t(75) = -.06$ ,  $p = .955$ .

**H1: Did participants with depression choose sad songs more than non-depressed participants in everyday life?** Groups did not reliably differ in the extent to which they chose sad songs, although the depressed group chose nominally more sad songs, 50.6% for the depression vs. 43.2% for the control group,  $t(75) = 1.84$ ,  $p = .069$ , 95% CI of the difference  $[-.006, .154]$ ,  $d = .41$ . To further examine relative song preference (sad vs. happy songs) within each group, one-sample t-tests were performed with the sad song proportion score as a test variable and the chance level of .5 as a test value per group, respectively. In these analyses, nondepressed controls chose more happy songs (56.8%) (and less sad songs, 43.2%) than a chance level,  $t(37) = -2.27$ ,  $p = .029$ , 95% CI  $[-.128, -.007]$ ,  $d = -0.36$ , whereas the depression group did not exhibit such pattern, happy (49.4%) and sad songs choices (50.6%),  $t(38) = .24$ ,  $p = .814$ , 95% CI  $[-.048, .612]$ ,  $d = 0.03$ . The results are presented in Figure 2.

## **H2: Did participants with depression report greater increases in relaxedness, happiness and decreased sadness after music choices than non-depressed participants?**

Since the three-way interaction of song choice\*time\*group was not significant in our initial model, we removed the interaction from the model. Across all participants, the main effect of sad song choice and group, and the interaction of Time (before vs. after listening)\*Song choice (happy vs. sad songs) yielded effects on all three reported emotions. Regardless of whether prior to or after listening to the chosen music, the depression group reported higher levels of sadness and lower levels of happiness and relaxedness, compared to nondepressed controls. Simple slope testing showed that both groups reported decreased happiness after hearing a sad chosen song ( $z = -2.24, p = .002$ ). Surprisingly, there was no change in reported happiness after hearing a happy chosen song ( $z = -0.23, p = .815$ ). In case of reported sadness, simple slope testing did not show any significant moderation of song choice on slopes,  $z = 1.53, p = .125$  for sad song choice,  $z = -.925, p = .796$  for happy song choice. Finally, simple slope testing revealed that both groups reported increased relaxedness after hearing a sad chosen song ( $z = 2.74, p = .006$ ); by contrast, there was no change in reported relaxedness after hearing a happy chosen song ( $z = -0.02, p = .977$ ). Detailed statistics are presented in Table 2 and Figure 3.

In sum, persons with depression lacked the preference for happy music demonstrated by nondepressed individuals. Unexpectedly, we found no group differences in mood changes after listening to music. Instead, we found that sad song choice predicted not only lower levels of happiness, but also the higher levels of reported relaxedness in both groups. Further, reports of sadness did not change after hearing sad songs.

### **Musical and affective characteristics of preferred songs: the song analysis study.<sup>i</sup>**

Because our study targeted individuals who reported listening to music almost every day,

only those who listened to music on *Spotify* at least 5 days over the 7-day study week were included in analyses of free song choice. Thirty-three depression and 35 non-depressed control persons' song choices were included. A total of 11,280 songs (8,874 albums) were collected across groups. Seventy-two percent of songs were heard only once and 16% was heard twice. Additional information about the collected songs are provided in the footnote<sup>ii</sup>.

Five-hundred-one songs (317 songs from 32 participants of the depression group, 184 from the 28 non-depression group) were classified as repeatedly heard and therefore analyzed for tempo and mode. There was no group difference in the number of songs per person included in the analysis,  $t(58) = 1.11, p = .271$  (the depression group, mean: 9.91 songs, SD: 14.63; vs. the non-depression group, 6.57, 6.52), as well as in the proportion of included vs. excluded participants,  $\chi^2(1) = .78, p = .376$ . For analysis of affective characteristics, a total of 117 songs (63 songs from 25 depressed participants and 54 songs from 20 non-depressed controls) were included for the analysis. Again, the group did not differ in the proportion of excluded participants,  $\chi^2(1) = 1.04, p = .307$ .

**H3: Would songs strongly preferred by participants with depression be judged as sadder, less energetic and happy by independent raters, compared to non-depressed persons' songs?** The intra-class correlation (ICC) coefficients among raters based on a two-way random model with consistency showed acceptable agreement: ICC = .68 for happy; ICC = .63 for sad; ICC = .83 for energetic,  $F_s(116,232), p_s < .001$  for all three emotions. Composite scores for each emotion were computed by summing the three ratings per song. The results showed that group was not associated with differences in any rated affective characteristics of preferred songs:  $B = -1.05, SE = 1.24, t(43) = -.84, p = .402$  for happy,  $B = 1.16, SE = 1.03, t(43) = 1.12, p = .265$  for sad, and  $B = -.98, SE = 1.29, t(43) = -.75, p = .454$  for energetic.

**H4-1: Would songs repeatedly heard by depressed participants have slower tempo and more minor keys, compared to non-depressed persons' songs?** Group predicted tempo (measured by BPM),  $B = -7.40$ ,  $SE = 3.43$ ,  $t(58) = -2.15$ ,  $p = .035$ : the depression group's preferred songs had slower tempo than non-depressed control's songs. Group did not predict mode,  $B = -0.02$ ,  $SE = 0.05$ ,  $t(58) = -.39$ ,  $p = .695$ . The grand mean of each variable is presented in table 1.

In sum, contrary to our prediction, the depression group's strongly preferred songs were not rated by independent judges as less happy or energetic and sadder than the non-depression group's. When it comes to musical elements of songs, both groups showed compatible preference for major and minor keys with a larger set of songs. However, participants with depression preferred slower songs, compared to non-depressed participants.

### **Reasons for music listening**

One participant from the depression group did not complete the reason survey. Seventy-six depressed and non-depressed participants (38 per group) were included in this analysis.

**H4-2: Why did participants want to hear music?** Analyses of stated reasons for music choices revealed significant interactions of Feeling states (when feeling happy vs. sad)\*Group,  $F(1,74) = 7.026$ ,  $p = .010$ , and Feeling states\*Reason,  $F(4.25,314.18) = 46.82$ ,  $p < .001$ . Bonferroni-corrected pairwise comparisons revealed that when feeling happy, the depression group endorsed a greater number of reasons for listening to music than non-depressed controls' ( $p = .001$ ). Further, when feeling sad, both groups reported that they listen to music to express, experience, or understand emotion in music ( $p=.006$ ) and to think or process thoughts ( $p<.001$ ), to a greater extent than when they were feeling happy. On the other hand, both groups reported

listening to music to get energy ( $p < .001$ ) and lift mood ( $p < .001$ ) to a greater extent when feeling happy than when feeling sad. In addition, when feeling sad, participants across groups endorsed fewer reasons related to high arousal positive affect (PA), such as getting energy or lifting their mood, compared to other reasons ( $ps < .05$ ). When feeling happy, both groups endorsed 'to lift mood' more than other reasons ( $ps < .05$ ). Detailed results are presented in figure 4.

To sum, these exploratory findings provided some indication that "to simply feel better or energetic" may not be the primary reason why people listen to music when feeling sad. Instead, when feeling sad, both depressed and non-depressed persons say they listen to music to feel relaxed, distract from negative thoughts, express or experience emotions, and process thoughts.

## CHAPTER FOUR: DISCUSSION

The main findings of this study were as follows: 1) When song choices were controlled, depressed persons did not choose more sad songs than nondepressed persons in daily life. However, the depression group lacked the preference for happy over sad songs evidenced by the non-depression group. 2) Depressed persons' freely chosen songs had a slower tempo than non-depressed controls'. 3) In addition, no group differences were observed in the affective consequences of choosing sad songs in everyday life. Notably, both depressed and non-depressed participants reported feeling more relaxed after hearing sad songs. 4) Finally, both groups reported that "to feel better or energetic" was not a primary reason for music listening when feeling sad. Overall, these results cast doubt on the idea that sad music only induces sadness, or that a mood enhancement is necessarily the prime motivator for music choices.

Although there was a trend level effect ( $p=.069$ ), our EMA study did not find a reliable depression group's preference for sad song in daily life, unlike previous studies (Millgram et al., 2015; Yoon et al., 2019). However, the lack of preference for happy to sad songs was observed in everyday contexts of this study as well as in a laboratory study (Yoon et al., 2019). These results suggest that the chief characteristic of music choice in persons with depression may be the lack of preference for happy music, rather than an increased preference for sad music. Notably, the same pattern was observed in people with induced sadness in laboratory studies: participants in a sad mood condition chose less happy music than did a happy condition, whereas there was no significant difference in sad music choice between conditions (Friedman, Gordis, & Förster, 2012; Hunter, Schellenberg, & Griffith, 2011). In addition, university students reported that

hearing happy music feels inappropriate when feeling sad (Friedman et al., 2012). Taken together, it is possible that a lack of preference for happy music may be characteristic of people who are in a sad mood, and not specific to a clinically significant depressive disorder.

When analyzing freely chosen songs, songs chosen by persons with depression had a slower tempo compared to non-depressed controls' songs. Why might people with depression prefer slower tempo? One possible explanation regards relaxation. To our knowledge, one of the most studied effects of hearing songs with slower tempo is increased relaxation in listeners, while the faster tempo does the opposite (e.g., Dillman Carpentier & Potter, 2007; Van der Zwaag, Westerink, & van den Broek, 2011). It is plausible that persons with depression choose musical stimuli that bring them increased relaxedness. If so, this carries an important implication for depression research on anhedonia.

Anhedonia, one of the core symptoms of depressive disorders (American Psychiatric Association, 2013), has been defined as a diminished motivation to approach PA-inducing activities or stimuli (Treadway, Bossaller, Shelton, & Zald, 2012). Most previous studies measured a PA-inducing stimulus using monetary rewards and concluded that depressed people lacked a motivation to approach PA-inducing stimuli (i.e., monetary rewards) observed in non-depressed individuals, which is viewed maladaptive (see Treadway & Zald, 2011 for review). However, such conclusion neglects that PA could be subdivided into pleasant states that are low in arousal, such as relaxedness, and those that are high in arousal, such as excitement (Feldman, 1995). Results from previous studies on depression anhedonia may reflect depressed persons' diminished motivation towards stimuli that specifically induce high-arousal PA, such as excitement resulting from earning the rewards. In fact, this study discovered that, when it comes to music, persons with depression appear to approach stimuli that bring increased low-arousal PA (i.e., relaxation) by

listening to slower songs. This study raises a fundamental question of whether “anhedonia” is an accurate terminology to describe depressed person’s motivational behaviors when they approach low-arousal, but hedonic (i.e., positive) stimuli, such as slower song. It is possible that people with depression do not have across the board “anhedonia”; but instead lack motivation towards stimuli that induce high-arousal PA states. Future studies are imperative to directly test this hypothesis using various high and low-arousal PA-inducing stimuli or activities.

Further, unlike tempo, no group difference was found in mode. The discrepancy in the results of mode and tempo should be noted, as it tells us which musical feature appeals to persons with depression. Various previous studies found that mode and tempo have distinct impacts on general mood and relaxation (e.g., Husain, Thompson, & Schellenberg, 2002; Ramos, Bueno, & Bigand, 2011; Trochidis & Bigand, 2013): the manipulation of tempo was associated with less self-reported arousal after listening, while mode manipulation led to increased improvement in overall mood after listening. This finding is also consistent with Yoon et al. (2019) where most participants with MDD reported that they liked sad music because it is relaxing. Overall, these results directly answer the question of which aspects of music are appealing to people with depression: tempo and relaxation.

This study revealed that sad song choice not only led participants to report feeling less happy, but also increased reports of relaxed feelings. Interestingly, choosing sad songs did not make participants report feeling sadder, and choosing happy songs did not change reported feelings after music listening across groups. These findings contradicted two previous assumptions regarding the maladaptive nature of sad music choices in depression. First, this study refutes the idea that sad music listening is always maladaptive as it increases sadness and decreases PA (Millgram et al., 2015). If we consider PA as also encompassing low arousal PA (Lee, Lin, Huang,

& Fredrickson, 2013), our findings suggest that sad music does not always decrease PA, because making listeners more relaxed increases low-arousal PA. Second, the finding that both depressed and non-depressed persons' reports of PA changed after listening to sad songs runs counter to the idea that depressed persons' sad music choice reflects maladaptive inertia where they choose music to maintain current states (Punkanen et al., 2011). Thus, depressed persons' preference for sad music found in previous laboratory studies (Millgram et al., 2015; Yoon et al., 2019) and their decreased preference for happy to sad music found in previous work (Yoon et al., 2019) and the current study cannot be assumed to reflect a maladaptive emotion regulation goal to seek "sad and lethargic mood".

Finally, the results from an exploratory analysis on reasons for music listening showed that "to lift mood" and "to be more energetic", are not the primary reasons for music listening when people are feeling sad. When feeling sad, participants across groups chose music to feel relaxed, to distract from unwanted thoughts and feelings, to express or experience emotion in music and to process internal experiences through music. Our study provides important additional information to a previous study on the motivation to hear music in depression (Wilhelm et al., 2013). Wilhelm et al. (2013) analyzed narrative reasons for music listening and found that depressed participants more likely reported hearing music to express and experience emotions in music while non-depressed participants more likely heard music to gain energy. However, the researchers could not test whether such group difference is depression-specific or simply due to increased sadness experienced by the depression group at the time of reporting. This study elucidates that the group difference found in Wilhelm et al. (2013) may be due to increased sadness. Not only depressed, but also non-depressed individuals did not listen to music to gain energy when feeling sad. When feeling sad, both groups reported listening to music for other reasons including "to experience or

express emotion in music”.

That non-depressed persons did not choose music to get high-arousal PA when feeling sad directly contradicts the idea that an “adaptive” emotion regulation goal of using emotional music is always to lift mood or feel energetic. Taken together with other results from this study (e.g., hearing a sad song increases feeling relaxed), these results tell a story that when a person feels sad, choosing a song inducing low arousal PA, such as sad or slower songs, is consistent with the person’s goal of music listening, rather than choosing happy or faster songs. Thus, the current findings of depressed participants’ lacking preference for happy songs and increased preference for songs with slower tempo may be because they had heightened sadness over the 3-day EMA period, which led them to having fewer reasons to choose songs that can increase their high arousal PA (e.g., happy and fast songs).

The current study does not stand without limitations. Firstly, sample consists of female university students. Although we did so to compare our results with a previous study (Yoon et al., 2019) where only female university students were included, it remains unclear whether the results from this study can be generalized to other age groups and male population. We urge future studies to test the same hypotheses in more diverse samples. Secondly, although we were able to analyze freely chosen music through *Last.fm* in the song analysis study, our focal analyses concerned pre-set music choices, allowing us to control over various characteristics of music, such as genre and lyrics. However, the pre-set music may have impacted affective changes after listening because some participants may have not liked the available excerpts generally. Some studies showed personally chosen/preferred songs led to greater affective changes, such as greater reduction of pain perception, compared to songs selected by researchers (e.g., Mitchell & MacDonald, 2006), whereas the opposite phenomenon was observed in arousal changes (e.g., Pelletier, 2004). Thus,

future study can examine the possible impact of preference of songs using a set of happy and sad songs self-identified by participants. Finally, because our study lasted only 7 days, we could not control participants' baseline musical preference between groups. A longitudinal study with a longer-term assessment will be valuable to test how music choice changes within an individual before and after depression.

Despite these limitations, this study has several novel implications about depression. First, persons with depression showed an increased approach to musical stimuli (i.e., songs with slower tempo) that can bring greater low-arousal PA (i.e., feeling relaxed) in daily life, indicating that the traditional view of depression anhedonia may not be generalized to low-arousal PA-inducing stimuli. Second, this study refutes the assumption that preference for sad music would always reflect a maladaptive desire to feel sadder or maintain their negative states. In everyday contexts, both depressed and non-depressed persons did not reported feeling sadder after hearing a sad song, rather they reported feeling more relaxed. Finally, this study counters the idea that a mood enhancement (i.e., to increase high-arousal PA) is always an adaptive goal for music listening. In conclusion, the current findings suggest that depressed persons' music choice may reflect their desire to feel increased low arousal PA, which cannot be assumed maladaptive or considered as a target for intervention.

## CHAPTER FIVE: TABLES

Table 1. Information regarding demographic characteristics and music listening behaviors

	<b>Depression (n=39)</b>	<b>Non-depression (n=38)</b>	<b>Statistics</b>	<b>p-value</b>
Age	19.92(2.22)	19.71(2.01)	$t(75)=.44$	.661
Education	13.49 (1.59)	13.24 (1.03)	$t(75) = .82$	.415
Ethnicity (Caucasian %)	53.8%	50.0%	$\chi^2(4) = .89$	.926
BDI-II	25.59 (8.12)**	2.84 (3.00)**	$t(73) = 16.18$	<.001
BAI-total	23.18 (11.53)**	3.76 (4.92)**	$t(75)=9.56$	<.001
Participants with music listening for 5 days and above	84.6%	92.1%	$\chi^2(1) = 1.05$	.306
Average number of songs per day <sup>a</sup>	43.37 (34.01)	36.94 (19.90)	$t(66)=.96$	.341
Participants with repeated listening <sup>b</sup>	82.1%	73.7%	$\chi^2(1) = .78$	.376
Mode (Major mode %) <sup>b</sup>	60.3%	61.7%	$t(58)=-.59$	.559
BPM (tempo) <sup>b</sup>	113.26 (28.28)*	123.77 (26.90)*	$t(58)=-2.46$	.017

Note. BDI-II, Beck Depression Inventory-II; BAI, Beck Anxiety Inventory; <sup>a</sup>Among participants who heard songs more than 5 days over a week; <sup>b</sup>Of the songs reported by participants who had songs heard equal to or greater than 5 times; BPM, Beat Per Minute

Table 2. HLM results on happiness, sadness, and relaxedness change after hearing music

	<b>Estimate</b>	<b>Std. Error</b>	<b>df</b>	<b>t</b>	<b>p</b>
<b>DV = happiness</b>					
Intercept	4.527888	0.256480	75	17.654	<0.001
Group (=depression)	-1.456093	0.358274	75	-4.064	<0.001
Time (=after hearing music)	-0.064706	0.100039	75	-0.647	0.520
Time*Group	0.148573	0.120412	75	1.234	0.221
Sad song choice	-0.850997	0.175320	75	-4.854	<0.001
Sad song choice*Group	0.054067	0.233640	75	0.231	0.818
Time of day	0.004222	0.035214	76	0.120	0.905
Sad song choice*Time	-0.409724	0.120321	76	-3.405	0.001
<b>DV = sadness</b>					
Intercept	0.481779	0.175674	75	2.742	0.008
Group (= depression)	1.253108	0.245550	75	5.103	<0.001
Time (=after hearing music)	-0.033363	0.080191	75	-0.416	0.679
Time*Group	-0.002682	0.095992	75	-0.028	0.978
Sad song choice	0.359577	0.135994	75	2.644	0.010
Sad song choice*Group	0.405783	0.183376	75	2.213	0.030
Time of day	0.044000	0.028607	76	1.538	0.128
Sad song choice*Time	0.267786	0.097408	76	2.749	0.007
<b>DV = relaxedness</b>					
Intercept	4.211365	0.233214	75	18.058	<0.001
Group (=depression)	-0.792683	0.323737	75	-2.449	0.017
Time (=after hearing music)	0.020716	0.142977	75	0.145	0.885
Time*Group	0.103386	0.181867	75	0.568	0.571
Sad song choice	-0.383831	0.175825	75	-2.183	0.032
Sad song choice*Group	-0.189552	0.208269	75	-0.910	0.366
Time of day	0.012392	0.043296	76	0.286	0.775
Sad song choice*Time	0.620627	0.164078	76	3.783	<0.001

Note. depression, participants with depression

## CHAPTER SIX: FIGURES

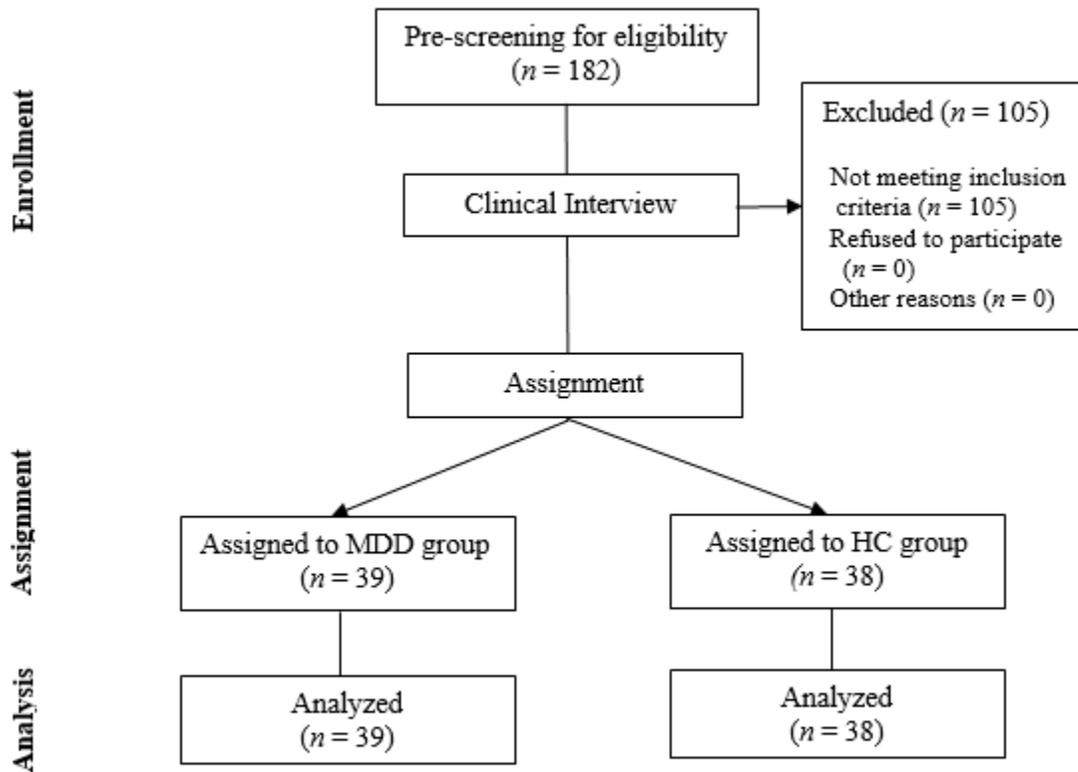
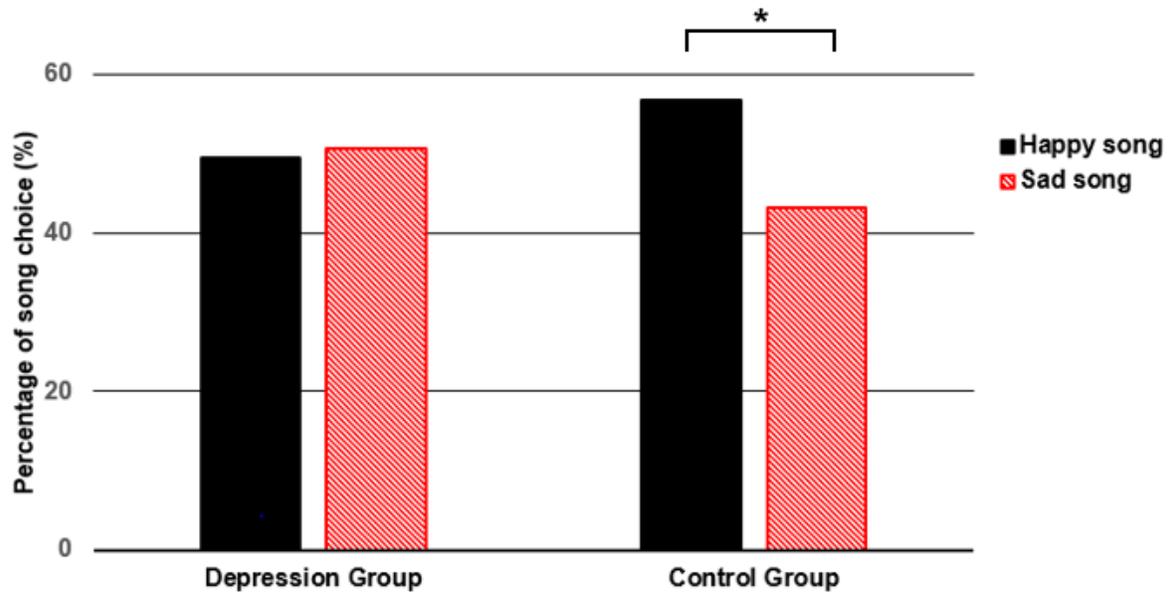


Figure 1. Flow chart of recruitment



Note. MDD, participants with depression; HC, non-depressed participants

Figure 2. The choice of happy and sad songs in the depression and non-depression groups

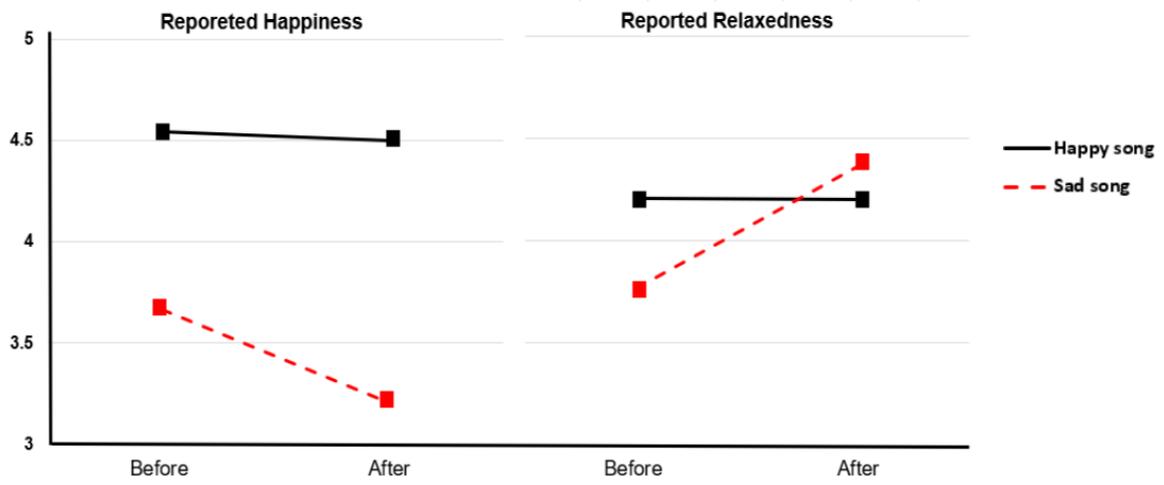
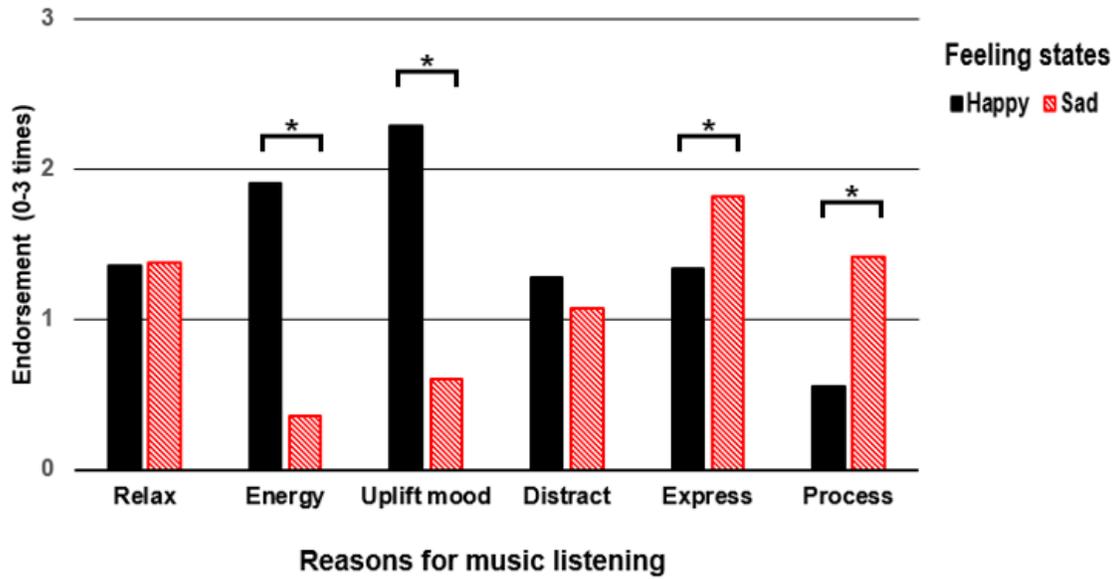


Figure 3. Happiness and Relaxedness change after listening to a sad/happy song across groups



Note. \*,  $p < .05$

Figure 4. Reasons to listen to music when feeling sad and happy across groups

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## **APPENDICES**

## Appendix A: Outline of Time 1 study protocol

1. Consent participant
2. Complete diagnostic interview with SCID I/ MINI
3. Self-report questionnaires (BDI, BAI)

**\*\*ONLY PARTICIPANTS THAT MEET CRITERIA FOR DEPRESSION GROUP OR NON-DEPERSSION GROUP AND NONE OF THE EXCLUSION CRITERIA COMPLETE THE FOLLOWING STEPS\*\***

4. Describe EMA study and practice sample surveys
5. (Install *Spotify* on a personal cell phone, if necessary) and connect *Last.fm* to *Spotify*. Describe how to use *Spotify*

## Appendix B: EMA study

**Hello! This is LAB[number] study!**

1. Please indicate how much you feel each emotion at the moment:

	None	Some	A lot						
	0	1	2	3	4	5	6	7	8
Joyful									
Sad									
Energetic									
Tired									
Relaxed									
Happy									
Downhearted									
Sluggish									
Lively									

2. Please listen carefully to the following 4 music excerpts [Listen to 4 music excerpts for 5 sec each]. You will hear an alphabet to choose at the end of the 4 songs. Only the response with the right answer will be valid. Please listen carefully. What is the alphabet you heard?
3. Which song do you want to listen in the full length?
4. [Listen to the song] Again, you will hear an alphabet to choose at the end of the song. Only the response with the right answer will be valid. Please listen carefully. What is the alphabet you heard?
5. Please indicate how much you feel each emotion now.

	None	Some	A lot						
	0	1	2	3	4	5	6	7	8
Joyful									
Sad									
Energetic									
Tired									
Relaxed									
Happy									
Downhearted									
Sluggish									
Lively									

## Appendix C: The reason survey

### Hello! This is LAB[number] study!

1. Please indicate three songs you wanted to hear when feeling happy over the past week.

1) Name of the first song

1-2) Please indicate how happy/ sad/ energetic the song is

	None	1	2	3	Some	4	5	6	7	A lot
Joyful										
Sad										
Energetic										
Tired										
Relaxed										
Happy										
Downhearted										
Sluggish										
Lively										

1-3) Please choose all the reasons why do you want to hear this song when feeling happy (multiple choices are allowed).

(1) to relax, (2) to get energy, (3) to lift my mood, (4) to distract myself from unwanted thoughts or feelings, (5) to express, experience or understand emotion in music, (6) to think or process thoughts, or (7) other\_\_\_\_\_.

[Same questions for two more songs and for three songs when feeling sad]

## Appendix D: Pilot study on musical stimuli

To test whether the 6 songs induce targeted emotions, two repeated measures ANOVAs were run where Emotion (2; happy, sad) and Songs (6; individual songs) were entered as within-subject variables and ratings were a DV, for songs and excerpts, respectively. The results showed a significant Emotion\*Songs interaction,  $F(5,120) = 67.87, p < .001$  for songs, and  $F(4.104, 98.502) = 63.63, p < .001$  for excerpts. The Bonferroni corrected comparisons showed that ratings of target emotion were significantly higher in the matching songs (e.g., happy songs sounded significantly happier than sad songs,  $ps < .05$ ) and excerpts ( $ps \leq .001$ ). A target emotion was rated higher than non-target emotion for all songs (e.g., happy songs had greater scores on happy than sad ratings,  $ps < .001$ ) and for all excerpts ( $ps < .05$ ). Mean and SDs of the included songs are presented in the below.

The final chosen songs were: the buffalo hunt (movie title = Dance with wolves, sound track no. = 10), the Growing montage (Big fish, 13), Oliver runs away (Oliver twist, 4) for happy songs; Farewell (Crouching Tiger, Hidden Dragon, 13), Preparing for patrol (Band of brothers, 15), Surrendering (Mother of mine, 16) for sad songs.

Affective ratings of songs used in the EMA study (mean, SD)

			Happy	Sad	Energy
Happy songs					
The buffalo hunt	no. 264	Full song	4.28 (2.26)	0.80 (1.12)	5.64 (1.35)
		Excerpt	5.88 (1.40)	0.32 (0.69)	5.44 (1.45)
Oliver runs away	no.205	Full song	5.68 (1.77)	0.48 (1.12)	5.32 (1.65)
		Excerpt	5.16 (1.91)	1.08 (1.53)	4.08 (1.61)
The Growing montage	no. 19	Full song	4.52 (1.61)	1.28 (1.34)	6.20 (1.63)
		Excerpt	4.80 (2.27)	0.32 (0.80)	6.32 (1.65)

Sad songs					
Preparing for patrol	no. 43	Full song	1.36 (1.19)	4.40 (2.45)	1.12 (1.62)
		Excerpt	1.20 (1.50)	4.68 (2.30)	1.08 (1.38)
Farewell	no. 210	Full song	1.64 (1.35)	4.12 (2.49)	2.68 (1.63)
		Excerpt	1.28 (1.31)	3.88 (2.40)	2.12 (2.13)
Surrendering	no. 279	Full song	0.88 (1.54)	5.56 (1.94)	1.92 (2.10)
		Excerpt	1.92 (1.71)	3.48 (2.16)	1.88 (1.92)

Note. No, song number in the Eerola and Vuoskoski (2011)'s data set

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<sup>i</sup> Additional information about the collected songs.

The most popular songs in the non-depression group were Youngblood (singer: 5 Seconds of Summer), God is a Woman (Ariana Grande), Nonstop (Drake), I Love It (& Lil Pump; Kanye West), Better Now (Post Malone), and SICKO MODE (Travis Scott). Each song was heard by 7 non-depressed participants at least once over the 7-day period. For the depression group, Thank U, Next (Ariana Grande) and Without Me (Halsey) were the most popular songs heard by 8 depressed participants at least once. The most popular album in the non-depression group was Scorpion (Drake- singer; 11 non-depressed participants heard at least one song from this album), followed by Sweetener (Ariana Grande; 10) and Youngblood (5 Seconds of Summer; 8). In the depression group, Thank U, Next (Ariana Grande; 12) was the most popular album, followed by Pray for the Wicked (Panic! At the Disco; 8), When We All Fall Asleep, Where Do We Go? (Billie Eilish; 8), ÷ and X (Ed Sheeran; 8 for both), and Without me (Halsey; 8).

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<sup>ii</sup> The results from an analysis on genre.

The information regarding genre was extracted from Organize Your Music online website where the tool provides sub-genre information about songs in Spotify (<http://organizeyourmusic.playlistmachinery.com/>) and from Google website for the songs not found in the above website. Using the sub-genre information, we re-categorized the sub-genres to parent genres of pop, rock, rhythm and blues (R&B), hip hop, and electronic dance music (EDM). Among 501 songs, we could not find accurate genre information about 36 songs. We sorted 465 songs. Fifty-three songs (e.g., religious, house and folk music) were not able to categorize into any of the above categories. For the depression group, the most popular genre was pop (i.e., 83%, the percentage of participants who heard the genre at least once), followed by hip hop (40%), R&B (37%) and Rock (27%). For the non-depression group, pop was most popular as well (64%), followed by hip hop (46%), R&B and Rock (18%<sup>s</sup>, respectively). No significant group difference was found in the genre of songs,  $\chi^2(5) = 2.13, p = .712$ .



RESEARCH INTEGRITY AND COMPLIANCE  
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6/21/2018

Sunkyung Yoon  
Psychology  
10511 plantation bay drive  
Tampa, FL 33647

RE: **Expedited Approval for Initial Review**  
IRB#: Pro00035707  
Title: DAILY MUSIC LISTENING IN DEPRESSION

**Study Approval Period: 6/20/2018 to 6/20/2019**

Dear Mr. Yoon:

On 6/20/2018, the Institutional Review Board (IRB) reviewed and **APPROVED** the above application and all documents contained within, including those outlined below.

**Approved Item(s):**

**Protocol Document(s):**

[IRB protocol V1.05.20.18 musiclistening.docx](#)

**Consent/Assent Document(s)\*:**

[IC\\_V1.05.20.18.Musiclistening.docx.pdf](#)

\*Please use only the official IRB stamped informed consent/assent document(s) found under the "Attachments" tab. Please note, these consent/assent documents are valid until the consent document is amended and approved.

It was the determination of the IRB that your study qualified for expedited review which includes activities that (1) present no more than minimal risk to human subjects, and (2) involve only procedures listed in one or more of the categories outlined below. The IRB may review research through the expedited review procedure authorized by 45CFR46.110 and 21 CFR 56.110. The research proposed in this study is categorized under the following expedited review category:

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

As the principal investigator of this study, it is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB. Any changes to the approved research must be submitted to the IRB for review and approval via an amendment. Additionally, all unanticipated problems must be reported to the USF IRB within five (5) business days.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely,

A handwritten signature in black ink, appearing to read 'Kristen Salomon', followed by a horizontal line.

Kristen Salomon, Ph.D., Vice Chairperson  
USF Institutional Review Board