Are music listening strategies associated with reduced food consumption following negative mood inductions; a series of three exploratory experimental studies

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Abstract

Emotions play an important role in overeating, yet there is little research looking at practical strategies to reduce overeating in response to a negative mood. In three different experimental studies, we tested if exposure to music can reduce food consumption in a negative mood. Female undergraduates (*N*= 120-121 in each study) completed a measure of emotional eating and reported baseline hunger. Mood ratings were taken at baseline, post-mood induction and post-eating. All participants were given a mood induction (sadness for study 1, stress for studies 2 and 3) and allocated to one of three music conditions (self-chosen in study 3) or a silent (control) condition. Music was selected from three pieces reported by each participant as being listened to regularly when experiencing the negative mood being examined (sadness or stress) in order to provide solace (comforting music), diversion (distracting positive music), or discharge (angry and/or sad music). Participants were provided with several snack foods to consume whilst completing a mock taste test and intake (in grams) was compared between conditions. In study 1 participants in the music for discharge condition consumed less than those in the control condition. Moreover, participants with high levels of self-reported EE ate more crisps in the control than in the distraction condition. In study 2 participants in the solace condition consumed less than those in the control and discharge conditions. In study 3 most participants chose music for diversion; this did not, however, lead to lower consumption, despite a reduction in reported stress. Overall, the results of these studies indicate that listening to certain types of music might reduce emotion-related eating after controlling for hunger using a standardized pre-session snack.

1. Introduction

According to the World Health Organisation (2021), in 2016 globally 1.9 billion (39%) adults, aged eighteen years or older met the Body Mass Index (BMI) criteria to be classified as being overweight, and a further 650 million (13%) were classified as obese. The determinants of obesity are complex and involve a number of epigenetic, behavioural and environmental factors (Dixon, 2010). Yet it is generally argued that the basic contribution to the obesity epidemic is an excess of energy intake over expenditure, or an increased amount of food eaten (Young & Nestle, 2002) which can be defined as 'overeating' (Gibson, 2006; Van Strien et al., 2013).

Overeating of highly palatable (high in fat, sugar and salt, and low in nutritional value) snack foods such as chocolate, crisps and biscuits is common in individuals in heightened emotional states (Bennett et al,, 2013; Evers, et al., 2018; Greeno & Wing, 1994; Nguyen-Rodriguezet al., 2008). Highly palatable foods are often referred to as comfort foods, implying that they have an emotion regulation function (Evers, et al., 2010). The tendency to overeat in response to negative emotions, such as stress, sadness, boredom, anxiety or irritability, has been defined as Emotional Eating (EE) and has been shown to exist along a continuum of severity (Van Strien et al., 1986; 2007). A recent meta-analysis indicated that over-eating can be observed as the result of both positive and negative emotional states (Evers, et al., 2018), and also depends on individual characteristics; for example compared with unrestrained eaters, self-reported restrained eaters consume more under negative emotional states (Polivy, et al., 2010). There are several theories of why individuals eat in response to negative affect with proposed mechanisms including escaping aversive negative self-awareness caused by negative affect (Heatherton & Baumeister, 1991), and increasing positive emotions in those who enjoy the sensory experience of eating (Lutter & Nestler, 2009). At the centre of all theories is the tenet that when confronted with a negative emotion that cannot be regulated, food can be used as an emotion regulation tool (Evers et al., 2010). The problem with using food to regulate affect is that, though it is successful in the short term at improving affect (Macht & Mueller, 2007), regular habitual use of food to regulate emotions can lead to overeating and weight gain.

Emotional eating is also regarded as a maladaptive strategy to regulate affect, as it does not address the reason behind the negative emotions, leading to the potential for a vicious circle of repeated episodes (Spoor, et al., 2007). As it is not so much the emotional state itself, but how that state is dealt with (Evers, Stok, & De Ridder, 2010) it may be

beneficial for those engaging in EE to learn alternative approaches to relieve their negative moods. It has, for example, been found that those who report a larger variety of strategies for coping with adversities have better mental health (Cheng, Lau, & Chan, 2014; Van den Tol, et al., 2016). Moreover, Thayer, Newman and McClain (1994), found that out of a number of affect regulation behaviours, eating was the least successful strategy for changing a bad mood. In contrast, they found that participants, especially younger adults, consistently viewed listening to music as a positive strategy to improve negative mood. In the current research, we therefore propose to study the effectiveness of music listening to reduce women's eating as a response to induced negative emotion.

The use of music is a common, conscious and unconscious method of regulating negative affect (Randall & Rickard, 2016; Thomson, et al. 2014; Van Goethem & Sloboda, 2011; Saarikallio & Erkkilä, 2007; Slobodaet al., 2009; Van den Tol, 2016). Neuroimaging studies show activation of emotion, reward, motivation, and arousal networks during music listening (Blood & Zatorre, 2001; Mas-Herrero, et al., 2012; Salimpoor, et al., 2011). Moreover, the results of several experimental studies in which participants were subjected to a stress induction found that listening to liked and self-selected music can decrease state anxiety, improve a negative mood, and reduce stress and sadness (Baste, & Gadkari, 2014; Getz, et al., 2014; Hanser, et al., 2016; Labbé, Schmidt, et al, 2007; Radstaak, et al, 2014). Research on the use of sad music when feeling sad additionally reports that listening to sad music can have benefits such as working through negative emotions, experiencing solace, relaxation, distraction, and acceptance of negative emotions (Van den Tol, 2016).

Recent research (Van den Tol, et al, 2020; Van den Tol, et al., 2019) investigated the association between the use of different music listening strategies, EE and symptoms of stress, anxiety and depression and has proposed a potential role for music in reducing EE. This research indicates that the use of music for discharge (i.e., for releasing anger or sadness, venting, similar to 'blowing off steam', through angry and/or sad sounding music) is associated with higher EE. Among those participants with low scores on measures of depression and stress, positive associations were found for EE with diversion, entertainment, and with mental work (working through problems). These associations suggest that EE and music may be used for relatively similar emotional purposes. No research to date has examined how the regulation strategies of music and eating may influence each other, which requires an experimental design.

The current research

Despite the existence of ample experimental studies on eating after a mood induction (for a review see Evers, et al., 2018), this was the first series of experiments to test the effect of music in reducing food intake after a mood induction. The main aim of the study was to adapt the design of traditional laboratory emotion induction experiments to test whether listening to music that the participants have identified they commonly use to regulate emotions, can change eating behaviour in the laboratory.

Music listening does not serve a homogenous emotion regulation function. In the Methods of Self-directed Emotion Regulation through Music Theory (Saarikallio, 2008), music listening behaviours have been categorised into seven areas. The three music listening strategies studied here are those typically used as responses to negative affect: diversion (using music to be distracted from negative thoughts and forgetting the current mood), discharge (using sad and angry music to express and feel feeling of sadness and anger) and solace (using music to feel comforted from negative emotions). Although research has found associations between music listening strategies and reported eating behaviour, the mechanisms of these relationships are still unclear (Van den Tol et al., 2020; Van den Tol et al, 2019). Therefore, this research also aimed to examine whether self-selected music selected for a specific music listening strategies (in particular, solace, diversion or discharge) affected food consumption when compared to a control condition. We perceived this focus on self-selected music to be particularly important, due to the greater emotional and positive impact of self-selected music over experimenter selected music (see for example Krause & North, 2017).

As this aspect of the research was exploratory, we did not form specific hypotheses relating to different music listening strategies. Therefore, the main experimental hypothesis was, *'Within a laboratory environment, listening to self-selected music that is habitually used to cope with negative emotions (vs. no music) will reduce eating of palatable snacks following a negative emotion induction procedure'.* An additional aim of this research is to explore whether there would be differences in snack food consumption across the conditions according to self-reported EE. .

Three between subject experimental laboratory studies were designed to test the main hypothesis (please see flow chart below for the experimental procedure across all three studies).

Baseline measures (at least 24 hours prior to data collection) gathered online:

1. Age and emotional eating (study 1 - 3) and music choices for solace, discharge and diversion (study 1- 3) restrained and external eating (study 2 and 3).

2. Instructions to fast for two hours before part 1 (study 3).

Part 1 (Minutes 0-30 minutes) in the lab:

1. Milkshake given (study 1), cheese sandwich given (study 2 and 3).

2. Measures of hunger and emotion (sadness study 1, stress study 2 and 3).

3. Emotion induction (sadness study 1, autobiographical event memory; stress study 2 and 3, unsolvable timed anagram task).

4. 2nd measures of emotion (sadness study 1, stress study 2 and 3).

Part 2 (minutes 30-35) in the lab: Participants are randomly allocated to a condition and will listen to music or sit in silence.

Study 1 and 2: Randomisation into 4 groups (solace, discharge, diversion or silence/ control). *Study 3*: Randomisation into 2 groups (self- selected music or control/ silence)

Part 3 (Minutes 35-50) in the lab: Measure of food consumption

1. 3rd measure of emotion (study 2 and 3)
2. Bogus taste test (study 1-3)
3. Measure of weight and height (study 2 and 3)
4. Manipulation check and mood repair music (study 1-3)

2. Study 1 (Sadness induction)

The aim of study 1 was to explore the effect of music (three different music regulating strategies vs. no music) on eating following induced sadness.

2.1. Method

2.1.1. Participants

One-hundred-and-twenty female undergraduate Psychology students from the **** University (anonymised for review) in the UK participated in return for course credits. Prior to participation, they declared that they were able to eat the experimental foods with no ill effects (no allergies or diets that excluded dairy). Only females were recruited for all three studies, as research suggests that women are more likely than men to engage in EE (Grunberg & Straub, 1992). The average age was 20.71, (*SD* = 4.05, ranging from 18 to 41) years old. The participants self-identified their ethnic origin as white-British (40; 33%), African/British-African (21; 17.5%), Asian/British Asian (22; 18.33), white-European (3; 2.5%), Arabic (3; 2.5%), Mixed ethnicity (18; 15%) and 12 (10%) people decided not to answer the question.

2.1.2. Design

A between participants design was adopted, with one independent variable: the type of music played during the experiment (discharge, diversion, or solace) or sitting in silence (control). The main dependent variables were the weight (in grams) of three snack foods (biscuits, crisps, and chocolate). These were analysed separately, and as total amount consumed.

2.1.3. Materials

2.1.3.1. Emotional Eating

Participants completed the EE sub-scale of the English version (Wardle, 1987) of the Dutch Eating Behaviour Questionnaire (DEBQ; Van Strien et al., 1986). This includes 13 items (*e.g. Do you have a desire to eat when you are feeling lonely?),* each rated on a 5-point Likert scale from 1 (*Never*) to 5 (*Very Often*), with a higher score indicating greater reported EE. Reliability analysis indicated that Cronbach's alpha in the current sample for EE (α=.88) was good (*N*=118, *M*=3.21, *SD*= .83).

2.1.3.2. Hunger and Sadness ratings

Visual Analog Scales (VAS; Gross & Levenson, 1997) were used to measure hunger and sadness. The instructions stated; '*Please mark an X on the horizontal line to indicate your response to the question*' followed by either '*How sad do you feel'* or '*How hungry do you feel*'. This was indicated on a ten-centimetre-long line with '*I am not sad/hungry at all*' (left) and '*I am very sad/hungry*' (right) at the end of the scale. Measurement was taken with a ruler to 2 decimal places from 0-10, where 10 represents a high score on the variable.

Hunger was measured at baseline (right after receiving the milkshake, but before the sadness induction) but at no other time. Sadness was measured at baseline (time 1) and right after the sadness induction (time 2; please see flowchart for more information about the timeline of all measurements and Table 1 for descriptive statistics).

2.1.3.3. Sadness induction

Participants were asked to think back to a sad event and describe this in enough detail so a stranger could understand it (based on Evers et al., 2010). The exact wording of these instructions was: *'I would like you to recall a recent and personally relevant sad event. It must be an event which still evokes sadness when it is brought to mind. Write down how you feel on this piece of paper. Verbalise freely as if you are talking to a friend. Keep writing until you feel as though you are re-experiencing the sad event again. Once you have completed this, it will be confidentially destroyed*.' As indicated in the results section below (2.2.1) the sadness manipulation was successful in our study.

2.1.3.4. Music selection procedure

Prior to the experiment participants were asked to provide details of pieces of music according to the following instructions:

1. Diversion "*Please tell me what piece of music you would ordinarily choose to listen to in order to distract you from a negative mood*",
2. Discharge "*Please tell me what piece of music you would ordinarily choose to listen to in order to express your negative mood*"
3. Solace "*Please tell me what piece of music you would ordinarily choose to listen to in order to feel solace and consolidation when you are not feeling well*"

Our approach here was novel but grounded in theory. Research has shown music listening to often be reported as the most important (Greenwood & Long, 2009) or second most important strategy (Van Goethem & Sloboda, 2011) for regulating moods (1st or 2nd

depending on the situation). While many studies (e. g. Hakanen, 1995; Hanser, et al., 2016; Knobloch & Zillmann, 2002; Thoma, Ryf, et al., 2012) have reported that musical features are important elements for people to consider when taking care of their emotional needs with the use of music. As expected, each participant came up with three different songs. Moreover, none of the participants communicated a problem with the task to the researchers or research assistants.

2.1.3.5. Food liking and consumption

Three experimental foods were used in study 1: chocolate (Cadbury's giant milk chocolate buttons - 212.0 calories in 40g); crisps (Burt's vintage cheddar and spring onion potato chips - 207.6 calories in 40g); and cookies (McVitie's mini chocolate-chip cookies - 196.8 calories in 40g). A Salter 1036 electronic platform scale (1-gram increments) was used to weigh the portions of 40 grams before and after each participant session. In addition, liking of each of the foods e.g. '*How much do you normally like these particular crisps?*', was measured on a five-point Likert scale from 1 (really dislikes) to 5 (really likes).

2.1.4 Procedure

A between subject experimental laboratory study was designed to test the main hypothesis (please note that the experimental method outlined in study 1 was replicated in studies 2 and 3 with some minor adjustment. See flow-chart for experimental procedure across all three studies). The studies were approved by a UK University Ethics Committee, which adheres to the British Psychological Society Code of Human Research Ethics (2014) and Code of Ethics and Conduct (2018). All participants were recruited into a study entitled *'The effect of music on taste'* to disguise the true purpose of the study and reduce the likelihood of demand characteristics. The complete experiment took approximately 30 minutes.

Prior to the experiment, participants completed a measure of EE and reported their music preferences.[1] To ensure that participants had similar levels of hunger prior to the

[1] An awareness of a studies focus on measuring food intake has found to reduce food intake in the lab and it is therefore sometimes recommended to distract participants from this focus (Robinson, et al., 2018). In study 1 and 2 we therefore did not let participants fast before coming to the lab and measured hunger only once (at baseline). However, as some researchers have noted (Best et al., 218) fasting before a food study also has benefits in terms of standardising hunger. We hence asked participants in Study 3 to fast for the two hours prior to coming to our lab.

negative mood induction, they drank a 200 ml chocolate or strawberry flavoured milkshake from the brand Yazoo (chocolate 65kcal/100ml, strawberry 60kcal/100ml). They were then asked to rate how hungry and how sad they were on a VAS before and after the sadness induction task. Participants were allocated to one of three types of music they normally liked to listen to when in a sad mood (discharge, solace, or diversion) or to a silent control condition (in study three, participants selected their preferred music condition). To achieve this, the experimenter used their participant number (for example, in studies 1 and 2 participant number 1 would be in the same condition as numbers 5 and 9).

The music was accessed through Spotify and played through Sennheiser HD205 MKII headphones with the volume of the computer set to 40%. The screens of the computer were turned to the side for all participants in this study (including the control). They listened to the music for three minutes. For the control condition, all participants were asked to sit in silence for three minutes. Participants were then presented with foods (crisps, chocolate and cookies) on three separate plates, and asked to take part in a taste test, a method commonly used to disguise the true purpose of a food consumption study (Lowe & Maycock, 1988). They were first asked to rate how much they normally liked each food. The instructions of the test then stated: '*Please rate these foods for the following characteristics from 0 (doesn't have this characteristic at all) to 10 (has this characteristic strongly)'* (saltiness, bitterness, sweetness, sourness, crunchiness, smoothness, and crumbliness). Finally, participants were asked if they had guessed the real aim of the study (no one had) and were then fully debriefed. They were also encouraged to listen to a self-selected happy and carefree song to counteract any negative mood effects before leaving.

2.1.5. Data analyses

Data analyses were completed using IBM SPSS 22. First, preliminary analyses were conducted to examine the differences between the conditions in terms of age, ethnic group, hunger, self-reported EE and levels of sadness at time 1 and 2 and the relationship that these variables had with the amount of food eaten. These analyses included a series of one-way between subject ANOVAs, one chi-square analysis and correlations. Results showed a significant difference for age only (also see Table 1), so this was entered as a covariate into the main analyses. Hunger was also entered as a covariate as this was the only variable that was associated with the total amount of food consumed ($p<.05$). None of the other

correlational analyses or ANOVAs yielded a significant effect. There was no difference in the distribution of different ethnic groups across the four conditions, χ^2 (18, *N*=121)= 26.16, *p*=.10 either. Hence none of these were entered in the analyses as a co-variate.

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For the main analyses, a series of one way between participant ANCOVA, controlling for age and hunger were carried out to look at differences in food consumption in grams (total, chocolate, crisps and cookies) between the four conditions (music for a) solace, b) discharge c) diversion or silence). LSD pairwise post hoc tests were used to examine differences between the different levels of the independent variable (music condition).

To explore if EE influenced intake across conditions, a series of 12 moderated regressions analyses were conducted using Process Model 1 (Hayes, 2013). The independent variable in these analyses compared either the control vs. discharge group, the control vs. distraction group, or the control vs. solace group. The EE score served as the moderator variable and each analysis was controlled for age and hunger. Either the variables that measured the amount of chocolate, crisps, cookies or the total amount of foods eaten (in gram) were the dependent variable. When significant, the interaction was further tested, with the EE scores set to +/− 1 SD from the mean.

2.2. Results

2.2.1. Sadness manipulation

To test if the sadness manipulation was successful, rated sadness was compared between pre- and post-manipulation. A repeated measures ANOVA revealed that sadness was significantly higher after the sadness induction than before (*M*-t1=1.88, *SD*-t1=1.99; *M*-t2=4.99, *SD*-t2=2.25, $F(1, 119) = 174.78$, $p<.001$, Wilk's $\Lambda = .41$, $\eta_p^2=.60$ which was a large effect size), meaning that the sadness manipulation was successful.

2.1.2. Differences in food consumption according to music condition

Four between-subject ANCOVAs were carried out to examine whether there were any differences in consumption of foods (chocolate, crisps, cookies, and total food eaten) between groups (discharge, diversion, solace, or control condition) with age and hunger entered as covariates. Out of these four ANCOVAs three reached a significant main effect (see Table 2). This supported the hypothesis that listening to self-selected music that is habitually used to

cope with negative emotions (vs. no music) will reduce eating of palatable snacks following a negative emotion induction procedure regarding chocolate, crisps and the total amount of food consumed. The ANCOVA for cookies did not yield a significant main effect, meaning that the hypothesis was not supported in terms of the weight of cookies eaten in grams.

INSERT TABLE 2 HERE

When chocolate eaten (g) was the dependent variable, the control (no music) group consumed more than the discharge group (p = .005). The discharge group also consumed less (p = .044) than the diversion group. No other comparisons approached significance (ps > .16). When crisps eaten (g) was the dependent variable, the control group ate more than the discharge group (p= .004) and the solace group (p= .018). The experimental groups did not appear to differ among each other (ps > .32). When total amount of food consumed was the dependent variable, the control group ate significantly more than the discharge group (p = .001) and solace group (p = .03). The experimental groups did not appear to differ among each other (ps > .10).

2.1.3. *Differences in food consumption according to music condition and self-reported emotional eating levels*

Out of the 12 analyses tested to explore if there were any significant interaction effects, one was significant. As can be seen in Table 3 this was the analysis that compared the control vs. distraction group (IV) at high and low levels of self-reported EE (MOD) for the amount of crisps eaten (DV) while controlling for age and hunger. Posthoc analyses revealed that at high (+1 SD) levels of the EE score there was a significant effect but not at low (−1 SD) levels. In particular, high levels of EE showed a difference between conditions in terms of the amount of crisps eaten, where people in the control condition ate more than in the distraction condition.

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2.3 Discussion study 1

Study 1 tested whether listening to music can reduce eating after controlling for hunger relative to a silent control condition following a sadness induction. There was a

significant difference between conditions in the total weight eaten, as well as for chocolate and crisps, but not for cookies. The solace and discharge groups consumed significantly less crisps and total weight of food compared with the control group, whilst the discharge group ate significantly less chocolate than the control.

In addition to the above findings, there appeared to be a general tendency for participants in the discharge condition to eat the least and the diversion group to eat the most of all music groups. Whilst this finding was only significant for chocolate eaten, the same trend was seen for crisps, biscuits and total amount of food eaten. Which, given that discharge is used to intensify feelings of sadness and anger (Saarikallio, 2008), begs the question why this would be effective in terms of lowering the urge to overeat? Unfortunately, one limitation of this study was that participants' levels of sadness was not measured after they had finished music listening. This information might have helped us understand if patterns of eating could have been explained in terms of participants' moods having been affected differently in each condition. Follow up studies should hence measure mood after music listening.

Moreover, when the control group was compared to the distraction group, participants ate higher amounts of crisps at high levels of self-reported EE than at low levels of self-reported EE (when controlling for hunger and age). With the later effect suggesting a role for EE at trait level in terms of the effectiveness of music in reducing food intake after a sadness manipulation.

Another potential explanation for the differences across conditions could have been that participants showed different patterns of eating due to individual differences across groups in terms of other eating behaviours (beyond self-reported EE). A review on experimental research on EE has found a link between actual EE behaviour and self-reported restrained eating (Evers, Dingemans, Junhans, & Boevé, 2018). Moreover, eating is also found to a greater extent in people with higher BMI levels, and reductions of eating during negative emotions have been found more commonly in people with lower BMI levels (Polivy & Herman, 2020; Geleibter & Aversa, 2003; Whiteside, Chen, Neighbors, Hunter, Lo, & Larimer, 2007). Follow up studies should also gather information about these personal differences in order to control for these across conditions.

Moreover, as EE is not only the result of sadness but can also result from many other emotions, follow up research should examine different emotion inductions. A final limitation was that the choice of three foods restricted the amount of preferred foods available for some participants; therefore, we decided to increase the number of experimental foods.

3. Study 2 (Stress induction)

The aim of study 2 was to explore the effect of different types of music regulation on eating in the absence of hunger, following a stress induction (rather than sadness). This study again included pre-identified, self-selected music in the categories of solace, discharge, and diversion.

We also attempted to address several of the limitations of study 1. To increase internal validity of the data, participants in this study were asked to complete the entire DEBQ (emotional, external, and restrained eating), and their height and weight were measured in order to calculate BMI. This would allow us to control for any potential differences across conditions with regard to these variables. Moreover, to ensure provision of preferred foods for all participants, we increased the foods to six (rather than three) in the bogus taste test.

3.1. Method

3.1.1. Participants

The sample comprised 120 female participants (30 in each condition), who were undergraduate Psychology students from a UK University (anonymised for review) who participated in return for course-credits. All participants indicated their willingness and ability to eat the experimental foods with no anticipated ill effects. The average sample age was 21.35, (*SD* = 5.83, ranging from 18 to 49) years old, with a mean BMI of 24.38 kg/m^2 (*SD*=5.48, ranging from 16.37 to 40.65). The participants self-identified their ethnic origin as white-British (48; 40%), African/British-African (26; 21.67%), Asian/British Asian (13; 10.83%), white-European (8; 6.67%) and Arabic/British Arabic (4; 3.33%), Mixed ethnicity (5; 4.17) and 16 (13.33) people decided not to answer the question.

3.1.2. Design

A between participants design was adopted, with one independent variable: the type of music played (discharge, diversion, or solace) or sitting in silence (control) and several dependent variables, which was the total weight and individual weights in grams of six foods (cheese savouries, crisps, chocolate, cookies, fruit jellies and popcorn) eaten during the taste test.

3.1.3. Procedure and Materials

The procedure and materials were identical to study 1, except for the following changes.

3.1.3.1. The Dutch Eating Behaviour Questionnaire

The English version (Wardle, 1987) of the Dutch Eating Behaviour Questionnaire (DEBQ; Van Strien et al., 1986) was completed by participants to measure restrained, EE, and external eating (This entire scale includes 33 items (α=.93) which are rated from 1 (*Never*) to 5 (*Very Often*). All three subscales showed good internal consistency: EE (13 items, α=.93, *e.g. Do you have a desire to eat when you are feeling lonely*); restricted eating (10 items, α=.91, e.g. *If you have put on weight, do you eat less than you usually do?*); external eating (10 items, α=.90, e.g. *If food smells good and looks good, do you eat more than you usually do?*).

3.1.3.2. Food prior to the study

Upon arriving in the lab, all participants consumed a cheese sandwich in the waiting room (Cathedral City Cheddar Slice, 83 Kcal; Warburtons wholemeal roll, 130 Kcal; butter portion 74 Kcal; total 277 Kcal).

3.1.3.3. Hunger and Stress ratings.

Participants rated how hungry and stressed they were using an adapted version of the Visual Analog Scales (VAS; Gross & Levenson, 1997) used in study one, with the word *sad* replaced by the word *stressed* (see Table 4 for descriptive statistics).

Hunger was measured at baseline (after the milkshake and pre-stress induction), and stress was measured at baseline (time 1), after the stress induction (time 2), and after listening to the music or sitting in silence (time 3). A stress change score was created for the difference between stress at time 2 and time 3. This was found important as finding a difference could potentially point towards different results across conditions for amount of food eaten being mediated by a stress reduction.

3.1.3.4. Stress induction

Participants were asked to solve several anagrams in a limited time (Aspinwall, & Richter, 1999) as a stress induction. The five minute test contained 18 five letter anagrams with twelve of them being solvable (e.g. trypa (party) ijnot (joint) tlanp (plant)) and six not

being solvable (e.g. oneci, amoos or acelo). As indicated in the result sections of both study 2 (3.2.1.) and 3 (4.4.2) and as has been found before in previous research (Zellner et al., 2006, 2007) the stress induction was successful.

3.1.3.5. Music exposure

As in study 1, participants were allocated to listen to one of their three previously identified songs or sit in silence for three minutes..

3.1.3.6. Bogus Taste Test

As in study 1, participants took part in a bogus taste test (Lowe & Maycock, 1988) during which they rated the characteristics of the following foods: cheese savouries (Crawfords cheese savouries, 210 KCal in 40g), chocolate (Milky Way Magic Stars, 223.6 KCal in 40g), cookies (Maryland mini chocolate-chip cookies, 199.6 KCal in 40g), Crisps (Walkers ready salted, 132 KCal in 40 g), fruit jellies (Pimlico Fizzy Fruit Flavoured Jellies, 128 Kcal in 40g) and

popcorn (Butterkist Cinema Sweet Popcorn, 210.4 KCal in 40g).

3.1.3.7. BMI

Weight and height were measured in the laboratory at the end of the study (wearing clothes but with shoes removed) to calculate participant BMI (kg/m^2**).**

3.1.4. Data analyses

First, a within participants ANOVA (all conditions collapsed) was used to check whether the stress ratings indeed changed after the stress induction, comparing time 1 to time 2.

Next, to test if we needed to control for any variables in the main analysis, a series of between-subject-ANOVA were carried out followed by a chi-square analysis and a series of correlational analyses. These analyses tested the differences between the conditions in terms of age, EE, hunger, nationality and levels of stress at time 1, 2 and 3 and the relationship that variables had with the amount of food eaten. There was no difference in the distribution of different ethnic groups across the four conditions, χ^2 (18, N=120)= 11.05, p=.89. None of the variables indicated a significant difference between the four conditions (see Table 4). Correlational analyses indicated that only hunger was associated with the total amount of food consumed (r=.22, p=.02, N=120) but none of the other variables did. As hunger was the

only significant variable in these analyses, it was the only covariate entered in the main analyses.

INSERT TABLE 4 HERE

For the main analysis, a series of one way between participant ANCOVA, controlling for hunger, were carried out to examine differences between the four conditions in terms of food consumption in grams (total, cheese savouries, chocolate, crisps cookies, fruit jellies and popcorn).

In order to explore if EE predicted intake, a series of 12 moderated regression analyses were conducted using Process Model 1 (Hayes, 2013), with the independent variable and moderator variables set as in study 1. The seven variables that measured the amount of each food eaten (this including the total amount) were entered as a dependent variable and each of analysis was controlled for hunger. When significant, the interaction was further tested, with the DEBQ scores set to +/− 1 SD from the mean.

After the main analysis we additionally explored if there was a difference in stress reduction between conditions using a one way between participant ANCOVA (this regarded a variable that represented the difference in stress between time 2 and 3). LSD pairwise post hoc tests were used to examine any differences between the different levels of the independent variable (music condition).

3.2. Results

3.2.1. Stress manipulation

The stress manipulation was successful, as stress was higher after the stress induction than before (*M*-t1=3.86, *SD*-t1=2.89, *M*-t2=5.27, *SD*-t1=2.53, $F(1, 119) = 65.17$, $p<.001$, $\eta_p^2=.35$).

3.2.2. Food intake

Seven between-subject analyses of covariance (ANCOVA) were carried out to examine whether there were any differences in consumption of food between conditions after controlling for hunger. Three analyses were significant: chocolate, popcorn, and total amount of food consumed (see table 5).

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Pairwise LSD tests indicated that participants in the control group ate significantly more chocolate (p =.001) and popcorn (p = .001) than those in the solace group. There was a small but significant main effect of total amount consumed, with pairwise LSD tests indicating that the control group ate significantly more than the solace group.

3.2.3. *Differences in food intake for participants with high and low level self-reported emotional eating levels*

12 moderated regression analyses were carried out to investigate self-reported EE would affect food-intake across conditions. As can be seen in table 6 none of the analyses yielded a significant effect.

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3.2.3. *Stress reduction after music listening*

It was explored if the conditions in this experiment led to differences in the change in stress at time 2 and time 3 using the stress change score (pre and post music listening). There was no main effect of stress between the four conditions ($F(3, 116) = 7.58$, $p<.12$, $\eta_p^2=.05$). [2]

3.3. Discussion study 2

Study 2 experimentally tested whether listening to music can reduce eating in the absence of hunger relative to a silent control condition following a stress induction. The results supported this idea for chocolate, popcorn and for the total amount of food eaten. These findings are in line with those of study 1. The results also indicated that the manipulation was successful in increasing stress. Moreover, self-reported EE, did not seem to moderate the eating across conditions.

Despite this study replicating the effect that music can be beneficial, but with a different emotion than in study 1, it further outlined the complexity of the use of music in

[2] Despite the results being non-significant we did run further post-hoc comparisons for the main analyses comparing conditions (out of curiosity). These (LSD) showed a marginally significant difference (p=0.06) between the solace (M=-2.55, SD =1.69) and the control condition (M=-1.62, SD =1.95). This pattern of stress reduction was in line with our predictions.

such research. Solace was the most effective music condition in reducing eating compared with the control condition.

A limitation which applies to the design of both studies conducted so far, is that we can only interpret these findings as the results of being 'exposed' to certain types of music commonly used to facilitate certain self-regulatory needs with the use of music. Music listening in real life, is not always the result of exposure, but in a large amount of music listening cases people play a conscious role in their selection of the music. Such music selection is often consciously aimed at regulate affective states (Van Goethem & Sloboda, 2011). To address this limitation, it would be important to study participants 'voluntary' exposure to one of three commonly used music strategy choices when feeling stressed.

4. Study 3

The aim of study 3 was to explore whether self-selection of the music condition following a stress induction, would lead to lower food consumption compared with a control (no music) condition. This study again looked at pre-identified, self-selected music in the categories of solace, discharge, and diversion. Yet, rather than assigning participants to a music condition using the same allocation method as in study 1 and 2, this time they could choose which one of the three earlier indicated pieces of music they preferred to listen to (also see flow chart for the experimental procedure). This was expected to closer resemble emotion regulation in everyday life and provide greater insight into how people consciously use music to regulate their emotions, whilst allowing the assessment of how beneficial this strategy is for regulating one's emotions. Moreover, participants were asked to fast for two hours before coming to the lab in order to standardise hunger (Best et al., 218).

F;l Consistent with studies 1 and 2 we hypothesised that music would lower amount consumed after a negative mood induction relative to the control (silent) condition. Given the previous finding that diversion is the most common music selection strategy in general (Chin & Rickard, 2013), we also hypothesised that '*among all 3 possibly selected music categories, diversion would be the most often selected'*.

4.1 Method

4.1.1.Participants

The sample comprised 121 female participants (with 69 in the music condition and 52 in the control) who were undergraduate Psychology students from a UK University (anonymised for review) who participated in return for course-credits. All participants indicated that they were able and willing to eat the experimental foods with no anticipated ill effects. The mean age was 20.37, (*SD* = 4.17, ranging from 18 to 45) years old, with a mean BMI of 24.89 kg/m^2 (*SD*=6.48, ranging from 15.22 to 55.63). The participants self-identified their ethnic origin as white-British (46; 38 %), African/British-African (30; 24.80%), Asian/British Asian (8; 6.6%), white-European (10; 8.3%) and Hispanic (3; 2.5%), Mixed ethnicity (2; 1.7%) and 22 (18.2%) people decided not to answer the question.

4.1.2. Design

A between participants design was adopted. In all analyses, there was one independent variable. For half of the analysis this was the presence of music vs. control, and for the other half this was diversion (the most selected music) vs. control. The dependent variables were the weight (g) of each of the six foods consumed, and the total weight of food eaten.*4.1.3. Procedure and materials*

Study three was almost identical to study two, in terms of its materials and design (see Figure 1 for a flow chart of the experimental procedure)[3], but in this study there only was one main music condition (with 3 sub-conditions). As part of this music condition participants were instructed to select one piece of music from their earlier three music choices for solace, diversion, or discharge. The entire procedure was again approved by a UK University Ethics Committee, which adheres to British Psychological Society guidelines.

4.1.4. Experimental and control conditions

To allow for comparisons between sub-conditions as well as main conditions, we aimed to recruit 120 participants, 60 in each condition. During data collection, an unequal number of participants self-selected into each music condition, so after 40 participants across all the music condition, we randomised on a 5:2 basis (to allow for more participants to be allocated to the experimental condition). There were 69 participants in the music condition and 52 in the control. Allocation to conditions was again based on participant number.

[3] Reliability analysis indicated that Cronbach's alpha for the DEBQ sub-scales in study 3 were good (α >.70).

4.1.5. Data analyses

Data analyses were completed using IBM SPSS 22. Chi-square analysis was carried out to examine if there was a difference in likelihood that participants would self-select into one of the music conditions (solace vs. discharge vs. diversion). As these showed a significant difference in group size (see section 4.4.1) we decided to precede further analysis with the music groups collapsed into one group compared to the control group and comparing the (largest music group) diversion to the control group.[4]

Next, to test if we needed to control for any variables in the main analysis, a series of between-subject-ANOVA were carried out followed by a chi-square analysis and a series of correlational analyses (IVs and DVs as in study 2). There was no difference in the distribution of different ethnic groups across the four conditions, χ^2 (18, N=121)= 17.53, p=.49. No other differences were found between the groups (see Table 7); however, hunger, was associated with the amount of food consumed, so was entered as a covariate in the further analyses None of the other variables related to the amount of food consumed or differed between conditions. Hence none of these were entered in the analyses as a covariate.

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To examine differences in the amount of food eaten (main analyses) and in the stress reduction (further analysis) two different sets of ANCOVA were carried out. The first set examined differences between the all the music condition collapsed and the control, after controlling for hunger. Then a second set of ANCOVA examined differences between the diversion and control condition, after controlling for hunger. LSD pairwise post hoc tests were used to examine any differences between the different levels of the independent variable.

A series of 14 moderated regressions analyses were conducted to explore if high or low levels of self-reported EE influenced food intake when comparing the different conditions. The seven variables (including the total amount) that measured the amount of food eaten were entered as a dependent variable. The independent variables in these analyses were either all the music condition collapsed vs. the control, or the diversion vs. control condition. The EE score served as the moderator variable in each of these analyse and each

[4] One of the music groups only ended up having 9 participants. We therefore believed that collapsing the music groups as well as comparing the largest group against the control provided more meaningful information.

analysis was additionally controlled for hunger. When significant, the interaction was further tested, with the EE score set to +/− 1 SD from the mean.

4.2 Results

4.2.1. Music selection

Of the 69 participants, 43 (35.5%) decided to listen to diversion music, 17 (14%) decided to listen to solace music, and 9 (7.4 %) decided to listen to discharge music. There was a significant difference between which type of music was self-selected by participants $\chi^2(2) = 24.48$, $p<.001$. This confirmed the hypothesis that diversion would be the most important music listening strategy.

4.2.2. Stress induction

To test if the stress manipulation was successful, stress scores were compared before and after the stress manipulation. A within-subject analysis of variance (ANOVA) revealed that stress was significantly higher after the stress induction than before (*M*-t1=3.89, *SD*-t1=2.74, *M*-t2=5.47, *SD*-t2=2.36, $F(1, 120) = 57.50$, $p<.001$, $\eta_p^2=.32$, indicating a large effect size).

4.2.3. Differences in food consumption according to experimental condition

None of the ANCOVA showed a significant difference between any of the collapsed music and control conditions, or between the diversion and the control condition (see Table 8).

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4.2.4. Stress reduction according to the music condition

It was found that there was a difference in stress reduction between the conditions ($F(1, 118) = 7.25$, $p=.008$, $\eta_p^2=.058$), with a smaller stress reduction for the control (*M*=-1.91, *SD* =1.93) than for the overall music conditions (*M*=-2.77=*SD* =1.54). However when comparing diversion against the control condition there was no significant difference between conditions ($F(1, 92) = 3.452$, $p=.069$, $\eta_p^2=.036$).

4.3. Discussion study 3

The findings of study 3 did not provide support for our hypothesis that music would reduce over-eating, despite yielding patterns of means in the expected direction. Interestingly, however, we did find that the music conditions lowered levels of stress, with the diversion category producing the highest stress reduction of all the music strategies. Moreover, as expected for the second hypothesis findings indicated the diversion strategy was most popular. This was followed by the solace strategy, with the discharge category being the least popular music listening strategy. EE scores did not influence the pattern of findings.

The above findings are in line with numerous studies that have found music listening to be effective in reducing stress. It might be interesting to note that we were not able to find a stress or sadness reduction in study 1 and 2. Although it is difficult to say why this happened, it may be possible that the free choice of music might have helped in further reducing participants stress level by providing them with more agency (Batt-Rawden, 2010).

To summarise the above, it appears that individuals tend to choose music for diversion, that this is effective for stress reduction, but that this stress reduction does not parallel a reduction in eating. Although we cannot be certain why we did not find significant differences in food intake in this study, we suspect that a reasonable explanation for these differences can be found by looking at the main differences between this study and study 2. That is, in this study, participants had a choice in which music they wanted to hear, and they additionally felt less stressed, which might have been the result of this choice. We hence think that it is possible that a moderate level of stress is better in reducing eating than a low level of stress (Evers, Dingemans, Junhans, & Boevé, 2018).

5. **General Discussion**

It was originally hypothesised that music would reduce the consumption of palatable snack foods after negative emotion inductions; however, no specific hypotheses were made about which music listening strategies would be the most effective. Across the three experiments a particular pattern of findings emerged, which suggests that certain types of music listening may be effective in reducing food consumption, depending upon the emotion induced. In study 1, after a sadness induction, participants in the discharge condition, and to a lesser extent the solace condition, ate significantly less than the control condition. In study 2, following a stress induction, participants ate less food in the solace condition compared to the control condition. In study 3 we did not find any differences in eating between the conditions,

yet we did find a reduction in stress experienced after the music listening. In line with the hypothesis, findings also indicated the diversion strategy was most popular music listening strategy.000

Both study 1 and 2 supported the hypothesis that music could result in lower food consumption, but study 3 did not.

The main difference between study 1 and 2 was that both had a different mood manipulation, hence it is possible that this explained the difference in terms of the successful music conditions. The main difference between study 3 and the other two studies was that the participants in study 3 decided which of the three pre-selected pieces to listen to. It is hence possible that this self- allocation influenced the results of this study (and can explain why we did not find a significant result).

It was additionally explored if people who scored differently on a scale of EE would show the predicted effect to a larger or smaller extent. In study 1 we indeed found one significant effect that indicated that participants with high levels of self-reported EE ate more crisps in the control than in the distraction group, while this was not the case for participants scoring low. None of the other interactions in study 1, 2, or 3 were found to be significant. Crisps have been identified as a particularly sonic snack, as their crunchy crisp texture produces a rhymical acoustic effect during consumption (Spence, 2015). It is possible that the greater sound of eating created by the crisps may have been comforting for those who habitually overeat in the absence of other sound within the silent control condition. We think one reason for not finding more significant effects may be because self-reported EE eating does not measure actual EE (Braden et al., 2020), but rather reflects a desire to eat in different emotional circumstances.

Research has shown that the effect of listening to music is influenced by the specific emotion regulation goals a listener has, as well as by the type of music (Baltazar & Saarikallio, 2019; Van den Tol & Edwards, 2013, 2015; Van den Tol & Giner-Sorolla, 2016; 2021). It is therefore possible that some music conditions in our experiments were more effective than others in facilitating a reduction in eating through affect regulation. Moreover, most theories of emotion regulation based on cognition state that arousal is an important aspect of emotional experience (Reisenzein, 2017), which can change food consumption. There is ample evidence that cognitive states vary across emotions (Smith & Elsworth, 1985; Tamir, 2016; Tamir, et al., 2020), with sadness being perceived as an unpleasant, low arousal emotion that promotes cognitive restructuring and disengagement from unattainable goals,

and stress being an unpleasant, high arousal emotion that promotes fight or flight (Lazarus & Folkman, 1984; Smith & Elsworth, 1985). In line with these findings, our research suggested that music was most effective when counteracting the particular arousal featured in the experiment. More specifically, after a stress induction, participants ate less food when listening to the solace condition music. In the low arousal sadness condition, they ate less food when listening to the higher arousal discharge music. The finding that self-selection was not preferable to no music could be because individuals did not choose the music that would best counteract arousal, and instead tended to choose happy, upbeat music. Although diversion selection strategies are found to relate to better mental health (Carlson et al., 2014) it is known that some individuals may also overeat when in a positive mood (Bongers et al., 2013) and this could be the explanation for the reduced effectiveness of self-selection, or music for diversion, on eating.

Affect regulation theories suggest that the timing of when a regulator is used may be crucial in determining its long-term efficacy (Gross & John, 2003), and this is an important consideration in the present study. More precisely regulators that are activated prior to the emotional experience tend to be more adaptive in the long term. In the present series of studies, participants were asked to select music that they had previously used for emotion regulation and it could therefore be argued that this is an antecedent strategy, as they were established regulators. The music that was selected also already had an emotion regulation function for the participants; however, they had, in all likelihood, not used it as a tool to stop over-eating in response to negative affect.

5.1 Strengths,

There are many advantages to the current studies, in particular the experimental design; all studies took place in a controlled laboratory setting, with participants assigned to different conditions. Moreover, emotions were manipulated prior to the food consumption condition, meaning that this research did not rely upon data subject to self-report or reporter bias.

In addition, this study has provided what is believed to be the first experimental findings into the role of different types of music on food intake following mood manipulation. It has been stated by Randall and colleagues (2014), that there is a lack of experimental data on the effects of music-based emotion regulation on wellbeing outcomes. Furthermore, Evers and colleagues (2010) claimed that there is a gap in the existing literature regarding alternative emotion regulation strategies to replace emotional eating. The

current research investigated music as an alternative emotion regulation strategy for eating in a negative mood.

5.2 Limitations

There were several limitations encountered in our studies, which need to be considered. Importantly, we can only interpret these findings as the results of being exposed to certain types of music commonly used to facilitate certain self-regulatory needs. However, we cannot say that people 'engaged' in these strategies while listening to the music or felt the respective desired effect of these strategies after listening to the music. Future research could be conducted to verify these results by asking people specifically to engage in the relevant strategies, or by asking people to report if they had engaged with the strategies and indeed had experienced the desired effect.

When designing all three studies, we relied on earlier research that has found that overeating happens more commonly after a negative mood induction (Evers, Dingemans, Junhans, & Boevé, 2018). Ideally, future research should try to replicate these findings while also including an emotionally neutral control condition. In addition, it will be important to examine how different emotions and coping strategies may be associated with the effectiveness of music to regulate emotions in the context of eating. Previous research (Van den Tol et al., 2019, 2020) has shown a stronger correlation between music listening for discharge and self-reported EE in participants with lower levels of depression and stress. This suggests that the relationship between music regulation and eating may differ according to multiple variables such as underlying mood and coping strategies. In the current set of studies, we cannot be sure if the results are due to some participants having better strategies for coping with negative emotions.

It is possible that there was a novelty effect whereby music simply distracted people from the presence of the food and that a reduction in eating would have happened anyway, independent of the presence of a negative mood induction. Interestingly, distraction is normally found to be associated with increased food consumption (Robinson et al., 2013), with experiments often using audio-visual distractors such television or games. Furthermore, some studies have found that listening to music at mealtimes can increase intake compared to eating in silence (Stroebele & de Castro, 2006), and other studies have found that faster music may increase the rate of chewing and thereby food intake (Caldwell & Hibbert, 2002). Therefore, despite past research suggesting that general use of music may increase intake at mealtimes, our findings showed that listening to music that had previously been identified as

an emotion regulator led to decreased intake, suggesting that the type of music listened to may be crucial in determining the outcome.

Another limitation of each study is that we only used music that is commonly listened to when people feel negative emotions; moreover. we also did not ask participants more questions about their emotional state in general. As these are the first few studies on this topic, we had to make concessions, which made us decide to study only those music listening strategies that people report using when experiencing negative affect. It must be considered, however, that the strategies studied may not necessarily be *the best* strategies for reducing tendencies to engage in eating during negative affect. Future research may hence want to consider looking into a broader range of music listening or other emotion regulation strategies, while also gathering more information about people's affective state.

It is important to note that the amount of foods consumed were modest even in the control condition and the differences between conditions were even smaller, with the average consumption being only 20 grams across the foods, and the average difference only 5 grams. This is in contrast to other research on mood induction and appetite. For example, in Wallis & Hetherington (2004) approximately 50g of a single food (chocolate, 150g presented) was consumed across three conditions (ego-threat, cognitive demand and neutral control). In a later study (Wallis & Hetherington, 2009) approximately 100g was consumed (from 150g chocolate and 180g dried fruit) across ego-threatening and control conditions. The range and amount of each food presented is likely to have an impact on how much is consumed, with a larger amount of each food providing an opportunity to consume a greater amount without any obvious risk of appearing to have over-consumed (which would be more obvious when presented with 40g of each food, as in the current studies). It is clear that the determinants of obesity are complex and involve a number of epigenetic, behavioural and environmental factors (Dixon, 2010). It is generally argued that the basic contribution to the obesity epidemic is excess of energy intake over expenditure, or increased amounts of foods eaten, which can be defined as over-eating (Young & Nestle, 2002). It is well accepted that small energy imbalances over time can lead to gradual but substantial weight gain.

There is still a lot to discover about the underlying processes that may explain our effects. Future research should test the theory that the effects of listening to music found in this experiment could indeed be explained by the chosen music being most effective for countering the intensity of the induced emotions. Moreover, it could be argued that by changing physiological arousal, individuals are not addressing the causes of negative emotions they are expressing, but temporarily regulating them. This is important when trying

to prevent a habitual and problematic regulation technique, like EE. Therefore, it would additionally be important to evaluate whether the use of music can work in naturalistic settings, perhaps using an app to record music listening and eating behaviour.

As a final limitation of our research, we would like to point out that we have only conducted studies with women. Therefore, future research should try to replicate our research with men. Moreover, we did not measure desire to eat, or hunger after the music manipulation as we thought this would make it too clear to our participants or that the amount they were eaten was studied rather than the taste of the food (Robinson, et al., 2018). Future research may hence want to design suitable studies to study the link between hunger and desire to eat and music listening.

5.3. Implications

Findings of several studies support affect regulation theories of emotional eating, which postulate that food is used as a maladaptive tool to regulate emotions (Evers et al., 2010; Gross & John, 2003). Whereas, music can be used effectively to regulate negative emotions (Van den Tol, 2016) and to counter and lower negative moods in experimental studies relatively similar to the current research (e. g. Radstaak et al., 2014). With the current research we have provided evidence of the possibility that music listening may also be used effectively to reduce the urge to overeat.

There has been some prior correlational research (Carlson et al., 2015; Chin & Rickard, 2013; Labbé et al., 2007; Getz et al., 2014; Van den Tol, et al., 2020) that has related music listening strategies to self-reported EE. However, these studies did not provide us with information in terms of what to expect regarding the power of music in reducing EE (for example, the earlier research by Van den Tol and colleagues (2020) proposed it to be equally likely that listening to music that provides discharge could reduce as well as increase EE). With this experimental research, we have not only contributed to a better understanding of over-eating in relation to music listening, but also provided causal evidence of music listening affecting EE, and evidence of the specific music emotion regulation strategies playing a role in this.

This research also has practical implications, as it allows for the development of new behavioural strategies for individuals to adopt in order to regulate their emotions more effectively. Research in this area has the potential to inform interventions to prevent eating in the absence of hunger and reduce overeating, which is particularly important for those who have problems with EE. There have been multiple recent studies on the use of mindfulness-meditation to reduce emotional eating (see Warren et al., for a systematic review, 2017).

Although these interventions are often effective, it is apparent that they do not work for everyone; for example, there is evidence that playing classical music may help to reduce intake of savoury foods, but not via changes in state mindfulness (Hussain et al., 2021). Furthermore, it has been proposed that different strategies may be effective for different individuals (Galante et al., 2021). EE and music listening are both complex psychological phenomena for which situation and person specific factors should be considered. It was, for example, not ascertained from the participants what their habitual coping responses were (Folkman & Lazarus, 1980). It could be that an individualised approach to overcoming EE is warranted, as it is both multi-faceted and context dependent (Lattimore, 2020). We propose that music would work well for some individuals and not others and this may be based on how they already use music to regulate their emotions (Randall & Rickard, 2016; Thomson, et al., 2014). The present study is one of the first to propose that music may be an important part of an individualised response to treatment.

5.4 Concluding statement

Overall, this paper reported the first series of experimental studies to examine whether listening to different types of music would affect consumption of palatable 'comfort' foods following a negative mood induction. Although we found that participants ate less when listening to certain types of music, we feel that further research is crucial before any firm conclusions can be drawn about the use of music to regulate EE behaviour, and whether different types of music may be effective based on individual regulation styles and habits. Research in this area, to assist people who have problems with EE, has the potential to be part of a toolbox of strategies to prevent eating in the absence of hunger and consequently reduce over-eating eating and weight gain.

Declarations of interest

All authors declare that they have no conflicts of interest.

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Data statement

Data available upon request to the corresponding author.

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Author Contributions

1 (names are hidden for review purposes) and 2 designed the studies. 3 and our paid research assistants collected the data. 1 and 2 conducted the data analyses. 1, 2 and 3 wrote the first draft of the manuscript. 4 provided advice, reviewed and edited the manuscript. All authors approved the final version of the manuscript.

References

Baltazar, M., & Saarikallio, S. (2019). Strategies and mechanisms in musical affect self-regulation: A new model. *Musicae Scientiae*, *2*(23), 177-195. https://doi.org/10.1177/1029864917715061

Baste, V. S., & Gadkari, J. V. (2014). Study of stress, self-esteem and depression in medical students and effect of music on perceived stress. *Indian Journal of Physiology and Pharmacology, 58*(3), 296-299. Retrieved from http://ijpp.com/IJPP%20archives/2014_58_3_July-%20Agut/296-299.pdf.

Batt-Rawden, K. (2010). The benefits of self-selected music on health and well-being. *The Arts in Psychotherapy, 37*, 301–310. https://doi.org/10.1016/j.aip.2010.05.005.

Bennett, J., Greene, G., & Schwartz-Barcott, D. (2013). Perceptions of emotional eating behavior. A qualitative study of college students. *Appetite, 60*, 187-192. doi: 10.1016/j.appet.2012.09.023.

Best, M., Barsalou, L. W., & Papies, E. K. (2018). Studying human eating behaviour in the laboratory: Theoretical considerations and practical suggestions. *Appetite, 130*, 339-343. https://doi.org/10.1016/j.appet.2018.06.001

Blood AJ, Zatorre RJ (2001). Intensely pleasurable responses to music correlate with activity in brain regions implicated in reward and emotion. *Proceedings of the National Acadamy of Science USA, 98*, 11818–11823. https://doi.org/10.1073/pnas.191355898

Bongers, P., Jansen, A., Havermans, R., Roefs, A., & Nederkoorn, C. (2013). Happy eating: the underestimated role of overeating in a positive mood. *Appetite, 67*, 74–80. https://doi.org/10.1016/j.appet.2013.03.017

Braden, A., Emley, E., Watford, T., Anderson, L., & Musher-Eizenman, D. (2020). Self-reported emotional eating is not related to greater food intake: results from two laboratory studies. *Psychology & Health*, *35*(4), 500-517. https://doi.org/10.1080/08870446.2019.1649406

British Psychological Society. (2018). *Code of Ethics and Conduct.* Leicester, UK.

Caldwell, C. & Hibbert S.A. (2002), The influence of music tempo and musical preference on restaurant patron's behavior. *Psychology and Marketing, 19* pp. 895-917

Carlson, E., Saarikallio, S., Toiviainen, P., Bogert, B., Kliuchko, M., & Brattico, E. (2015). Maladaptive and adaptive emotion regulation through music: A behavioral and neuroimaging study of males and females. *Frontiers in Human Neuroscience*, *9*. doi: 10.3389/fnhum.2015.00466.

Chao, A., Grey, M., Whittemore, R., Reuning-Scherer, J., Grilo, C. M., & Sinha, R. (2016). Examining the mediating roles of binge eating and emotional eating in the relationships between stress and metabolic abnormalities. *Journal of Behavioral Medicine, 39*(2), 320-332. doi: 10.1007/s10865-015-9699-1.

Cheng, C., Lau, H. B., & Chan, M. S. (2014). Coping flexibility and psychological adjustment to stressful life changes: A meta-analytic review. *Psychological Bulletin, 140*, 1528–1607. DOI: 10.1037/a0037913

Chin, T., & Rickard, N. S. (2013). Emotion regulation strategy mediates both positive and negative relationships between music uses and wellbeing 42(5). 692-713. *Psychology of Music*. doi: 10.1177/0305735613489916.

Dixon, J. B. (2010). The effect of obesity on health outcomes. *Molecular and Cellular Endocrinology, 316*(2), 104-108. https://doi.org/10.1016/j.mce.2009.07.008.

Evers, C., Stok, F. M., & De Ridder, D. T. D. (2010). Feeding your feelings: Emotion regulation strategies and emotional eating. *Personality and Social Psychology Bulletin, 36*(6), 792–804. doi: 10.1177/0146167210371383.

Evers, Dingemans, Junhans, & Boevé, (2018). Feeling bad or feeling good, does emotion affect your consumption of food? A meta-analysis of the experimental evidence. *Neuroscience & Biobehavioral Reviews. 92*, 195-208. doi: 10.1016/j.neubiorev.2018.05.028.

Folkman, S., & Lazarus, R. S. (1980). An analysis of coping in a middle-aged community sample. *Journal of Health and Social Behavior, 21*, 219-239.

Galante J, Friedrich C, Dawson AF, Modrego-Alarcón M, Gebbing P, et al. (2021) Mindfulness-based programmes for mental health promotion in adults in nonclinical settings: A systematic review and meta-analysis of randomised controlled trials. *PLOS Medicine, 18*(1): e1003481. https://doi.org/10.1371/journal.pmed.1003481

Geliebter, A., & Aversa, A. (2003). Emotional eating in overweight, normal weight, and underweight individuals. *Eating Behaviors, 3*(4), 341–347. doi: 10.1016/s1471-0153(02)00100-9.

Getz, L. M., Marks, S., & Roy, M. (2014). The influence of stress, optimism, and music training on music uses and preferences. *Psychology of Music, 42*(1), 71-85. doi: 10.1177/0305735612456727.

Gibson, E. L. (2006). Emotional influences on food choice: sensory, physiological and psychological pathways. *Physiology & Behavior, 89*(1), 53-61

Gibson, E. L. (2012). The psychobiology of comfort eating: implications for neuropharmacological interventions. *Behavioural Pharmacology, 23*(5-6), 442-460. doi: 10.1097/FBP.0b013e328357bd4e.

Greenwood, D. N., & Long, C. R. (2009). Mood specific media use and emotion regulation: Patterns and individual differences. *Personality and Individual Differences,* 46(5–6), 616–621. http://doi. org/10.1016/j.paid.2009.01.002

Greeno, C. G., & Wing, R. R. (1994). Stress-induced eating. *Psychological Bulletin, 115*(3), 444–464. doi: 10.1037/0033-2909.115.3.444.

Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology, 85 (2),* 348–362. https://doi.org/10.1037/0022-3514.85.2.348

Gross, J. J., & Levenson, R. W. (1997). Hiding feelings: the acute effects of inhibiting negative and positive emotion. *Journal of Abnormal Psychology, 106*(1), 95–103. https://doi.org/10.1037/0021-843X.106.1.95.

Grunberg, N. E., & Straub, R. O. (1992). The role of gender and taste class in the effects of stress on eating. *Health Psychology,* 11, 97-100. doi: 10.1037/0278-6133.11.2.97

Hakanen, E. A. (1995). Emotional use of music by African American adolescents. Howard *Journal of Communications, 5*(3), 214–222. http://doi.org/10.1080/10646179509361664

Hanser, W. E., Tom F. M., Ter Bogt, T. F. M., Van den Tol, A. J. M., Mark, R. E., & Vingerhoets, A. J. J. M. (2016). Consolation through music: A survey study. *Musicae Scientiae, 20*(1), 122–137. doi: 10.1177/1029864915620264.

Heatherton, T. F., & Baumeister, R. F. (1991). Binge eating as escape from self-awareness. *Psychological Bulletin, 110*(1), 86–108. https://doi.org/10.1037/0033-2909.110.1.86

Hussain, M., Egan, H., Keyte, R., & Mantzios, M. (2020). Exploring the environmental manifestation of types of music on reinforcing mindfulness and concurrent calorie intake. *Psychological Reports, 124*(6), 2633-2650. https://doi.org/10.1177/0033294120967276

Knobloch, S., & Zillmann, D. (2002). Mood management via the digital jukebox. *Journal of Communication*, 52(2), 351–366. http://doi.org/10.1111/j.1460-2466.2002.tb02549.x

Krause, A. E., & North, A. C. (2017). Pleasure, arousal, dominance, and judgments about music in everyday life. *Psychology of Music*, 45(3), 355-374. https://doi.org/10.1177/0305735616664214

Labbé, E., Schmidt, N., Babin, J., & Pharr, M. (2007). Coping with stress: The effectiveness of different types of music. *Applied Psychophysiology and Biofeedback, 32*(3-4), 163–168. doi:10.1007/s10484-007-9043-9.

Lattimore P. (2020). Mindfulness-based emotional eating awareness training: taking the emotional out of eating. *Eating and Weight Disorders: EWD, 25*(3), 649–657. https://doi.org/10.1007/s40519-019-00667-y

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

Lowe, M. R.,& Maycock, B. (1988). Restraint, disinhibition, hunger and negative affect eating. *Addictive Behaviors,* 13 (1988), pp. 369-377

Lutter, M., & Nestler, E. J. (2009). Homeostatic and hedonic signals interact in the regulation of food intake. *The Journal of Nutrition,* 139 (3). 629-632. https://doi.org/10.3945/jn.108.097618

Macht, M., & Mueller, J. (2007). Immediate effects of chocolate on experimentally induced mood states. *Appetite*, *49*(3), 667–674. https://doi.org/10.1016/j.appet.2007.05.004

Mas-Herrero, Marco-Pallares, Lorenzo-Seva, Zatorre, & Rodriguez-Fornells, 2012 . Individual differences in music reward experiences. Music Perception: An *Interdisciplinary Journal,* 31(2), 118-138. https://doi.org/10.1525/mp.2013.31.2.118

Neumann, S. A., & Waldstein, S. R. (2001). Similar patterns of cardiovascular response during emotional activation as a function of affective valence and arousal and gender. *Journal of Psychosomatic Research,* 50, 245-253. https://doi.org/10.1016/S0022-3999(01)00198-2.

Nguyen-Rodriguez, S. T., Chou, C.-P., Unger, J. B., & Spruijt-Metz, D. (2008). BMI as a moderator of perceived stress and emotional eating in adolescents. *Eating Behaviors, 9*(2), 238–246. doi: 10.1016/j.eatbeh.2007.09.001.

Polivy, J., Herman, P. & Deo, R. (2010). Getting a bigger slice of the pie. Effects on eating and emotion in restained and unrestrained eaters. *Appetite, 55(3),*426-430. doi.org/10.1016/j.appet.2010.07.015

Polivy, J. & Herman C. P. (2020). Overeating in restrained and unrestrained eaters. *Frontiers in Nutrition,* 7, 30, doi: 10.3389/fnut.2020.00030.

Radstaak, M., Geurts, S. A., Brosschot, J. F., & Kompier, M. A. (2014). Music and psychophysiological recovery from stress. *Psychosomatic Medicine, 76*(7), 529-537. doi: 10.1097/PSY.0000000000000094.

Randall, W. M., & Rickard, N. S. (2016). Reasons for personal music listening: A mobile experience sampling study of emotional outcomes. *Psychology of Music, 45*(4), 479–495. doi:10.1177/0305735616666939.

Randall, W. M., Rickard, N. S., & Vella-Broderick, D. A. (2014). Emotional outcomes of regulation strategies used during personal listening: A mobile experience sampling study. *Musicae Scientiae,* 18(3), 275-291. doi: 10.1177/1029864914536430.

Reisenzein, R. (2017). Varieties of Cognition-Arousal Theory. *Emotion Review,* 9(1), 17–26. https://doi.org/10.1177/1754073916639665.

Robinson, E., Aveyard, P., Daley, A., Jolly, K., Lewis, A., Lycett, D., & Higgs, S. (2013). Eating attentively: a systematic review and meta-analysis of the effect of food intake memory and awareness on eating. *The American Journal of Clinical Nutrition, 97*(4), 728–742. https://doi.org/10.3945/ajcn.112.045245

Robinson, E., Bevelander, K. E., Field, M., & Jones, A. (2018). Methodological and reporting quality in laboratory studies of human eating behavior. *Appetite,* 125, 486-491. http://doi.org/10.1016/j.appet.2018.02.008

Saarikallio, S. (2008). Music in mood regulation: Initial scale development. *Musicae Scientiae, 12*(2), 291-309. doi:10.1177/102986490801200206.

Saarikallio, S., & Erkkilä, J. (2007). The role of music in adolescents' mood regulation. *Psychology of Music, 35*(1), 88–109. doi: 10.1177/0305735607068889.

Salimpoor, V. N., Benovoy, M., Longo, G., Cooperstock, J. R., & Zatorre, R. J. (2009). The rewarding aspects of music listening are related to degree of emotional arousal. *PLoS ONE,* 4(10):e7487. https://doi.org/10.1371/journal.pone.0007487.

Sloboda, J., Lamont, A., & Greasley, A. (2009). Choosing to hear music. In S. Hallam, I. Cross, & M. Thaut (Eds.). *Oxford Handbook of Music Psychology.* (pp. 431-440). doi: 10.1093/oxfordhb/9780199298457.013.0040.

Smith, C. A., & Ellsworth, P. C. (1985). Patterns of cognitive appraisal in emotion. *Journal of Personality and Social Psychology,* 48, 813-838.

Spence, C. (2015). Eating with our ears: assessing the importance of the sounds of consumption on our perception and enjoyment of multisensory flavour experiences. Flavour 4, 3 https://doi.org/10.1186/2044-7248-4-3

Spoor, S. T. P., Bekker, M, H. J., Van Strien, T., & Van Heck, G. L. (2007). Relations between negative affect, coping, and emotional eating, *Appetite, 48*(3), 368-376. doi: 10.1016/j.appet.2006.10.005.

Stroebele N., & de Castro, J. M. (2006), Listening to music while eating is related to increases in people's food intake and meal duration, *Appetite, 47*(3), 285-289, Doi: 10.1016/j.appet.2006.04.001.

Tamir, M. (2016). Why do people regulate their emotions?: A taxonomy of motives in emotion regulation. *Personality and Social Psychology Review*, 20(3), 199–222. https://doi.org/10.1177/1088868315586325.

Tamir, M., Vishkin, A., & Gutentag, T. (2020). Emotion regulation is motivated. *Emotion, 20*(1), 115–119. https://doi.org/10.1037/emo0000635.

Thayer, R. E., Newman, J. R., & McClain, T. M. (1994). Self-regulation of mood: Strategies of changing a bad mood, raising energy and redirecting tension. *Journal of Personality and Social Psychology*, 67(5), 910-925.

Thoma, M. V., Ryf, S., Mohiyeddini, C., Ehlert, U., & Nater, U. M. (2012). Emotion regulation through listening to music in everyday situations. *Cognition & Emotion*, 26(3), 550–560. DOI:10.1 080/02699931.2011.595390

Thomson, C. J., Reece, J. E., & Di Benedetto, M. (2014). The relationship between music-related mood regulation and psychopathology in young people. *Musicae Scientiae, 18*(2), 150–165. DOI: 10.1177/1029864914521422.

Van den Tol, A. J. M, (2016). The appeal of sad music: A brief overview of current directions in research on motivations for listening to sad music, *The Arts in Psychotherapy* 49, 44-49. DOI:10.1016/j.aip.2016.05.008.

Van den Tol, A. J. M, Coulthard, H., & Hanser, W. E. (2020). Music Listening as a Potential Aid in Reducing Emotional Eating: An exploratory study. *Musicae Scientiae,* DOI:10.1177/1029864918780186.

Van den Tol, A. J. M., & Edwards J. (2013). Exploring a rationale for choosing to listen to sad music when feeling sad. *Psychology of Music, 41*(4), 440–465. DOI:10.1177/0305735611430433.

Van den Tol, A. J. M., & Edwards J. (2015). Listening to sad music in adverse situations: How music selection strategies relate to self-regulatory goals, listening effects, and mood enhancement. *Psychology of Music,* 43 (4), 473-494. DOI:10.1177/0305735613517410.

Van den Tol, A. J. M., & Giner-Sorolla, R. (2016). Listening to ironically- enjoyed music: A self-regulatory perspective. *Psychology of Music*, 1-17. DOI: 10.1177/0305735616658956.

Van den Tol, A. J. M., & Giner-Sorolla, R. (2020). Ironically enjoyed music: An investigation of the unique self-regulatory value of irony as part of the enjoyment of music. *Psychology of Music*, DOI: 0305735620978689

Van den Tol, A. J. M., Ward, M. R., & Fong, H., (2019). The role of coping in emotional eating and the use of music for discharge when feeling stressed. *The Arts in Psychotherapy 64*, 95-103. DOI:10.1016/j.aip.2019.02.004.

Van Goethem, A., & Sloboda, J. (2011). The functions of music for affect regulation. *Musicae Scientiae*, 15(2), 208–228. doi: 10.1177/1029864911401174.

Van Strien, T., Cebolla, A., Etchemendy, E., Gutiérrez-Maldonado, J., Ferrer-García, M., Botella, C., & Baños, R. (2013). Emotional eating and food intake after sadness and joy. *Appetite, 66,* 20-25. DOI:10.1016/j.appet.2013.02.016.

Van Strien, T., Frijters, J. E. R., Bergers, G. P. A., & Defares, P. B. (1986). The Dutch eating behavior questionnaire (DEBQ) for assessment of restrained, emotional, and EXE behavior. *International Journal of Eating Disorders*, *5*(2), 295–315. DOI: 10.1002/1098-108x(198602)5:2<295::aid-eat2260050209>3.0.co;2-t.

Van Strien, T, Van de Laar, F. A., Van Leeuwe, J. F. J., Lucassen, P. L. B. J., Van den Hoogen, H. J. M. & Rutten, G. E. H. M. (2007). The dieting dilemma in patients with newly diagnosed type 2 diabetes: Does dietary restraint predict weight gain 4 years after diagnosis? *Health Psychology*, 26: 105–112. DOI: 10.1037/0278-6133.26.1.105.

Wallis, D.J., & Hetherington, M.M. (2004). Stress and eating: the effects of ego-threat and cognitive demand on food intake in restrained and emotional eaters. *Appetite, 43*(1), 39-46. doi:10.1016/j.appet.2004.02.001.

Wallis, D.J., & Hetherington, M.M. (2009). Emotions and eating: self-reported and experimentally-induced changes in food intake under stress. *Appetite*, *52*, 355-362. doi:10.1016/j.appet.2008.11.007.

Wardle, J. (1987). Eating style. A validation study of the Dutch Eating Behaviour Questionnaire in normal weight subjects and women with eating disorders. *Journal of Psychosomatic Research*, 31(2), 161–169. doi:10.1016/0022-3999(87)90072-9.

Warren, J. M., Smith, N., & Ashwell, M. (2017). A structured literature review on the role of mindfulness, mindful eating and intuitive eating in changing eating behaviours: effectiveness and associated potential mechanisms. *Nutrition Research Reviews*, 30(2), 272–283. https://doi.org/10.1017/S0954422417000154.

Whiteside, U., Chen, E., Neighbors, C., Hunter, D., Lo, T., & Larimer, M. (2007). Difficulties regulating emotions: Do binge eaters have fewer strategies to modulate and tolerate negative affect? *Eating Behaviors,* 8, 162-169. doi: 10.1016/j.eatbeh.2006.04.001.

World Health Organisation (2021). Obesity. www.who.int/news-room/facts-in-pictures/detail/6-facts-on-obesity

Young, L. R., & Nestle, M. (2002). The contribution of expanding portion sizes to the US obesity epidemic. *American Journal of Public Health,* 92(2), 246-249. https://doi.org/10.2105/AJPH.92.2.246/

Zellner, D. A., Loaiza, S., Gonzalez, Z., Pita, J., Morales, J., Pecora, D., et al. (2006). Food selection changes under stress. *Physiology & Behavior*, 87, 789–793.

Zellner, D. A., Saito, S., & Gonzalez, J. (2007). The effect of stress on men's food selection. *Appetite*, 49(3), 6

Table 1:
Study 1: Baseline demographic, eating, hunger and stress variables across the four conditions.

	Control	Discharge	Divergence	Solace	Total	ANOVAs (DF=3, 117), 4 conditions		
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	*p*-value	F-Value	Partial η2
Age in years	**19.47(1.41)**	**2.53(4.02)**	**2.38(3.54)**	**22.47(5.62)a**	**2.71(4.05)**	**.03**	**3.06**	**.07**
Hunger	4.57(3.12)	4.33(2.66)	3.40(2.34)	4.33(2.66)	4.42(5.52)	.18	1.68	.04
Emotional eating	2.65(.93)	3.06(.61)	3.17(.68)	2.96(.75)	3.02(.72)	.32	1.18	.03
Sadness 1	1.75(2.37)	2.04(1.90)	1.80(1.69)	1.92(2.04)	1.88(1.99)	.94	.13	.003
Sadness 2	4.27(2.36)	5.44(2.43)	5.38(2.04)	4.88(2.06)	4.99(2.25)	.16	1.78	.04

Means within rows with differing subscripts are significantly different at the $p < .05$ level based on Fisher's LSD post hoc paired comparisons.

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Table 2:
Study 1: Total grams of food eaten in each condition. Results of a series of ANCOVAs controlled for age and hunger.

	Control	Discharge	Divergence	Solace	Total	ANCOVAs (DF=3, 117) 4 conditions		
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	*p*-value	F-Value	Partial η2
Chocolate	**7.33 (6.36) a**	**3.10 (2.23) bc**	**5.24 (4.60) bd**	**4.60 (4.40)**	**5.07 (4.83)**	**.039**	**2.89**	**.071**
Cookies	9.40 (6.80)	5.50 (3.48)	6.93 (4.67)	6.67 (5.10)	7.13 (5.29)	.13	1.92	.049
Crisps	**8.37 (6.86) a**	**3.83 (3.63) b**	**5.00 (4.23)**	**4.77 (5.10) b**	**5.50 (5.29)**	**.023**	**3.30**	**.081**
Total food	**25.10 (16.78)a**	**12.43 (6.75)**	**17.17 (1.94) b**	**16.03 (13.46) b**	**17.69 (13.23)**	**.012**	**3.80**	**.092**

Means within rows with differing subscripts are significantly different at the $p < .05$ level based on Fisher's LSD post hoc paired comparisons.

Table 3:

Study 1: Moderated regression analyses controlled for hunger and age.

DV: Chocolate	B	SE for B	T	*P*	95%LLCI for B	95ULCI for B	R	R-sq	MSE	DF1(2)	model *p*
Control vs. discharge	-.17	1.57	-.11	.91	-3.33	2.91	.65	.43	16.78	5(54)	.000
Control vs. distraction	-1.22	1.82	-.67	.50	-4.88	2.43	.55	.31	24.73	5(51)	.002
Control vs. solace	1.74	1.64	1.06	.29	-1.56	5.03	.59	.34	22.63	5(53)	.000
DV: Cookies	B	SE for B	T	*P*	95%LLCI for B	95ULCI for B	R	R-sq	MSE	DF1(2)	model *p*
Control vs. discharge	-2.00	1.88	-1.01	.31	-5.97	1.96	.50	.25	26.52	5(54)	.006
Control vs. distraction	-3.42	1.95	-1.75	.08	-7.34	.50	.49	.24	28.48	5(51)	.02
Control vs. solace	-.06	1.99	-.03	.98	-4.04	3.93	.45	.20	33.02	5(53)	.03
DV: Crisps	B	SE for B	T	*p*	95%LLCI for B	95ULCI for B	R	R-sq	MSE	DF1(2)	model *p*
Control vs. discharge	-1.18	1.83	-.65	.52	-4.84	2.48	.62	.39	22.61	5(540	.000
Control vs. distraction	**-3.86**	**1.90**	**-2.04**	**.047**	**-7.68**	**-.05**	.56	.32	26.88	5(51)	.013
EE1SD-mean	-.16	2.11	-.08	.94	-4.39	4.07					
EE1SD+mean	-6.15	2.04	-3.01	.04	-1.25	-2.05					
Control vs. solace	.32	.10	.18	.86	-3.38	4.03	.58	.34	28.62	5(53)	.000
DV: Total Food	B	SE for B	T	*p*	95%LLCI for B	95ULCI for B	R	R-sq	MSE	DF1(2)	model *p*
Control vs. discharge	-3.35	4.19	-.8	.43	-11.75	5.04	.68	.46	118.75	5(54)	.000
Control vs. distraction	-8.51	4.48	-1.9	.06	-17.51	.49	.61	.37	149.80	5(51)	.000
Control vs. solace	2.00	4.59	.44	.66	-7.21	11.21	.60	.36	176.45	5(53)	.000

Table 4:
Study 2: Baseline demographic, eating, hunger and stress variables across the four conditions.

	Control	Discharge	Divergence	Solace	Total	ANOVAs (DF=3, 117) 4 conditions		
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	*p*-value	F-Value	Partial η2
Age in years	21.37(5.33)	21.70(6.78)	21.03(3.91)	21.30(6.99)	21.35(5.83)	.53	.74	.002

BMI	24.88(6.17)	24.05(4.13)	24.14(4.92)	24.41(6.96)	24.37 (5.48)	.96	.10	.001
Emotional eating	2.99(.90)	2.89(1.00)	2.89(1.17)	2.79(1.02)	2.89(1.02)	.82	.31	.01
External eating	3.48(.69)	3.41(.77)	3.50(.81)	3.30(.64)	3.42(.72)	.78	.36	.001
Hunger	4.09(2.41)	3.71(2.35)	4.06(2.26)	4.26(2.51)	4.03(2.36)	.92	.16	.01
Restrained eating	2.76(.92)	2.73(1.09)	2.73(.83)	2.79(.98)	2.76(.95)	.67	.52	.001
Stress 1	3.80(2.71)	2.92(2.39)	3.84(2.85)	4.90(3.31)	3.86(2.89)	.23	.87	.06
Stress 2	5.12(2.50)	4.62(2.36)	5.26(2.57)	6.09(2.61)	5.27(2.54)	.49	.81	.04
Stress 3	3.50(2.29)	3.01(2.47)	2.88(2.11)	3.54(2.68)	3.23(2.39)	.03	3.23	.02

Means within rows with differing subscripts are significantly different at the $p < .05$ level based on Fisher's LSD post hoc paired comparisons.

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Table 5:
Study 2: Total grams of food eaten in each condition. Results of a series of ANCOVAs controlled for hunger.

	Discharge	Divergence	Solace	Control	Total	ANCOVAs (DF=3, 116)		
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	*p*-value	F-Value	ηp2
Cheese Savouries	2.77 (3.58)	2.57 (2.47)	2.10 (2.17)	2.93 (3.07)	2.59 (2.85)	.66	.54	.014
Chocolate	**4.21 (4.46)**	**4.70 (3.85)**	**2.70(2.79)a**	**6.43(5.74)b**	**4.51 (4.49)**	**.009**	**4.02**	**.096**
Cookies	6.53 (4.15)	6.50 (4.07)	5.27 (2.89)	6.87 (4.52)	6.29 (3.95)	.37	1.05	.027
Crisps	5.07 (2.93)	5.47 (2.62)	5.03 (2.77)	5.20 (2.52)	5.19 (2.68)	.92	.17	.004
Fruit Jellies	9.37 (5.20)	8.67 (5.20)	8.03 (3.85)	9.17 (4.71)	8.81 (4.58)	.64	.56	.014
Popcorn	**2.67 (2.81)**	**2.03 (2.51)**	**1.60(1.43)a**	**4.07(4.31)b**	**2.59 (3.01)**	**.006**	**4.32**	**.101**
Total Food	**29.40 (16.11)**	**29.43 (16.11)**	**22.57(9.04)a**	**34.80(19.51)b**	**29.05(16.11)**	**.021**	**3.38**	**.08**

Means within rows with differing subscripts are significantly different at the $p < .05$ level based on Fisher's LSD post hoc paired comparisons.

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Table 6:
Study 2: Moderated regression controlled for hunger.

DV: Cheese Savouries	B	SE for B	T	*P*	95%LLCI for B	95ULCI for B	R	R-sq	MSE	DF1(2)	model *p*
Control vs. discharge	.50	.94	.54	.59	-1.37	2.38	.18	.03	11.38	4(54)	.77
Control vs. distraction	1.09	.74	1.46	.15	-.40	2.58	.21	.04	7.86	4(54)	.67
Control vs. solace	.40	.73	.75	.59	-.18	1.86	.28	.08	7.00	4(55)	.33
DV: Chocolate	B	SE for B	T	*P*	95%LLCI for B	95ULCI for B	R	R-sq	MSE	DF1(2)	model *p*
Control vs. discharge	-.81	1.28	-.63	.53	-3.39	1.76	.33	.11	25.57	4(54)	.17
Control vs. distraction	-.19	1.39	-.14	.89	-2.98	2.60	.38	.15	25.04	4(54)	.07
Control vs. solace	-1.27	1.24	-1.03	.31	-3.76	1.22	.44	.19	.44	4(55)	.17
DV: Cookies	B	SE for B	T	*P*	95%LLCI for B	95ULCI for B	R	R-sq	MSE	DF1(2)	model *p*
Control vs. discharge	-.81	1.28	-.63	.53	-3.39	1.76	.33	.11	23.57	4(54)	.17
Control vs. distraction	1.06	1.18	.90	.37	-1.30	3.43	.3	.09	18.08	4(55)	.26
Control vs. solace	1.05	1.04	1.02	.31	-1.02	3.13	.33	.11	14.15	4(55)	.17
DV: Crisps	B	SE for B	T	*p*	95%LLCI for B	95ULCI for B	R	R-sq	MSE	DF1(2)	model *p*
Control vs. discharge	-.33	1.09	-.30	.76	-2.52	1.86	.36	.13	15.49	4(55)	.09
Control vs. distraction	.48	1.23	.39	.70	-1.99	2.94	.21	.05	21.66	4(55)	.63
Control vs. solace	-.85	1.05	-.81	.42	-2.95	1.25	.45	.20	14.49	4(55)	.013
DV: Fruit Jellies	B	SE for B	T	*P*	95%LLCI for B	95ULCI for B	R	R-sq	MSE	DF1(2)	model *p*
Control vs. discharge	-.33	.25	-.26	.80	-2.90	2.24	.25	.06	21.31	4(55)	.46
Control vs. distraction	-.24	1.33	-.18	.86	-.90	2.42	.18	.03	25.14	4(54)	.76
Control vs. solace	-.62	1.21	-.51	.61	-3.05	1.80	.16	.03	19.13	4(55)	.83
DV: Popcorn	B	SE for B	T	*P*	95%LLCI for B	95ULCI for B	R	R-sq	MSE	DF1(2)	model *p*
Control vs. discharge	-1.13	1.00	-1.13	.26	-3.14	.87	.33	.11	12.94	4(55)	.20
Control vs. distraction	-1.17	.91	-1.28	.21	-3.00	.66	.37	.13	11.90	4(54)	.09
Control vs. solace	-.90	.87	-1.03	.31	-2.65	.85	.44	.2	1.07	4(55)	.02
DV: Total food	B	SE for B	T	*p*	95%LLCI for B	95ULCI for B	R	R-sq	MSE	DF1(2)	model *p*
Control vs. discharge	-.46	4.81	-.10	.92	-1.10	9.18	.36	.13	3.19	4(55)	.09
Control vs. distraction	1.05	4.78	.22	.83	-17.14	15.16	.27	.08	326.87	4(54)	.36

Control vs. solace	-.20	4.19	-.53	.6o	-1.60	6.20	.43	.19	231.65	4(55)	.02

Table 7:
Study 3: Baseline demographic, eating, hunger and stress variables across the four conditions.

	Control (*N*=52)	Discharge (*N*=9)	Divergence (*N*=43)	Solace (*N*=17)	Music collapsed (*N*=69)	Total (*N*=121)	ANOVA (DF=3, 118) Diversion vs. Control			ANOVA (DF=3, 118) Music collapsed, vs. Control		
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	*p*-value	F-Value	Partial η2	*p*-value	F-Value	Partial η2
Age in years	2.86(4.49)	18.89(.93)	2.32(4.67)	19.76(2.54)	2.00(3.91)	2.37(4.17)	.57	.33	.004	.26	1.28	.01
BMI	24.68(7.37)	22.09(3.17)	25.49(6.13)	25.84(7.12)	25.08(6.02)	24.89(6.65)	.64	.22	.003	.79	.07	.001
Emotional Eating	2.96(.95)	2.96(1.15)	2.78(.99)	2.95(.87)	2.85(.97)	2.89(.96)	.38	.79	.01	.53	.40	.003
External Eating	3.56(.74)	3.42(.78)	3.42(.81)	3.57(.62)	3.46(.75)	3.50(.75)	.38	.79	.01	.46	.56	.01
Hunger	4.31(2.56)	4.58(2.55)	4.35(2.52)	3.68(.84)	4.27(2.43)	4.29(2.48)	.94	.01	.001	.95	.004	.001
Restrained Eating	2.59(1.01)	2.79(.89)	2.66(.99)	2.35(1.07)	2.60(.99)	2.59(1.00)	.73	.12	.001	.95	.004	.001
Stress 1	4.11(2.78)	4.02(3.10)	3.67(2.72)	3.70(2.70)	3.72(2.73)	3.89(2.74)	.44	.60	.01	.45	.59	.01
Stress 2	5.65(2.38)	6.18(2.33)	5.05(2.50)	5.59(2.13)	5.33(2.40)	5.47(2.38)	.24	1.39	.02	.48	.51	.004
Stress 3	**3.73(2.12)**	**2.95(2.25)**	**2.47(1.98)a**	**2.61(2.15)**	**2.57(2.03)**	**3.07(2.14)**	**.004**	**8.85**	**.09**	**.003**	**9.41**	**.07**

Means within rows with differing subscripts are significantly different at the $p < .05$ level based on Fisher's LSD post hoc paired comparisons.

Table 8:

Study 3: Total grams of food eaten in each condition. Results of a series of ANCOVAs controlled for hunger.

	Discharge (*N*=9)	Divergence (*N*=43)	Solace (*N*=17)	Control (*N*=52)	Music collapsed (*N*=69)	Total (*N*=121)	ANCOVA (DF=3, 118) Diversion vs. Control			ANCOVA (DF=3, 118) Music collapsed vs. Control		
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	*p*-value	F-Value	ηp2	*p*-value	F-Value	ηp2
Cheese Savouries	3.78 (2.49)	2.91 (4.35)	1.59 (1.06)	2.77 (2.89)	2.70 (3.63)	2.73 (3.32)	.87	.03	.00	.91	6.45	.00
Chocolate	6.11 (5.42)	4.37 (5.37)	4.94 (3.61)	6.10 (5.51)	4.74 (4.97)	5.32 (5.23)	.12	2.53	.03	.16	2.05	.02
Cookies	8.33 (5.77)	5.60 (5.05)	6.71 (4.69)	7.17 (5.04)	6.23 (5.07)	6.64 (5.06)	.12	2.49	.03	.31	1.03	.01
Crisps	5.22 (5.69)	5.37 (5.69)	3.82 (2.60)	4.81 (4.14)	4.97 (4.79)	4.90 (4.50)	.58	.31	.00	.83	.05	.00
Fruit Jellies	8.78 (6.18)	8.60 (5.85)	7.00 (4.82)	9.52 (5.05)	8.23 (5.62)	8.79 (5.40)	.40	.72	.01	.19	1.70	.01
Popcorn	2.78 (3.03)	3.16 (4.57)	3.29 (2.42)	3.29 (3.77)	3.04 (3.92)	3.15 (3.84)	.87	.03	.00	.12	.12	.00
Total Food	34.44 (2.23)	30.22 (2.29)	26.94(8.57)	33.63(19.13)	29.84 (19.42)	31.47(19.31)	.36	.85	.01	.28	1.20	.01

Table 9:
Study 3: Moderated regression controlled for hunger.

DV: Cheese Savouries	B	SE for B	t	*p*	95%LLCI for B	95ULCI for B	R	R-sq	MSE	DF1(2)	model *p*
Control vs. music collapsed	-.20	.64	-.32	*.75*	-1.46	1.06	.23	.05	10.79	4(116)	.17
Control vs. distraction	.43	.77	.56	*.57*	-1.07	1.95	.26	.07	12.67	4(90)	.83
DV: Chocolate	B	SE for B	t	*p*	95%LLCI for B	95ULCI for B	R	R-sq	MSE	DF1(2)	model *p*
Control vs. music collapsed	.21	1.00	.21	.83	-.76	2.19	.26	.07	26.38	4(116)	.08
Control vs. distraction	.3	1.15	.26	.79	-1.98	2.58	.31	.10	28.43	4(90)	.06
DV: Cookies	B	SE for B	t	*p*	95%LLCI for B	95ULCI for B	R	R-sq	MSE	DF1(2)	model *p*
Control vs. music collapsed	-1.42	.96	-1.47	.14	-3.33	.49	.25	.06	24.77	4(116)	.1
Control vs. distraction	2.00	1.04	1.92	.058	-.07	4.08	.35	.12	23.55	4(90)	.02
DV: Crisps	B	SE for B	t	*p*	95%LLCI for B	95ULCI for B	R	R-sq	MSE	DF1(2)	model *p*
Control vs. music collapsed	-1.08	.85	-1.27	.20	-2.75	.6o	.30	.09	19.04	4(116)	.02
Control vs. distraction	1.83	1.00	1.84	.069	-.15	3.82	.36	.13	21.58	4(90)	.01
DV: Fruit Jellies	B	SE for B	t	*p*	95%LLCI for B	95ULCI for B	R	R-sq	MSE	DF1(2)	model *p*
Control vs. music collapsed	.27	1.04	.26	.8o	-1.79	2.33	.21	.04	28.84	4(116)	.27
Control vs. distraction	-.33	1.16	-.28	.78	-2.63	1.98	.22	.05	29.14	4(90)	.34
DV: Popcorn	B	SE for B	t	*p*	95%LLCI for B	95ULCI for B	R	R-sq	MSE	DF1(2)	model *p*
Control vs. music collapsed	.19	.74	.26	.79	-1.28	1.67	.19	.04	14.72	4(116)	.37
Control vs. distraction	-.10	.89	-.12	.91	-1.86	1.66	.21	.05	16.99	4(90)	.38
DV: Total Food	B	SE for B	t	*p*	95%LLCI for B	95ULCI for B				DF1(2)	model *p*
Control vs. music collapsed	-2	3.61	-.55	.58	-9.16	5.16	.31	.10	347.95	4(116)	.02
Control vs. distraction	4.14	4.22	.98	.33	-4.24	12.52	.36	.13	384.57	4(90)	.01

96-699. https://doi.org/10.1016/j.appet.2007.06.013.