# EFFECTIVENESS OF RUMINATION, REAPPRAISAL AND MUSIC IN STRESS RECOVERY

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# Abstract

Since stress has been linked to depression, PTSD, cardiovascular disease and high mortality, it is highly important to investigate positive and negative ways of coping with stress. Research suggests that whilst rumination is detrimental to stress recovery, reappraisal and music have a more positive impact on both psychological and physiological states. However, it is uncertain whether rumination indeed hinders stress recovery or the negative findings are purely a reflection of negative affect. Secondly, there is a very limited research on the effects of reappraisal. Finally, the findings regarding the effects of music are inconsistent. The main experiment aim of the present study was to assess potential differences in participants' physiological and psychological recovery from a stress task between rumination, reappraisal and music stress recovery procedures. Participants performed a stress task consisting of a hypothetical job interview and were assigned to rumination, reappraisal or music conditions. SBP, DBP, HR and mood were measured at the baseline, during the stress task and at the 15-minute recovery. There were no differences between conditions in recovery on any of the studied physiological measures. The only significant difference in mood found was that participants were significantly more relaxed in the music than in the rumination condition. The findings suggest that the choice of stress recovery procedure in applied settings should be left to individuals' personal preferences as they all appear to be similarly effective. This area, however, should be further investigated by comparing the effects of the studied stress recovery procedures with a no-intervention control condition to determine if any of them are any more effective than natural stress recovery.

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# List of abbreviations

**VAMS** - Visual Analogue Mood Scale

**SBP**- Systolic Blood Pressure

**DBP** –Diastolic Blood pressure

**HR** – Hear Rate

**MAP** - Mean Arterial Pressure

# Chapter 1

# Introduction

## 1. Stress

Stress is a response to a stimulus resulting in a physiological and psychological arousal (Ogden, 2012). Physiological arousal is characterised by activation of autonomic nervous system and endocrine system leading to such physiological changes as increases in blood pressure, heart rate, respiration and cortisol stress hormone secretion (Carlson, 2013). Psychological arousal is a subjective stress response described by the Transactional Model of Stress (Lazarus & Folkman, 1987). The model illustrates how a stimulus is appraised by an individual for its degree of stressfulness. This process is followed by the individual evaluating their coping resources. For instance, a public speaker may experience anxiety prior to his performance which may cause feelings of nervousness. The second phase described by the model consists of an evaluation of the ability to cope that leads to different stress coping procedures. For example, in the presented case, the individual may consider listening to music before speech as it proved to be effective in the past, or perhaps reappraising whether it is worth worrying, and what the potential consequences are.

Stress is associated with hypertension (Lucini, Di Fede, Parati & Pagani, 2005; Marvar & Harrison, 2012; Stewart, Harshfield, Zhu & Hanevold, 2015) high mortality (Steptoe & Kivimaki, 2012) and disruptions in the immune system (Radek, 2010). It has been also linked to higher levels of depression (Stewart, Mazurka, Bond, Wynne-Edwards & Harkness, 2013; Warren, Postolache, Groer, Pinjari, Kelly & Reynolds, 2014; Wickham, Taylor, Shevlin & Bentall, 2014) and maintenance of PTSD symptoms (Hu, Koucky, Brown, Bruce, & Sheline, 2014).

Since stress is reported to lead to serious psychophysiological consequences, it is important to study its recovery.

Different stress coping procedures have different impacts on stress recovery. Before examples of stress recovery procedures are discussed, the concept of stress recovery must be defined. Stress recovery is defined hereafter as a process of a return to physiological and psychological baselines following arousal to stress. Since stress has been linked to various negative outcomes, as presented earlier, it is important to investigate procedures that contribute to or inhibit stress recovery to promote overall well-being. Some of the most studied coping procedures in this area are rumination, reappraisal and listening to music. The research on these will be now discussed.

## 2. Rumination

Rumination is one of the concepts encompassed within the wider construct of preservative cognition. Preservative cognition involves repetitive thinking about stressors; and it comprises of different cognitive processes such as rumination, worry and anticipation (Brosschot, Gerin & Thayer, 2006). The features which distinguish rumination from other processes of preservative cognition are past-focused thinking, and a passive fixation on the reasons and meanings of events and on negative emotional experiences (Nolen-Hoeksema, 1991; Thomsen, Mehlsen, Christensen & Zacharie, 2003). For example, following an unsuccessful public speaking episode, ruminating would involve repeatedly mentally replaying the course of this experience, focusing on how unpleasant it was, how negative listeners' facial expressions were, or perhaps on the absence of perceived approval from the audience. However, rumination does not involve using one's failures as means to improve in the future.

Morrow and Nolen-Hoeksema (1990) suggested that rumination can sustain and even intensify emotional responses. In addition, according to the rumination-arousal model (Gerin, Davidson, Christenfeld, Goyal & Schwartz, 2006), rumination leads to emotional responses which, in turn, elevate physiological responses. For instance, rumination about an argument an individual had with their partner may lead to feelings of anger raising cardiovascular activity.

## *2.1. Impact of Rumination on stress recovery*

Rumination has been reported to detrimentally affect stress recovery (Glynn, Christenfeld & Gerin, 2007; Santa Maria, Reichert, Hummel & Ehring, 2012). Glynn et al. (2007) measured blood pressure and heart rate in 22 adult participants (13 females) while they performed a mathematical task which included an element of harassment. Participants were assigned to one of the two groups – immediate or delayed recall. The former group recalled their task performance 30 minutes after the task, and the latter recalled it one week later. Participants' Systolic blood pressure (SBP) and Diastolic blood pressure (DBP) were significantly higher during both immediate and delayed rumination conditions than at the baseline; however, SBP, DBP and heart rate (HR) were significantly lower during the rumination conditions than the task itself. Moreover, there were no differences in physiological response between the immediate and delayed rumination. The results suggest rumination may have negative consequences for cardiovascular health as it increases physiological responses over and above a baseline. Moreover, its effects are persistent over time. Nevertheless, it could be argued that the immediate recall in the experiment was in fact delayed recall as it was not conducted immediately after the stress task. Although the difference in physiological response between

immediate and delayed recall was not statistically significant, the direction of the difference suggested that time decreased the negative effect of rumination to some extent. If the immediate recall was conducted immediately after the stress task, a significant difference between immediate and delayed recall may have been found. Therefore, the inference that the negative consequences of rumination are persistent may be questionable.

In another study 115 individuals wrote a mini-essay and were verbally evaluated by a confederate who made provocative comments on the essays (McClelland, Jones & Gregg, 2009). This evaluation was designed to prompt visual recall of the task or rumination. Although the procedure for the rumination phase in this research was relatively unique and differed from the experimental design of the previously discussed research, the results were similar. SBP and DBP were significantly higher during rumination than at the baseline, but no such effect was observed in HR activity, thus this research demonstrated a partially detrimental effect of rumination on cardiovascular recovery.

Recent stress research has employed cortisol activity as a measure of stress response. Cortisol is a vital stress hormone; and one of its crucial functions is in the maintenance of blood pressure. Research shows a positive relationship between cortisol levels and blood pressure (Gianferante, Thoma, Hanlin, Chen, Breines, Zoccola & Rohleder, 2014; Zoccola, Dickerson & Yim, 2011); an excess of cortisol elevates blood pressure and vice versa (Carlson, 2013; Kelly, Mangos & Williamson, 1998). Therefore, it is important to consider research on rumination which measures cortisol activity.

In one of such study, 119 participants were asked to complete measures of state rumination before and after sleep (Zoccola et al., 2011). Participants were assigned to either a high or low rumination group based on their score on a rumination scale. Cortisol awakening response (CAR), which is a natural rise in

cortisol levels following awakening, was measured in the morning 30, 45 and 60 minutes after sleep. Participants who ruminated the evening before had a significantly higher CAR than those who did not; and this relationship was independent from duration of sleep, sleep quality, anxiety, depression and recent stress. This research demonstrated how rumination can elevate physiological activity over time even when rumination has stopped, thus rumination itself may have acted as a unique stressor having a prolonged impact on physiological response. Nevertheless, although rumination following awakening has been measured, no results on its levels and its effect on cortisol levels after sleep have been reported. If participants engaged in rumination following awakening, this, rather than rumination before sleep, may have caused elevated cortisol levels. Nonetheless, despite this limitation, the study does demonstrate the detrimental effects of rumination on stress recovery.

Recent research (Gianferante et al., 2014) investigated the effects of rumination on stress response to a repeated stressor and demonstrated similar results. In this experiment, 27 participants were exposed to a social stressor. Cortisol levels were measured before and 10, 30, 60 and 120 minutes following the stress procedure; and rumination measures were obtained post-stress as well. A similar procedure was carried out the following day. Rumination following the first stress procedure was significantly related to higher cortisol levels suggesting that rumination impeded stress recovery. Additionally, rumination following the first stress procedure predicted higher cortisol levels during the second stress procedure. These findings indicate that rumination elevates stress response to a repeated stressor.

The literature discussed here employed physiological measures of stress but did not consider psychological markers. Research suggests that positive and negative psychological states produce a very similar physiological response

(Jacob, Thayer, Manuck, Muldoon, Tamres, Williams, Ding & Gatsonis, 1999). Therefore, measures of cardiovascular activity alone may not provide entirely reliable grounds for the conclusion that an experimental stress task worked as a stressor to begin with; physiological changes may instead reflect positive psychological responses since they do not convey the emotional valence of the physiological arousal. Measuring both psychological and physiological response would be a more reliable methodology in stress research.

In contrast to the previously discussed studies, Ehring, Fuchs and Klasener (2009) studied 51 students who experienced a distressing event in the previous two years. Participants recalled the event (free recall) in an interview and were assigned to either a distraction or rumination condition, where they either completed a general knowledge quiz or were asked to focus on ruminative sentences, respectively. Whilst negative mood significantly decreased from the free recall to the distraction condition, there was no significant decrease in negative mood in the rumination condition. These results suggest that whilst distraction contributes to psychological stress recovery to some extent, rumination can be detrimental to psychological stress recovery.

A more recent study (Santa Maria et al., 2012) measured levels of intrusive memories in 57 (38 female) participants who focused on their most distressing personal event for half a minute (free recall). Following this, participants were assigned to either a rumination, or a concrete-experiential writing condition (which constituted the instructed recall element of the experiment). Whilst the former group ruminated about the past event, the latter focused on present feelings and thoughts. Participants wrote down their thoughts during the instructed recall in both conditions; this procedure was employed to control for adherence to instructions. There was no significant difference in levels of intrusive memories between free and instructed recall in the rumination

condition. The reductions in levels of intrusive memories were significantly larger for the concrete-experiential condition than for the rumination condition, both between the free and instructed recall, and between the instructed recall and follow-up, 36 hours after. This experiment further demonstrated that rumination sustained the negative psychological impact of stress. However, it can be argued that the writing task that was used for control of adherence, may have contributed to a concrete way of thinking which is slightly inconsistent with the concept of rumination and is similar to concrete-experiential thinking. Therefore, the rumination condition may not have reflected natural ruminative thinking in this experiment, suggesting that the writing task may be a flawed procedure for control of adherence to instructions for rumination. Nevertheless, the results of this study, together with the previously discussed research, suggest that, overall, rumination has a negative impact on cardiovascular activity, is detrimental to physiological and psychological stress recovery; and its effects do not decrease with time.

### *2.2. The role of trait rumination in stress recovery*

Whilst state rumination is the extent to which one ruminates in a present moment, trait rumination is one's general tendency to ruminate in everyday life. Research predominantly shows that there is a relationship between these two concepts (Gianferante et al., 2014; Key, Campbell, Bacon & Gerin, 2008), and between trait rumination and stress recovery (Key et al., 2008; Stewart et al., 2013; Zoccola & Dickerson, 2015).

For example, in one study 64 adult female participants performed a five-minute speech about a recent personal stressful event that they found difficult not to think about (Key et al., 2008). The speech acted as a stress task as it contained an element of time constraint and evoked memories about a personal

stressful event that participants previously ruminated about. This was followed by a 15-minute recovery period where state rumination was assessed at five and ten minutes using a thought report diary. Whereas there were no significant differences in the ten-minute recovery measures, participants who scored high on trait rumination were significantly more likely to report rumination after five minutes. Additionally, DBP was significantly higher throughout the whole recovery phase for those who scored higher on trait rumination than those who scored lower. The results indicate that women who tend to ruminate in everyday life are more inclined to ruminate following stress which is also accompanied by higher physiological responses than those who generally do not ruminate.

In another study, 64 (47 female) clinically depressed and non-depressed adolescents took part in a stressful task (Stewart et al., 2013). Those who scored high on a trait rumination scale had a significantly slower recovery of cortisol levels to baseline than participants who scored low suggesting that ruminative tendency is related to prolonged stress recovery. In addition, in the most recent experiment in this area of research, 144 participants performed a five-minute long speech in which they were to present why they were the best candidates for a job (Zoccola & Dickerson, 2015). They were assigned to one of two stress conditions - a social-evaluative threat (SET) stress task condition or a condition without a social component. Whilst two confederates were present during the speech to elevate stress response in the SET condition, participants were alone in the non-SET condition. Trait rumination and cortisol levels were measured. Those participants scoring high on trait rumination had a slower stress recovery as measured by cortisol levels than those scoring low.

One study, however, failed to find a relationship between trait rumination and stress levels. The previously discussed study by Zoccola et al. (2011) where participants completed measures of state rumination before and after sleep and

had their cortisol awakening response measured (CAR) found no significant difference in the CAR between high and low trait ruminators. A possible explanation for such discrepancy in findings may lie in differences in the study design between this and the previously discussed research. Whereas all of the previously discussed experiments employed a stress procedure in their study design, there was no stress task in this experiment. Two distinct suggestions can be made based on these facts. First, whilst there was no stress task and no relationship found between trait rumination and stress levels in the study by Zoccola et al. (2011), the study that employed a stress task found a relationship between these variables (Zoccola & Dickerson, 2015). Therefore, an actual stress experience may be essential for relationships between trait rumination and stress recovery to be detected in research. Second, since the conditions of the study conducted by Zoccola et al. (2011) were close to natural real life conditions and all other discussed research used a laboratory artificial stressor, trait rumination may only play a role in stress recovery in artificial settings and have no impact in natural settings.

These suggestions are slightly contradicted by findings of a more recent study which employed conditions close to natural settings in the absence of a laboratory stressor (Johnson, Brenda, Key, Routledge, Gerin & Campbell, 2014). The research sought to examine the relationship between trait rumination and blood pressure activity during a 24 hour period in 60 undergraduate female students. Participants were assigned to either a high or low trait rumination group based on their scores on a trait rumination scale. They followed a typical daily routine in the university while their blood pressure was measured every 20 minutes during the day and every half an hour at night. High trait ruminators had a significantly smaller drop in DBP from day to night than low trait ruminators suggesting that poorer DBP recovery was related to higher trait rumination. However, no such difference was revealed in SBP. Although no

causal inferences can be made with certainty due to the cross sectional nature of the study, the findings may indicate some role of trait rumination in stress recovery.

Overall, whilst the previously discussed literature on trait rumination consistently shows a relationship between state and trait rumination, findings regarding the relationship between trait rumination and stress recovery are somewhat inconsistent. Nevertheless, the research evidence predominantly indicates that trait rumination is an important factor to be controlled for in research investigating the impact of state rumination on stress recovery.

### *2.3. Is arousal due to rumination or simply negative content?*

The majority of the research discussed so far has investigated the effects of rumination on stress recovery in comparison to the baseline response only. For instance, blood pressure during a recovery phase of an experiment was compared to baseline blood pressure. If recovery blood pressure was significantly higher than a baseline, it was determined that rumination was detrimental to stress recovery. However, such methods bring uncertainty into conclusions on the effects of rumination. It cannot be confidently claimed that significant physiological responses result from the specific way the negative event was recalled that is due to the rumination, and do not simply reflect a negative emotional response to the experience being recalled (Ray, Wilhelm & Gross, 2008). For example, the previously discussed study by Ehring et al. (2009) found no difference in negative mood between the free recall of a distressing event and the rumination about it. Therefore, it is unknown whether previous results on rumination were caused by rumination itself or merely due to thinking about a stressful event. Including a condition in the study that required a drastically different thinking style could help to address this limitation. If recovery measures

indicate a significantly worse stress recovery following rumination than after a different, more positive stress coping procedure, such as reappraisal (to be discussed in section three), then conclusions regarding the negative effects of rumination would be more valid.

### *2.4. Gender effects*

Some of the previously discussed literature studied exclusively female samples (Hu et al., 2014; Key et al., 2008; Santa Maria et al., 2012) due to research reporting that females tend to ruminate more than males, and that recovery from rumination is more prolonged in women (e.g. Nolen-Hoeksema, Larson & Grayson, 1999). However, a more recent study (Ottaviani, Shapiro, Davydov, Goldstein & Mills, 2009) found only limited evidence of sex differences in physiological reactivity to, and recovery from, rumination. Additionally, the previously discussed study by Stewart et al. (2013) found no sex differences in the effects of rumination on stress recovery in a mixed sex sample.

Since literature shows inconsistent findings on sex differences, there is no consistent support for these which would necessitate separate studies of males and females in this research area. However, as there is some evidence of sex differences, to avoid potential confounds and aid generalisability, it is suggested that samples should be sex-balanced, or, if the sample is unbalanced, the data should be analysed for gender differences in key measures before any further analyses are conducted.

## 3. Reappraisal

The theory of appraisal suggests that a cognitive appraisal of a situation determines the way an individual feels about it; that is cognition is related to

emotional experience (Lazarus, 1991). This is fundamental to the concept of reappraisal.

In comparison to rumination, reappraisal is a more positive, future oriented thinking that involves changing the meaning of a negative experience into one which does not cause an intense emotional response (Gross, 1998). It can be carried out, for example, by changing an individual's perspective into a third person's viewpoint (Ray et al., 2008). For instance, following an unsuccessful public performance, reappraising the situation for the speaker would be considering not only his mistakes but also the positives and constructing a balanced representation of the performance which would help to improve future performance. As the intensity of an emotional response is diminished through reappraisal, physiological arousal and perceived psychological stress levels should decrease (Gross, 2002). Therefore, reappraisal has been linked to the lesser signs of psychopathology (Moore, Zoellner & Mollenholt, 2008).

### *3.1. Effects of reappraisal on stress reactivity and recovery*

Research generally indicates a positive effect of reappraisal on psychological reactivity to stress and stress recovery but less so on a physiological stress response (Beltezer, Nock & Jamieson, 2014; Denson, Creswell, Terides & Blundell, 2014; Jamieson, Nock & Mendes, 2011; Wolgast, Lundh & Viborg, 2011). For instance, one study asked 50 participants to perform a stress speech task and assigned them to one of the three groups (Jamieson et al., 2011). One group was instructed to reappraise their arousal during stress, one was asked to ignore stimuli that induced stress, and one received no instructions. The reappraisal group reinterpreted their perception of physiological arousal to stress as a stress adaptive procedure that helped to improve

performance. Following the speech, all participants completed a Stroop task testing them for an attentional bias to emotionally negative and neutral words. The results showed that participants in the reappraisal condition had a significantly higher cardiac output than the no-instruction group; that is the former group demonstrated a more pronounced reactivity to the stress task suggesting a negative impact of arousal reappraisal on physiological recovery. This study, however, did not find any differences in experienced emotions and subjective stress perception between conditions.

Another study with a similar experimental procedure obtained analogous results on physiological response to stress in 85 participants (Beltezer et al., 2014). An important difference in this study was the inclusion of 42 individuals meeting the criteria for social anxiety disorder. The findings showed that participants in the reappraisal condition had a higher serum amyloid A (sAA) reactivity to the stress task than the no-instruction condition. SAA is a lipoprotein responding to inflammation and infection; it predicts cardiovascular disease and is related to cardiovascular stress response (Hansson & Edfeldt, 2005; Willerson & Ridker, 2004).

Nevertheless, contrary to the previously discussed study, the findings also showed significantly more positive appraisals of stress experience, less anxiety and less shame in the reappraisal condition than in the no-intervention group. The difference in the results on psychological response to reappraisal between this and the previously discussed study may be attributable to the difference in the nature of sample. Individuals suffering from social anxiety disorder are more prone to be affected by events containing a social component (Farmer & Kashdan, 2015; Yoon & Joormann, 2011), such as the stress task used in the discussed experiment, and experience more anxiety. The beneficial effects of reappraisal on psychological recovery may be more apparent in individuals

suffering from anxiety whose anxiety levels are initially very high and whose reactivity to stress is higher than those without anxiety disorder.

Wolgast et al. (2011) used a stress procedure of a different nature. They presented 94 participants with sadness, disgust and fear eliciting film clips and assigned them to one of three groups. The reappraisal group was asked to reinterpret emotion-eliciting stimuli in the clips into unemotional stimuli; the acceptance group was asked to fully accept all emotions that the scenes caused without trying to control them; and the watch group simply watched the clips without instructions. The Reappraisal group had a significantly lower skin conductance and reported less psychological distress than the no instruction group demonstrating a positive effect of reappraisal on physiological and psychological state. Nevertheless, this study as well as the previously discussed studies in this section focused on the effects of reappraisal or other stress recovery procedures on stress response. Although the intensity of stress response is positively related to stress recovery, the considered studies have not directly studied the impact of reappraisal on stress recovery.

Contrary to this research, a more recent experiment investigated effects of reappraisal on stress recovery 30 minutes after a stress task (Denson et al., 2014). Ninety participants were assigned to either a reappraisal or a control condition, and performed a stress speech task while their cortisol levels, heart rate and psychological response were monitored. Participants in the reappraisal condition reported significantly less negative feelings and emotions but had significantly higher cortisol levels following the stress recovery period than the control condition. There were no differences in HR measures between conditions.

The research discussed indicates that the effects of reappraisal on physiological and psychological reactivity to stress and stress recovery depend on the type of reappraisal. When reappraisal is directed on reinterpretation of

one's arousal into a stress adaptive process, it intensifies physiological stress response. This happens when individuals learn that stress is a perfectly normal process that helps to mobilise physiological resources to fight stress. The effects of this phenomenon on psychological response are less clear as the research shows mixed results. The literature discussed above indicates that reappraisal directed at reinterpretation of psychological components of a stress situation lowers psychological response. That is when individuals reappraise the situation by turning emotional into unemotional stimuli, which is usually successfully carried out through taking a third person's perspective. In this type of reappraisal, however, the effects on physiological response are less clear. Nevertheless, overall, the literature tends to show that, independent of the type, reappraisal is generally a positive stress recovery procedure for psychological response.

### *3.2. The role of trait reappraisal in stress reactivity*

Trait reappraisal is hereafter defined as an individual's general tendency to use the reappraisal stress recovery procedure in everyday life. Research indicates that trait reappraisal has a positive impact on stress reactivity. Carlson, Dikecligil, Greenberg and Mujica-Parodi (2012) studied the relationship between trait reappraisal and psychological and physiological response to stress. They measured HR and cortisol response in 21 individuals performing a skydive. There was a significant negative correlation between scores on a trait reappraisal measure and cortisol levels, HR and self-reported anxiety. Thus, participants who generally tend to reappraise stressful experiences in daily lives were more likely to have lower physiological and psychological stress responses. However, the analyses did not take into account participants' skydiving experience. For instance, more experienced participants may feel less fear and have a less

pronounced physiological response than those skydiving for the first time. If this is the case, then skydiving experience may have been a confounding variable in this research.

There is other research supporting a relationship between trait reappraisal and stress response. One study found that women who scored higher on trait reappraisal responded to a stressful situation with a drop in blood pressure (Memedovic, Grisham, Denson & Moulds, 2010). Trait reappraisal has been also linked to lower levels of subjective stress-related symptoms (Moore et al., 2008). However, one study found that trait reappraisal predicted higher cortisol levels in response to the stress task suggesting that trait reappraisal is related to heightened physiological reactivity (Lam, Dickerson, Zoccola & Zaldivar, 2009). Nevertheless, all of the mentioned research indicates a relationship between trait reappraisal and stress response making trait reappraisal a relevant variable to be controlled for in stress research and the present study.

## 4. Comparison of effects of reappraisal and rumination

In addition to the discussed research considering effects of reappraisal and rumination on stress recovery separately, there is research comparing the impact of these two recovery stress procedures. It suggests that whilst rumination keeps psychological stress levels from returning to a baseline, reappraisal successfully reduces stress response to a baseline and, overall, is a more positive stress recovery procedure than rumination is.

For instance, in one study 81 participants were asked to recall a recent personal negative event in a free recall experiment stage (Grisham, Flower, Williams & Moulds, 2011). In the instructed recall phase, they were assigned to one of the two conditions – rumination or reappraisal. Whereas participants in

the rumination condition where instructed to turn the event over and over in their minds and focus on the way it made them feel, participants in the reappraisal condition were asked to take a perspective of an impartial observer and think of some positive aspects of the situation. Results showed that participants in both conditions experienced a significant decrease in negative affect from the free to the instructed recall; however, negative affect scores returned to the baseline during the instructed recall only in the reappraisal group. Additionally, whilst the reappraisal group reported a significant increase in positive affect from the free to the instructed recall, the rumination group experienced a significant decrease in positive emotions. Finally, the rumination group had a significantly higher negative and lower positive affect following the instructed recall than the reappraisal group. Therefore, the findings indicate that although both stress recovery procedures were successful at reducing psychological stress induced by the free recall task, only reappraisal reduced psychological stress to baseline levels.

Another study investigated how rumination and reappraisal impact the psychological state of individuals recalling an anger-evoking event (Ray et al., 2008). Anger has been consistently linked to negative emotions, elevated blood pressure and HR and an overall strain on cardiovascular activity (May, Sanchez-Gonzalez, Hawkins, Batchelor, & Fincham, 2014; Richter, Deter, Rudat, Schächinger, Zimmermann-Viehoff & Weber, 2011; Fairclough & Spiridon, 2012). Therefore, since anger is related to a pronounced physiological and psychological impact on an individual, it may be that a state of anger produces a stress experience. Ray et al. (2008) instructed 82 participants to recall a recent personal anger-evoking event and assigned them to either a rumination or a reappraisal condition. The instructions used in these conditions were similar to those described in the previously discussed study (Grisham et al., 2011). The results showed that participants in the rumination condition reported significantly

higher levels of anger and more negative emotions than those in the reappraisal condition, suggesting that rumination is detrimental to stress recovery in comparison to reappraisal. Participants also reported significantly less negative emotion in the reappraisal condition than during the free recall such that psychological stress levels decreased during reappraisal from the recall of the unpleasant event. However, these results should be interpreted with caution. It cannot be inferred that reappraisal decreased stress levels since no results on the differences between the baseline negative emotions and emotions experienced during reappraisal were presented in this research.

Whilst the research discussed in this section focused on the psychological response to reappraisal (e.g. Grisham et al., 2011, Ray et al., 2008), it did not employ any physiological measures of stress. A second experiment by Ray et al. (2008) addressed this limitation by measuring cardiovascular activity. The experiment had a research design similar to the design of the first study by Ray et al. (2008) where 117 participants were asked to recall a recent anger-evoking event and assigned to either a rumination or a reappraisal group. The rumination group reported significantly more anger and had higher cardiovascular activity than the reappraisal group, demonstrating that reappraisal has a positive effect on physiological stress recovery, particularly in comparison to rumination.

## 5. Music

Although results of research on music and stress recovery are inconsistent, a majority of research demonstrates that music positively impacts stress recovery. The research demonstrating these findings will be discussed in the following sections in details. Firstly, the research on music and stress recovery in non-clinical and clinical samples will be considered. Then, gender will

be considered as a potential extraneous variable. Finally, meta-analytic research will be considered.

### *5.1. Music and stress recovery in non-clinical samples*

The research in non-clinical participant samples indicates that music tends to exclusively promote physiological stress recovery and does not impact psychological recovery. In one study 75 participants were asked to perform a mathematical task with an element of harassment (Chafin, Roy, Gerin & Christenfeld, 2004). Then, they listened to personally or experimenter selected music or sat quietly for ten minutes. The only significant difference was that participants listening to classical music had a lower SBP than those who sat quietly. There were no significant differences between conditions in DBP, HR and anxiety levels. Classical music was the only music genre among the studied that had some positive impact on stress recovery. Nevertheless, it had only a partial effect on physiological recovery and no effect on psychological stress response. However, the results on anxiety levels may not be entirely reliable as there was only one measure of anxiety taken in the end of the experiment. Taking multiple measures throughout the experiment would allow for testing differences in subjective stress between experiment phases. Additionally, the only extraneous variable controlled for was use of medications affecting cardiovascular activity which, however, the exact type of such medication was not specified. Therefore, it can be argued that the experiment was poorly controlled.

Another similar experiment also used mathematical tasks as a stress procedure. Twenty individuals performed the task and then listened to either low or high tempo music (Yamamoto, Naga & Shimizu, 2007). Participants in the low tempo music condition had a significantly better mood than those in the high tempo condition. Participants also had a significantly lower HR in both music

conditions than during the stressful task. There were no significant differences in SBP, skin conductance, respiration and cortisol levels between the groups. Although the results indicate that low tempo music is more effective in psychological stress recovery, it cannot be inferred that music promotes HR recovery due to following reasons. The lower HR in the music conditions than in the stress task may have been the result of a natural recovery; and the experiment design did not include a control condition.

Contrary to this experiment, the previously discussed research (Chafin et al., 2004) included a control condition and found that classical music positively affected stress recovery, although according to the SBP measures only. Since the music pieces used in that study were two classical pieces with a changeable tempo and were somewhat effective in cardiovascular stress recovery, low tempo exclusively may not be an important factor in music effects on physiological recovery. The findings by Yamomoto et al. (2007) support this notion as no difference between high and low tempo was found in the cardiovascular recovery measures. However, their findings also indicate that only low tempo music promoted psychological stress recovery. Therefore, using low tempo music in stress research may be good practice if a psychological relaxation effect is to be achieved.

Whilst the previously discussed research used stressful mathematical tasks in their procedures, there are studies which employ different paradigms to induce stress in participants. For example, in one study 29 female participants were asked to watch unpleasant and distressing pictures of mutilated bodies (Sokhadze, 2007). This was followed by listening to pleasant or sad music or white noise. Participants listening to sad music had a significantly higher HR than during the stress procedure, and a significantly larger rise in HR following the task than in the pleasant music and white noise conditions. However, there were

no significant differences in anxiety levels between the experimental manipulation phase of the stress procedure and the music listening phase in all conditions. The results indicate that sad music had a partially negative impact on cardiovascular stress recovery, and that none of the investigated music genres promoted psychological stress recovery. However, it can be argued that psychological stress response was somewhat poorly assessed as participants indicated how stressed, depressed and nervous they felt on a Likert scale. The use of a standardised questionnaire, the inclusion of additional psychological dimensions or the use of a wider Likert scale with more points of values would provide a more comprehensive measure of psychological stress response.

Another study used a social evaluative task as a stress induction procedure, and investigated whether music can act as a buffer against stress (Thoma, La Marca, Bronnimann, Finkel, Ehlert & Nater, 2013). It assigned 60 women to three groups: listening to relaxing music, listening to sound of rippling water, and a control group. Following this, participants performed a social stress task. Cortisol levels were significantly higher in the relaxing music condition than in the sound of rippling water conditions, however, there were no significant differences between both acoustic conditions and the control group. Additionally, no significant differences were found in HR, mood and anxiety between conditions. The findings suggest that the sound of rippling water was more successful in buffering stress comparing to relaxing music, however, both acoustic conditions did not have an effect different from the control group.

### *5.2. Music and stress recovery in clinical samples*

The research on the use of music in stress recovery produces somewhat different results in samples of clinical participants. This research demonstrates a stronger beneficial effect of music on reduction of psychological stress in addition

to physiological stress relief. For instance, in one study, 60 adults aged over 65 undergoing cardiovascular surgery were studied (Twiss, Seaver & McCaffrey, 2006). There were 28 participants who listened to music through headphones during and post-surgery while in intensive care. Participants in the music condition reported significantly less anxiety after surgery and had a significantly shorter intubation time than those in the control condition. The results on the psychological measures indicate that music helped older adults to recover from the surgery stress. The findings provide some support for the results of the previously discussed research (e.g. Yamomoto et al., 2007) where a positive music effect on psychological stress recovery was found when high and low tempo music effects were compared. However, they also contradict the findings of other research (e.g. Chafin et al., 2004) who found no differences in anxiety levels. A possible explanation for the discrepancy may be a difference in the nature of stress experiences used. Whilst studies discussed in the previous section (e.g. Chafin et al., 2004) used an artificial laboratory stressor, this experiment (Twiss et al., 2006) allowed measuring responses to a naturally occurring stressful event. However, the latter research did not use measurements of physiological stress response which precludes conclusions on the effects of the naturally occurring stressor on physiological recovery, although it could be argued that the lower intubation time for participants in the music condition found by Twiss et al. (2006) reflects a better physiological recovery. However, 26 individuals who were going to take part originally could not complete their participation in the study due to the post-surgery complications. Fourteen among them were in the experimental group. It is unclear what caused these complications, nevertheless, music was not a sufficient factor to decrease intubation time for these participants. However, since the measures of anxiety could not be obtained post-surgery, it cannot be concluded that music did not relieve anxiety for these individuals.

The following study (Kushnir, Friedman, Ehrenfeld & Kushnir, 2012) addressed the limitation of the previously discussed study and employed physiological, in addition to psychological, measures of stress. The study investigated the impact of music on stress relief in 60 females who were about to undergo a cesarean section. One group listened to popular, classical or Israeli tuned music for 40 minutes and then underwent surgery. Women in the music condition had significantly more positive and less negative moods, and lower SBP after listening to music than at the baseline. There was an opposite pattern in the mood results for participants in the no-music condition, and a significantly higher DBP and respiratory rate after 40 minutes than at the baseline.

This indicates that whilst music promoted psychological and, to an extent, physiological pre-surgery stress recovery, having no intervention resulted in an increased psychological and physiological stress response. Nevertheless, participants in the no-music condition had a significantly higher number of previous births than those in the music condition. Therefore, this could have decreased their levels of stress due to having more experience in child birth. However, although the results still demonstrated higher stress levels in the no-music condition, the significance may have been higher had there been no difference in child births between the groups. The results are also consistent with the previously discussed study (Twiss et al., 2006) which found positive music effects on psychological stress recovery suggesting music promotes stress reduction.

### *5.3. Gender differences*

Some of the previously discussed research on music and stress recovery (Kushnir et al., 2012; Sokhadze, 2007; Thoma et al., 2013) investigated female samples only. Since research indicates that there are gender differences in

reactivity to stress (Uhart, Chong, Oswald, Lin & Wand, 2006; Verma, Balhara & Gupta, 2011), it would be useful to look into the findings of music effects in an exclusively male sample. To the best of knowledge, one such study exists where 24 men were asked to perform a speech in front of the panel of judges (Khalfa, Bella, Roy, Peretz & Lupien, 2003). During the recovery phase after the stress task, participants either listened to music or simply sat silently. Whilst there were no changes in cortisol levels from the stress task to the recovery phase in the music group, cortisol significantly increased in the silent group.

The results demonstrated that whilst music did not promote stress recovery, it helped to prevent a further deterioration of stress symptoms, and was more efficient than having no intervention. The findings cannot be entirely fairly compared with the previously discussed research (Sokhadze, 2007; Kushnir et al., 2012) as cortisol levels were not measured there. Nevertheless, the results are very similar to findings of one study (Thoma et al., 2013) that also revealed no differences in cortisol levels between music and control conditions in a strictly female sample; thus, the findings of these two studies indicate that gender is unlikely to become an extraneous variable. Nevertheless, having some research evidence of gender differences in stress reactivity, it is suggested that the outcome measures in stress research with a mixed gender sample should be analysed for gender differences to prevent gender from becoming an extraneous variable.

### *5.4. Meta-analyses*

Since the research findings considered so far are inconsistent, it can be beneficial to review meta-analytic studies. Meta-analyses allow pooling the results of a number of studies on a certain phenomenon and determining precise effects (Burcharth, Pommergaard & Rosenberg, 2015). One such research

analysed the results of 32 studies on music effects on stress recovery in cancer patients (Zhang, Wang, Yao, Zhao, Davis, Walsh & Yue, 2012). The findings revealed that music significantly decreased anxiety, depression, pain, heart rate, respiratory rate and improved a quality of life. However, it did not produce significant difference in fatigue, and SBD and DBP. Similarly, another study conducted a meta-analysis and found that 11 studies out of 12 analysed suggested a positive impact of music on anxiety reduction (Cooke, Charboyer and Hiratos, 2004).

Both meta-analyses indicate that, overall, music relieves stress symptoms. Nevertheless, the common critique of meta-analyses is that its findings can be misleading as the data of studies with different methodologies are analysed as one (Burcharth et al., 2015). To illustrate the point, some of the studies included in one of the meta-analyses (Zhang et al., 2012) did not provide a detailed procedure of music selection that can be an important factor in stress recovery. For instance, Bradt, Dileo and Potvin (2013) found that individuals suffering from coronary heart disease who personally selected music genre had significantly lower anxiety levels than those who did not have such an opportunity.

## 6. Research on influences on stress

It is important to understand potential influences on stress in order to control for them in stress research. There are different important variables that can elevate stress by increasing physiological and psychological response. Interestingly, a lot of these variables are often unaccounted for in stress research which can potentially affect the results and produce a wrongful message. Therefore, it is highly important to be aware of such variables in order

to control them and control for how they affect responses in a given study. These variables will be discussed in this section further.

### *6.1. Coffee intake*

Caffeine increases physiological response and alertness (Smith, 2002). It has been also found that approximately 130 mg of caffeine significantly continuously increased HR for a period of a half an hour (McMullen, Whitehouse, Shine, Whitton and Towell, 2011). However, following this, the same amount of time was needed for HR recovery to the baseline. Therefore, an approximate time of one hour is suggested to be allowed after one coffee intake before the physiological baseline is reached. In another study, a mixed sample of 77 males and females was studied (Hartley, Lovallo & Whitsett, 2004). Similar results were found where caffeine produced increases in SBP and DBP. Finally, a more recent study with a larger sample of 369 participants revealed significantly higher anxiety, alertness and faster reaction times in those who drank more coffee than those who drank less (Rogers, Heatherley, Mullings & Smith, 2013). Overall, the research evidence shows that caffeine increases physiological response and also affects individual's psychological state which makes it an important variable to be controlled for in stress research.

### *6.2. Alcohol*

Individuals who consume alcohol on a specific occasion have a significantly higher HR than those who do not (Lewis & Vogeltanz-Holm, 2002). Alcohol intake also increases the number of speech errors and pauses (Tisljár-Szabó, Rossu, Varga & Pléh, 2014) which is an important factor in stress research employing speech tasks as a stress procedure. Research indicates that

SBP, DBP and HR significantly drop during alcohol withdrawal (Kähkönen, Zvartau, Lipsanen & Bondarenko, 2011); and Prat, Adan, Pérez-Pàmies & Sànchez-Turet (2008) reported in their review that hangover, characterised by negative physical and mental states the morning after alcohol consumption, is accompanied by slower reaction time, poorer attention and cognitive abilities, and subjectively lower alertness and more tiredness. Taking into consideration both the effects of alcohol and a potential hangover occurring approximately 14-15 hours following alcohol consumption, in the best practice of stress research, participants should not consume alcohol approximately 24 hours before their participation.

### *6.3. Smoking*

Smoking increases activity of the sympathetic nervous system and decreases parasympathetic activity that results in a higher SBP, DBP and HR (Dinas, Koutedakis & Flouris, 2013). Additionally, it has been found that smoking increases physiological reactivity and negative mood in response to stress situations (McKee, Sinha, Weinberger, Soufuoglu, Harrison, Lavery & Wanzer, 2010). As such, smoking prior to the experiment could potentially increase physiological response to the stress task. By interfering with participants' reactivity to stress, smoking may change their pattern of stress recovery as well. Therefore, smoking behavior should be controlled for in stress research to avoid it becoming an extraneous variable and affecting cardiovascular activity.

### *6.4. Intense physical activity*

Llorens, Sanabria and Huertas (2015) found that individuals with lower levels of physical fitness performed a spatial task more poorly following intense

physical exercise than they did beforehand whilst there was no such effect in participants with higher levels of fitness. Therefore, intense exercise before participation can affect cognition during stress tasks in low fitness individuals, which consequently may impact stress response and recovery. Since it is difficult to foresee the physical fitness of participants prior to an experiment, asking participants not to do any intense exercise before the study would eliminate the potential impact of fitness on task performance.

### *6.5. Oral contraceptives*

There are mixed findings on the effects of oral contraceptives on cardiovascular activity. For example, Naz, Jyoti, Afzal and Siddique (2012) suggested in their research review that oral contraceptives change the biochemical balance of such substances as lipoproteins and serum cholesterol and, thus, alter cardiovascular activity (Naz et al., 2012). However, another study assessed 12 women who performed a physical challenge testing cardiovascular response to stress, and found no effects of oral contraceptives on mean arterial pressure or HR (Carter, Klein & Schwartz, 2009). Therefore, due to inconsistent research findings, it is suggested that the use of oral contraceptives should be registered in stress research and analysed for its impact on the outcome variables.

### *6.6. Perceived stress*

Chronic stress is associated with lower DBP which demonstrates a diminished physiological response (Ohira, Matsunaga, Kimura, Murakami, Osumi, Isowa, Fukuyama, Shinoda &Yamada, 2011). This suggests that individuals who perceive a high level of stress in everyday life may demonstrate an unusually low

physiological response when exposed to a laboratory stressor, making perceived stress an important variable to be controlled for in stress research.

## 7. Rationale and research aims

Since stress has been linked to depression, PTSD, cardiovascular disease and high mortality, it is highly important to investigate positive and negative ways of dealing with stress. The considered research suggests that whilst rumination is detrimental to stress recovery, reappraisal and music have a more positive impact on both subjective and physiological states following exposure to stress. However, there is a number of issues in the existing research. Firstly, rumination has been largely studied in isolation from other techniques to this date; and only a scarce number of studies considered effects of rumination in comparison to techniques of a drastically different thinking style, such as reappraisal. The results of such research can be misleading for the following reason. It is uncertain whether rumination indeed hinders stress recovery or the negative effects in research were assigned to rumination when, in fact, they were purely a result of a negative content brought into participants' minds. Secondly, there is a very limited research on effects of reappraisal. Finally, the findings regarding the effects of music are inconsistent.

The present research aims to address these limitations. In the present study, participants performed a stress task and were assigned to rumination, reappraisal or music conditions. Systolic and diastolic blood pressure, heart rate and mood were measured at the baseline, during the stress task and at the 15-minute recovery. Important variables were controlled for. The main experiment aim was to assess the differences in participants' physiological and psychological recovery among the three named stress recovery procedures.

# Chapter 2

# Method

## Participants

Participants were 72 students from the University of Huddersfield (49 females); 25 participants were in the rumination condition, 24 in the reappraisal condition, and 23 in the music condition. The age range of the sample was from 18 to 62 years-old with a mean age = 23.70 years (SD = 8.11). Exclusion criteria were: consuming alcohol 24 hours before the study; consuming coffee, smoking or having an intense exercise one hour before; and having psychotic disorder, conduct disorder, developmental disability, or substance dependence; and being clinically diagnosed as having anxiety disorder or depression. These were assessed by a self-report checklist available in Appendix 1. Inclusion criteria were any individuals of age 18 and above who did not meet exclusion criteria. Whereas participants who were students of the University of Huddersfield received course credits in exchange for their participation in the study, those participants who were not students received a chocolate incentive.

## Apparatus and materials

*Apparatus*

An Omron HEM-907 Clinically Validated Blood Pressure Meter was used to measure Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP) and Heart Rate (HR). A video camera and a tripod were used to film participants' speech during the stress task. Headphones were used for participants who listened to music in the music condition.

*Questionnaires*

*Visual Analogue Scales (VAMS)* were used to measure immediate mood. This is a suitable measure for the purpose of the study as it is brief, precise and easy to administer unlike the Stress Arousal Checklist (Cox & Mackay, 1985), the Positive and Negative Affect Scale (Watson, Clark & Tellegen, 1988), and the Emotional Stress Reaction questionnaire (Larsson & Wilde-Larsson, 2010). Participants indicated how relaxed, tense, calm, nervous and ashamed they felt on a scale from '0' (not at all) to '100' (extremely). A higher score indicated more intense emotion. In addition, the five following emotion words were used as filler items to attempt to prevent participants from knowing which emotions were the focus of investigation: happy, tired, alert, scared and excited. The VAMS are available in Appendix 2.

*Perceived Stress Scale (PSS,* Cohen, Kamarck & Mermelstein, 1983*)* was employed to measure the extent to which participants perceived their lives as uncontrollable, unpredictable and overloading, and thus indicated their level of chronic stress. The questionnaire consists of ten questions, e.g. 'In the last month, how often have you felt nervous and "stressed"?' (Item 3), and asks participants to indicate a frequency of feelings on a scale from 0 'never' to 4 'very often'. A higher score indicates a higher level of perceived stress. The scale is available in Appendix 3. Lee (2012) reported that this measures has been found to have a good internal consistency in 12 studies (Chronbach`s α >.70), good test-retest reliability in four studies (r >.70); and scores of the PSS had a moderate-to-strong correlations (r >.70) with questionnaires measuring emotional variables, such as Beck Depression Inventory (Beck, Steer & Garbin, 1988), State-Trait Anxiety Inventory (Spielberger, 1983), and General Health Questionnaire (Goldberg & Williams, 1991). Cohen and Janicki-Deverts (2012) also found a good reliability of this scale (Chronbach`s α between .78 and .91).

Finally, the PSS had a good internal consistency in the present sample (Chronbach`s α = .87).

*Emotion Regulation Questionnaire* (*ERQ*, Gross & John, 2003) was used to assess the way individuals usually deal with emotions caused by stress. The ERQ is designed to assess cognitive reappraisal and expressive suppression, and contains five statements measuring each behaviour, e.g. 'When I want to feel more positive emotion, I change the way I'm thinking about the situation' (Item 7 from the cognitive reappraisal subscale), 'When I am feeling negative emotions, I make sure not to express them' (Item 9 from the expressive suppression subscale).The questionnaire asks participants to indicate the extent to which the presented statement describes their behavior on a scale from 1 'strongly disagree' to 7 'strongly agree'. A higher score indicates a higher tendency to reappraise and suppress emotions. The scale is available in Appendix 4. It is a reliable measure (Reappraisal subscale: Chronbach`s α from .75 to .82; Suppression subscale: Chronbach`s α from .68 to .76); and has a good test-retest reliability (r=.69, Gross & John, 2003). Ioannidis and Siegling (2015) found that whilst the Suppression subscale items significantly negatively correlated with positive affect (r=-.08), the Cognitive reappraisal subscale items were significantly negatively related to negative affect (r=-.27) and significantly positively related to positive affect (r=.24). Both subscales had good reliability in the present sample (Reappraisal subscale: Chronbach`s α =.89; Suppression subscale: Chronbach`s α =.81).

*Perseverative Thinking Questionnaire* (PTQ, Szkodny, 2010) was used to assess trait rumination. The PTQ contains a total of 26 items measuring five aspects of worry and rumination: general, future control, understanding, past-focused and obsessive repetitive thinking. However, for the purposes of the present experiment, only six items measuring past-focused (PAST) repetitive

thinking were used, e.g. 'Things I've said or done always seem to be playing in my mind' (Item 1). Participants were asked to indicate the extent to which the statements are true of themselves on a scale from 1 'not at all like me' to 6 'very much like me'. The questions used are available in Appendix 5. Szkondy (2010) found a good internal consistency (Chronbach`s α = .87) and test-retest reliability (r =.80) for the selected subscale of the PTQ. Significant correlations have been found between the selected subscale items and the Generalized Anxiety Disorder Questionnaire (Newman, Zuellig, Kachin, Constantino, Przeworski, Erickson & Cashman-McGrath, 2002), r =.56, Response Styles Questionnaire (RSQ; Nolen-Hoeksema & Morrow, 1991), r =.41, negative affect of the PANAS (Watson et al., 1988), r =.45, and positive affect, r =-.26 (Szkondy, 2010).The PAST subscale had good reliability in the present sample (Chronbach`s α = .81).

*Short Test of Music Preference* (STOMP, Rentfrow &Gosling, 2013) was used to control for preference of music genres. It allowed monitoring any discrepancies between music preference and a choice of music in the experiment. The questionnaire contains 14 items: Classical, Blues, Country, Dance/Electronica, Folk, Rap/Hip-hop, Soul/Funk, Religious, Alternative, Jazz, Rock, Pop, Heavy metal, and Soundtracks/Theme songs. The scale is available in Appendix 6.

*Stress task*

The stress task used in the experiment was a slightly modified Trier Social Stress Test (TSST). The TSST is an appropriate standardised protocol for stress induction and has been widely used in stress research previously (Brikett, 2011). Due to limited time and resources, only the first task of the TSST; the job interview, was used in the present study. The test required participants to perform a five-minute long presentation on why they are suitable for a job in the

presence of the researcher and an assistant. The job position participants were applying for was up to their imagination. Participants` speech was recorded on a video camera. This was done to manipulate stress only, and all recordings were destroyed immediately after the experiment. Participants had three minutes to prepare for their speech; and they were given a piece of paper and a pen in case they wanted to write their thoughts down. If participants struggled to speak after three minutes of their speech, the researcher asked some of the questions from the list of standard questions. The full list of questions and task instructions are available in Appendix 7 and Appendix 8.

*Conditions*

*Rumination*. Participants were given the following instruction in the Rumination condition: "Think of the situation that has happened and focus on it from your own perspective turning it over and over in your mind. Focus on things that made you feel and respond this way." These are standard instructions that have been used in the rumination research before (Ray et al., 2008; Grisham et al., 2011).

*Reappraisal.* Participants in the reappraisal condition were instructed to "Think of the situation that has just happened from a 3rd person`s perspective as if you were an impartial observer. Think of some positive aspects of the situation, such as lessons you have learnt and ways you can improve in the future if the same event or situation was to arise." These are also standard instructions that have been used in the reappraisal research previously (Ray et al., 2008; Grisham et al., 2011).

*Music*. The music condition required participants to select and to listen to one of the five options of music selection or sound – "Classical", "Hip-Hop, Rap and RnB", "Jazz and Blues", "Rock" and "Sound of rippling water". Low tempo music (i.e Andante, Adagio, Largo) representative of each style was selected and

obtained from the two databases of royalty free music (http://incompetech.com/ and http://www.freemusicarchive.org/). Music was administered through headphones; and participants selected a preferable volume themselves. After music listening, participants were asked to report whether the selected music evoked any personal memories ("Was a selected piece of music/sound associated with any personal memory?). If they answered 'yes', they were asked to report the mood of the evoked memory ("Was this memory positive, negative or neutral?"). Participants also indicated a reason for the music choice.

**Procedure**

Participants were asked to abstain from alcohol consumption 24 hours prior to the study, and from coffee drinking and smoking one hour before the study. In the laboratory experiment, participants were seated and informed about the procedure, confidentiality of their participation and their right to withdraw at any time without giving a reason up until the data analyses are conducted. Informed consent for participation was obtained in a written form. The participant information sheet and the consent form are available in Appendix 9.

Participants completed a 'yes/no' questionnaire assessing coffee and alcohol intake and smoking. If any of these questions were answered with 'yes', participants were thanked for coming and offered to reschedule their participation in the study. The checklist also contained questions assessing for anxiety disorder, psychotic disorder, conduct disorder, developmental disability, substance dependence, and use of mood-altering medications, anti-hypertensive medications and oral contraceptives.

Participants' physiological baseline SBP, DBP and HR was established by taking measures of SBP, DBP and HR at the second, fourth and sixth minute of the seven-minute long baseline period. Participants read neutral magazines, such as "Nature" and "National geographic", during this phase. Following this, they immediately completed the baseline VAMS, the PSS, and the ERQ.

Participants were then randomly assigned to one of the three conditions - rumination, reappraisal or music - by a method of computer random number generation. Additionally, participants in the Rumination condition completed the PTQ, and participants in the music condition completed the STOMP.

Following this, participants were exposed to the stress task where they performed a speech task in front of the researcher and a video camera. Physiological measures were taken by a research assistant at the start of, and on the second and the fourth minute of the five-minute long speech. After the task, participants immediately competed the VAMS and indicated how engaging the task was on a Likert scale from one 'not engaging at all' to 7 ' highly engaging'.

The recovery phase took approximately 15 minutes during which, according to the instructions, participants ruminated about or reappraised the stress task situation or listened to the selected genre of music. The physiological data was recorded at the start and every two minutes of this period resulting in a total of eight measures taken.

Immediately following this, participants from all conditions completed the VAMS for the last time and indicated how well they adhered to the instructions on a Likert scale from 0 'did not adhere at all' to 7 'adhered strongly'. Finally, all of the apparatus were detached, participants were debriefed, thanked for their participation and asked if they had any questions. The debriefing report is available in Appendix 10. The whole experiment took approximately 45 minutes.

**Data analyses**

*D-score*. For the purposes of analyses, D-scores for physiological and mood recoveries were calculated. D-scores were the differences between the recovery and the baseline measures (Salkind & Rasmussen, 2007); and have been calculated by subtracting the mean recovery measure values from the mean baseline value. Such a strategy has been previously used in research (Levesque, Moskowitz, Tardif, Dupius & D'Antono, 2010; Stewart, Janicki & Kamarck, 2006); and has been found to minimise the effects of measurement errors and improve reliability (Kamarck, Debski & Manuck, 2000; Rutledge, Linden & Paul, 2000). For example, if a participant with an unusually high SBP were to take part in the study, his data would not skew the results as only his SBP difference between the baseline and the recovery would be measured. Thus, this technique minimises the effects of individual differences in baseline SBP measures as a potential extraneous variable in independent groups designs such as the present.

*MAP*. Mean Arterial Pressure (MAP) is an important cardiovascular variable that illustrates the average arterial blood pressure of the whole cardiac cycle (Mohrman & Heller, 1996). It has been found to be a more sensitive and reliable measure than SBP in detection of hypotension, low blood pressure, and hypertension, high blood pressure (Henry, Miller, Kelly & Champney, 2002; Miller, Rosales, Kelly & Henry, 2005). Therefore, it is a more reliable reflection of cardiovascular activity and stress response and is a useful additional parameter to counteract any unstable or unreliable blood pressure measures. It was calculated using the following formula: MAP = (1/3 x SBP) + (2/3 x DBP) (Stouffer, 2007). MAP D-score was calculated by subtracting the mean recovery MAP from the mean baseline MAP.

**Data analytic strategy**

A series of 3x10 mixed analyses of variance (ANOVA) were carried out on the physiological data where the three between-group factors were the conditions (rumination, reappraisal, music) and the ten repeated measures factors were the mean baseline SBP, DBP and HR; the mean task SBP, DBP and HR, and eight SBP, DBP and HR recovery D-scores. Greenhouse-Geisser correction for degrees of freedom are reported where the assumptions of sphericity have been violated.

Mood data were analysed using a series of one-way ANOVAs where the three between-group factors were the conditions (rumination, reappraisal and music), and the dependent variables were D-scores on feeling relaxed, tense, calm, nervous and ashamed.

The data on the MAP D-scores were analysed using a one-way ANOVA where the three between-group factors were the conditions (rumination, reappraisal, and music) and the dependent variable was the MAP D-scores.

The data on scores of the PSS and ERQ questionnaires, and the control variables (e.g. use of oral contraceptives) were analysed using a chi-squared test to examine associations between perceived stress, emotion regulation and the control variables.

In order to examine the extent to which age, scores on PSS, and scores on Suppression and Reappraisal subscales of the ERQ predicted physiological and psychological stress recovery, nine simple linear regressions were calculated each with a specific criterion (D-scores on feeling Relaxed, Tense, Calm, Nervous and Ashamed; mean D-scores of SBP, DBP and HR; and a MAP D-score). For each of these analyses four predictors were entered (age, score on PSS, and scores on Suppression and Reappraisal subscales of the ERQ).

To determine whether sex predicted physiological and psychological stress recovery, independent t-test was conducted where sex was an independent variable and nine dependent variables were D-scores on feeling Relaxed, Tense, Calm, Nervous and Ashamed; mean D-scores of SBP, DBP and HR; and a MAP D-score.

Two series of nine simple linear regressions were calculated to study whether trait rumination predicted stress recovery in the Rumination group, and whether trait reappraisal predicted stress recovery in the reappraisal group. For each of the regressions a specific criterion (D-scores on feeling Relaxed, Tense, Calm, Nervous and Ashamed; mean D-scores of SBP, DBP and HR; and a MAP D-score) and one of the two predictors (scores on the PTQ, and scores on the Reappraisal subscale of the ERQ) were entered.

# Chapter 3

# Results

## Descriptive statistics

*Physiological measures*. Means and standard deviations of the mean baseline, mean stress task and eight recovery SBP, DBP and HR are shown in Table 1.

Table 1: Mean (SD) SBP, DBP and HR during baseline, stress task and eight recovery measures.

| | | Baseline | Task | Rec1 | Rec2 | Rec3 | Rec4 | Rec5 | Rec6 | Rec7 | Rec8 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **SBP** | **Rumination** | 112.58 (*10.72*) | 128.22 (*14.74*) | 114.25 (*13.05*) | 111.85 (*11.53*) | 110.60 (*12.48*) | 110.20 (*12.91*) | 109.95 (*11.99*) | 111.05 (*14.14*) | 110.20 (*10.70*) | 110.75 (*12.76*) |
| | **Reappraisal** | 116.37 (*13.68*) | 127.71 (*18.48*) | 118.60 (*15.11*) | 114.45 (*13.44*) | 113.20 (*14.28*) | 112.25 (*12.66*) | 114.55 (*14.70*) | 112.30 (*13.89*) | 112.05 (*13.17*) | 112.30 (*13.39*) |
| | **Music** | 113.53 (*9.89*) | 133.72 (*10.88*) | 118.84 (*13.70*) | 115.58 (*11.36*) | 114.21 (*10.18*) | 112.74 (*11.61*) | 112.89 (*11.71*) | 113.16 (*11.44*) | 112.58 (*11.02*) | 112.53 (*9.26*) |
| **DBP** | **Rumination** | 67.22 (*7.07*) | 83.23 (*13.09*) | 71.10 (*8.34*) | 68.70 (*9.11*) | 66.75 (*8.21*) | 66.85 (*9.71*) | 66.25 (*8.83*) | 66.85 (*9.34*) | 65.55 (*8.44*) | 65.95 (*8.33*) |
| | **Reappraisal** | 72.22 (*9.07*) | 87.55 (*9.16*) | 73.50 (*9.29*) | 71.80 (*8.80*) | 70.25 (*9.42*) | 70.25 (*8.87*) | 72.35 (*14.10*) | 72.15 (*14.68*) | 70.60 (*8.88*) | 70.33 (*8.77*) |
| | **Music** | 68.90 (*6.45*) | 90.56 (*7.72*) | 77.11 (*10.73*) | 74.68 (*7.58*) | 73.11 (*11.36*) | 72.68 (*9.72*) | 72.79 (*10.29*) | 71.42 (*9.21*) | 71.53 (*10.28*) | 70.53 (*9.05*) |
| **HR** | **Rumination** | 72.78 (*13.58*) | 84.63 (*14.05*) | 70.45 (*13.72*) | 71.35 (*13.82*) | 71.60 (*14.98*) | 71.60 (*13.61*) | 70.55 (*12.66*) | 71.25 (*13.53*) | 72.65 (*13.95*) | 72.35 (*12.85*) |
| | **Reappraisal** | 76.18 (*10.35*) | 87.30 (*11.38*) | 72.80 (*8.95*) | 73.40 (*10.71*) | 72.80 (*10.79*) | 74.90 (*10.45*) | 76.40 (*10.29*) | 74.50 (*9.43*) | 73.35 (*10.69*) | 75.85 (*9.59*) |
| | **Music** | 75.20 (*14.28*) | 91.47 (*17.99*) | 70.74 (*13.07*) | 72.21 (*12.88*) | 73.53 (*13.39*) | 74.11 (*13.88*) | 74.58 (*14.12*) | 73.95 (*12.86*) | 75.84 (*13.70*) | 74.16 (*12.86*) |

Means and standard deviations of the SBP, DBP and HR recovery D-scores are available in Table 2.

Table 2: Mean (SD) SBP, DBP and HR recovery D-scores for all conditions.

| | | Rec1 | Rec2 | Rec3 | Rec4 | Rec5 | Rec6 | Rec7 | Rec8 |
|---|---|---|---|---|---|---|---|---|---|
| **SBP** | **Rumination** | -1.19 (*5.24*) | .81 (*6.81*) | 2.48 (*7.43*) | 2.81 (*5.24*) | 3.15 (*6.21*) | 2.54 (*4.88*) | 3.09 (*4.87*) | 1.81 (*4.98*) |
| | **Reappraisal** | -1.25 (*6.80*) | 3.81 (*7.64*) | 4.88 (*7.25*) | 6.13 (*6.78*) | 3.06 (*6.93*) | 5.63 (*5.39*) | 6.25 (*6.81*) | 6.56 (*6.51*) |
| | **Music** | -3.01 (*6.50*) | .28 (*4.98*) | 1.99 (*6.35*) | 3.28 (*6.63*) | 2.75 (*6.75*) | 3.05 (*6.11*) | 2.64 (*7.07*) | 3.87 (*7.27*) |
| **DBP** | **Rumination** | -3.61 (*4.65*) | -1.11 (*5.74*) | .94 (*4.15*) | .67 (*4.63*) | 1.89 (*4.36*) | .72 (*4.81*) | 2.00 (*4.06*) | 1.72 (*3.96*) |
| | **Reappraisal** | .04 (*5.04*) | 1.42 (*4.64*) | 2.92 (*6.34*) | 3.60 (*7.12*) | .29 (*12.60*) | .54 (*12.14*) | 3.04 (*8.03*) | 3.42 (*6.81*) |
| | **Music** | -5.44 (*4.77*) | -3.15 (*5.50*) | -1.26 (*4.45*) | -.91 (*5.19*) | -1.38 (*5.48*) | -.38 (*4.22*) | -.26 (*6.53*) | .38 (*5.82*) |
| **HR** | **Rumination** | 1.83 (*5.93*) | .94 (*6.61*) | .28 (*8.18*) | .61 (*6.14*) | 1.78 (*6.14*) | .67 (*4.99*) | -.17 (*7.59*) | -.17 (*6.56*) |
| | **Reappraisal** | 4.85 (*6.24*) | 2.73 (*5.93*) | 2.98 (*4.63*) | 1.73 (*7.*80) | .04 (*7.57*) | 3.04 (*6.31*) | 3.04 (*4.73*) | 2.04 (*9.14*) |
| | **Music** | 5.08 (4.*54*) | 3.37 (*4.28*) | 2.25 (*3.74*) | 1.96 (*3.93*) | 1.73 (*4.46*) | 1.84 (*5.32*) | .37 (*4.80*) | 1.55 (*4.93*) |

The rumination condition had the highest mean MAP D-score (M=.66, SD=4.29), followed by the reappraisal (M= -.79, SD=12.36), and the music (M= -.94, SD=4.41) conditions.

*Mood*. Means and standard deviations of the recovery scores on the VAMS across conditions are available in Table 3.

Table 3: Mean (SD) VAMS scores at baseline, post stress task, and post recovery in the rumination (Ru), reappraisal (Re) and music (Mu) groups.

| | **Baseline** | | | | **Stress task** | | | | **Recovery** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ru | Re | Mu | Total | Ru | Re | Mu | Total | Ru | Re | Mu | Total |
| **Relaxed** | 8.68 (*24.63*) | -1.83 (*18.62*) | -5.91 (*16.00*) | 69.31 (*19.23*) | 45.72 (*26.93*) | 45.17 (*23.01*) | 26.13 (*5.45*) | 41.42 (*25.76*) | 62.28 (*23.19*) | 72.00 (*14.49*) | 72.52 (*24.22*) | 68.79 (*21.32*) |
| **Tense** | 21.32 (*23.60*) | 28.63 (*22.68*) | 30.96 (*24.50*) | 26.83 (*23.63*) | 34.68 (*24.40*) | 38.92 (*23.95*) | 48.22 (*28.78*) | 40.42 (*25.99*) | 21.44 (*21.09*) | 18.63 (*17.99*) | 19.04 (*21.29*) | 19.74 (*19.93*) |
| **Calm** | 68.16 (*24.30*) | 73.04 (*17.12*) | 66.74 (*24.41*) | 69.33 (*22.05*) | 34.28 (*25.63*) | 38.38 (*25.34*) | 33.87 (*21.97*) | 35.51 (*24.16*) | 57.88 (*26.62*) | 64.92 (*19.86*) | 68.35 (*23.61*) | 63.57 (*23.65*) |
| **Nervous** | 18.96 (*20.87*) | 22.75 (*22.41*) | 28.04 (*22.33*) | 23.12 (*21.87*) | 33.12 (*27.84*) | 37.71 (*28.36*) | 51.70 (*27.54*) | 40.58 (*28.63*) | 11.28 (*16.05*) | 10.17 (*14.31*) | 10.43 (*10.97*) | 10.64 (*13.18*) |
| **Ashamed** | 2.36 (*9.05*) | 1.17 (*3.21*) | 3.78 (*10.68*) | 2.42 (*8.22*) | 6.12 (*11.72*) | 6.13 (*11.30*) | 13.13 (*17.25*) | 8.36 (*13.82*) | 4.24 (*8.97*) | 2.33 (*6.51*) | 2.43 (*4.93*) | 3.03 (*7.02*) |

Means and standard deviations of the recovery D-scores on the VAMS are available in Table 4.

Table 4: Mean (SD) VAMS D-scores at baseline, post stress task and post recovery in the rumination, reappraisal and music groups.

| | **Relaxed** | **Tense** | **Calm** | **Nervous** | **Ashamed** |
|---|---|---|---|---|---|
| **Rumination** | 8.68 (*24.63*) | -.12 (*21.81*) | 10.28 (*30.49*) | 7.68 (*19.42*) | -1.88 (*10.01*) |
| **Reappraisal** | -1.83 (*18.62*) | 10.00 (*26.54*) | 8.13 (*19.67*) | 12.58 (*20.42*) | -1.17 (*5.43*) |
| **Music** | -5.91 (*16.00*) | 11.91 (*20.55*) | -1.61 (*25.06*) | 17.61 (*19.53*) | 1.35 (*9.40*) |

*Music choice*. In the music condition, three participants chose to listen to "Classical" music (13 %), nine chose "Hip-Hop, Rap and RnB" option (39 %), one selected "Jazz and Blues" (4%), five listened to "Rock" (22 %) and five chose to listen to the "Sound of rippling water" (22%). Fifteen participants reported selecting a particular music option because they "enjoyed" or "liked" it; five said that the chosen genre "is relaxing"; two explained their choice by the fact that it reminded them of their parents; and one reported that the chosen music style distracted them from the previous stress task. Participants' choice of music was consistent with the music style they assigned one of the highest scores on the Short Test of Music Preference (STOMP), indicating their high preference for the chosen style. Six participants reported that the music evoked some personal memories, however, memories had a positive nature for all of them.

*Questionnaires*. The Rumination group (M=21.40, SD=4.05) had the highest mean score on the Perceived Stress Scale, followed by the music (M=19.96, SD=4.18) and the reappraisal groups (M=19.79.79, SD=2.80). The highest mean score on the Emotion Regulation Questionnaire was in the reappraisal condition (M=45.48, SD=10.27), followed by the rumination (M=43.52, SD=7.21) and the music conditions (M=43.13, SD=7.42).

*Task engagement*. On average, the stress task was sufficiently engaging for participants (M=5.67, SD=1.20, Mode=6) with a maximum task engagement value assigned of seven and the minimum value assigned of three. The rumination group reported the strongest adherence (M=5.72, SD=1.37), followed by the reappraisal group (M=5.71, SD=1.00); and the music group had the lowest adherence (M=5.57, SD=1.24).

*Adherence check.* Overall, participants moderately adhered to the instructions of the recovery phase (M=6.35, SD=1.2). The music group reported the strongest adherence (M=6.70, SD=1.11), followed by the reappraisal group (M=6.42, SD=1.14); and the rumination group had the lowest adherence (M=5.96, SD=1.27).

*Other variables*. One participant reported using mood-altering medications, two reported using anti-hypertensive medications, and two suffered from anxiety disorder at the time of the experiment. None had psychotic disorder, conduct disorder, developmental disability, or substance dependence. Nine female participants reported using oral contraceptives.

**Pre-experimental checks**

*Physiological measures*. There were no significant differences between conditions in baseline SBP, $F$ (2, 71) =.423, $p$=.66, $\eta^2$ =.012; DBP, $F$ (2, 71) =.951, $p$=.39, $\eta^2$ =.027; or HR, $F$ (2, 71) =.028, $p$=.97, $\eta^2$ =.001.

*Mood.* There were no significant differences between conditions in baseline scores on feeling relaxed, $F$ (2, 71) =.336, $p$=.72, $\eta^2$ =.010; tense, $F$ (2, 71) =1.103, $p$=.34, $\eta^2$ =.031; calm, $F$ (2, 71) =.527, $p$=.59, $\eta^2$ =.015; nervous, $F$ (2, 71) =1.04, $p$=.36, $\eta^2$ =.029; or ashamed, $F$ (2, 71) =.589, $p$=.56, $\eta^2$ =.017.

*Questionnaires.* There were no significant differences between groups both in scores on the PSS, $F$ (2, 71) =1.458, $p$=.24, $\eta^2$ =.041, or on scores on the ERQ, $F$ (2, 71) =.522, $p$=.60, $\eta^2$ =.015.

*Other variables*. There were no significant differences between groups in using mood-altering medications, $\chi^2$ (2) = 2.03, $p$=.65; anti-hypertensive

medications, $\chi^2$ (2) = 1.03, $p$=.77; oral contraceptives, $\chi^2$ (2) = 2.06, $p$=.44; and having depression, $\chi^2$(2) =2.03, $p$=.65, or anxiety disorder, $\chi^2$(2) =.97, $p$=1.

**Manipulation checks**

There were no significant differences between conditions in task engagement, $F$ (2, 71) =.12, $p$=.89, $\eta_p^2$ =.003; or adherence to the recovery instructions, $F$ (2, 71) =2.40, $p$=.10, $\eta_p^2$ =.065.

**Effects of the stressful task**

*Physiological data*. Participants had a significantly higher SBP during the stress task ($M$=131.93, $SD$=18.54) than at the baseline ($M$=115.83, $SD$=14.19), $F$ (1, 65) =121.01, $p$<.001, $\eta_p^2$ =.65.There was a significantly higher DBP during the stress task ($M$=87.65, $SD$=12.62) than at the baseline ($M$=70.10, $SD$=9.23), $F$ (1, 65) =319.15, $p$<.001, $\eta_p^2$ =.83. Finally, the HR was significantly higher during the stress task ($M$=87.83, $SD$=14.10) than at the baseline ($M$=75.59, $SD$=12.27), $F$ (1, 65) =101.00, $p$<.001, $\eta_p^2$ =.61. This suggests the task was successful in elevating physiological stress measures.

*Mood*. Means and standard deviations of total scores on the VAMS at the baseline and after the stress task are available in the Table 3. Participants reported being significantly less relaxed, $F$ (1, 69) =81.99, $p$<.001, $\eta_p^2$ =.54; more tense, $F$ (1, 69) =16.21, $p$<.001, $\eta_p^2$ =.19; less calm, $F$ (1, 69) =92.37, $p$<.001, $\eta_p^2$ =.57; more nervous, $F$ (1, 69) =24.40, $p$<.001, $\eta_p^2$ =.26; and more ashamed $F$ (1, 69) =18.91, $p$<.001, $\eta_p^2$ =.22; after the stress task, than at the baseline. This suggests the task was successful in inducing subjective stress.

**D-score differences in recovery**

*Physiological data*

*SBP*. There was a significant main effect of time on SBP, $F$ (7, 378) =12.01, $p$<.001, $\eta_p^2$ =.18. Pairwise comparisons showed that there were significant differences between the first recovery measure D-score and every single following measure (all $p$s<.01). However, there were no other significant differences between time points. There was also no significant interaction between SBP x condition, $F$ (14, 378) =.57, $p$=.89, $\eta_p^2$ =.02, and no significant difference in SBP between conditions, $F$ (1, 54) =.53, $p$=.53, $\eta_p^2$ =.02.

*DBP*. There was a significant main effect of time on DBP, $F$ (4.30, 219.26) =7.20, $p$<.001, $\eta_p^2$ =.12. Pairwise comparisons revealed that there were significant differences between the first recovery measure D-score and all except with the fifth and the sixth measures (all $p$s<.05). There were also significant differences between the second measure and the fourth, the second and the seventh, and the second and the eighths (all $p$s<.05). All other comparisons were non-significant ($p$s>.05).

There was also no significant interaction between DBP x condition, $F$ (8.60, 219.26) =.92, $p$=.50, $\eta_p^2$ =.04, and no significant difference in DBP between conditions, $F$ (1, 51) =1.91, $p$=.16, $\eta_p^2$ =.07.

*HR*. There was a significant main effect of time on HR, $F$ (5.19, 285.40) = 3.56, $p$<.05, $\eta_p^2$ =.06. Pairwise comparisons showed that there were significant differences between the first recovery measure D-score and the fifth; and between the first and the eighths (both $p$s<.05).There were no other significant differences in comparisons.

There was also no significant interaction of HR x condition, $F$ (10.38, 285.40) =1.53, $p$=.13, $\eta_p^2$ =.05, and no significant difference in HR between conditions, $F$

(1, 55) =.27, $p$=.76, $\eta_p^2$ =.01. This suggests that the different stress-recovery strategies did not influence recovery from stress.

*MAP*. A one-way ANOVA showed no significant differences between conditions in the MAP D-score, $F$ (2, 71) =.30, $p$=.74, $\eta_p^2$ =.01.

*Mood*

There was a significant difference between conditions in D-scores on feeling relaxed, $F$ (2, 71) =3.37, $p$<.05, $\eta_p^2$ =.09. Pairwise comparisons showed that participants in the Rumination group had a significantly higher D-score than participants in the music group, $p$<.05 suggesting that music made participants significantly more relaxed than rumination. Other group comparisons were non-significant, $p$>.05.

There were no significant differences between conditions in D-scores on feeling tense, $F$ (2, 71) =1.91, $p$=.16, $\eta_p^2$ =.05; calm, $F$ (2, 71) =1.45, $p$=.24, $\eta_p^2$ =.04; nervous, $F$ (2, 71) =1.51, $p$=.23, $\eta_p^2$ =.04; or ashamed, $F$ (2, 71) =.93, $p$=.40, $\eta_p^2$ =.03.

**Additional and supplementary analyses**

*Age, sex, perceived stress and emotion regulation*

There were no significant differences in any of the physiological and mood D-scores between males and females, all $p$s>.05. There were significant correlations between the Nervous D-score and the PSS score ($r$= .24, $p$<.05), and the mean HR D-score and the scores on the Suppression subscale ($r$= .38, $p$<.05). In addition, there were correlations between the scores on the

Reappraisal subscale and the PSS scores ($r$= -.29, $p$<.05), the PSS scores and age ($r$= -.25, $p$<.05), age and sex ($r$= -.36, $p$<.05). There were no significant correlations between any other variables, all $p$s>.05.

The regression analyses indicated that for each criterion, the model containing all predictors was not significant: Relaxed D-score, $F$ (5, 63) =.72, $p$=.61, $R^2$= .054; Tense D-score, $F$ (5, 63) =.608, $p$=.69, $R^2$= .046; Calm D-score, $F$ (5, 63) =.112, $p$=.99, $R^2$= .009; Nervous D-score, $F$ (5, 63) =1.123, $p$=.36, $R^2$= .082; Ashamed D-score, $F$ (5, 63) =.868, $p$=.51, $R^2$= .064, MAP D-score, $F$ (5, 63) =.858, $p$=.51, $R^2$= .064; mean SBP D-score, $F$ (5, 48) =.686, $p$=.64, $R^2$= .067; mean DBP D-score, $F$ (5, 46) =1.386, $p$=.25, $R^2$= .131; mean HR D-score, $F$ (5, 49) =1.843, $p$=.12, $R^2$= .16. These results show that age, sex, perceived stress and emotion regulation predict only from five to 16 percent of the variation in the studied criteria; and these models do not significantly predict physiological or psychological stress.

*Trait rumination and response in the rumination group*

There were no significant correlations between the PTQ scores and any of the response variables (all $p$s>.05), and the regression analyses indicated that for each criterion, the model containing all predictors was not significant: Relaxed D-score, $F$ (1, 22) =.014, $p$=.91, $R^2$= .001; Tense D-score, $F$ (1, 22) =.032, $p$=.86, $R^2$= .001; Calm D-score, $F$ (1, 22) =.621, $p$=.44, $R^2$= .027; Nervous D-score, $F$ (1, 22) =.001, $p$=.98, $R^2$= .00; Ashamed D-score, $F$ (1, 22) =.101, $p$=.75, $R^2$= .005, MAP D-score, $F$ (1, 22) =.165, $p$=.69, $R^2$= .007; mean SBP D-score, $F$ (1, 17) =1.448, $p$=.25, $R^2$= .079; mean DBP D-score, $F$ (1, 16) =.507, $p$=.49, $R^2$= .031; mean HR D-score, $F$ (1, 17) =.981, $p$=.34, $R^2$= .055. The results show that trait rumination predicts only from point-one percent to

eight percent of the variation in the studied criteria; and these models do not significantly predict physiological or psychological stress.

*Trait reappraisal and response in the reappraisal group*

There were no significant correlations between the scores on the Reappraisal subscale of the ERQ and any of the response variables (all *p*s>.05), and the regression analyses indicated that for each criterion, the model containing all predictors was not significant: Relaxed D-score, $F$ (1, 22) =2.289, $p$=.15, $R^2$= .094; Tense D-score, $F$ (1, 22) =.059, $p$=.81, $R^2$= .003; Calm D-score, $F$ (1, 22) =1.597, $p$=.22, $R^2$= .068; Nervous D-score, $F$ (1, 22) =2.602, $p$=.12, $R^2$= .106; Ashamed D-score, $F$ (1, 22) =.752, $p$=.40, $R^2$= .033, MAP D-score, $F$ (1, 22) =.933, $p$=.34, $R^2$= .041; mean SBP D-score, $F$ (1, 17) =.307, $p$=.59, $R^2$= .018; mean DBP D-score, $F$ (1, 16) =.788, $p$=.39, $R^2$= .047; mean HR D-score, $F$ (1, 17) =.016, $p$=.90, $R^2$= .001. The results show that trait rumination predicts only from point-one percent to 11 percent of the variation in the studied criteria; and these models do not significantly predict physiological or psychological stress.

# Chapter 4

# Discussion

The present research examined the differences in physiological and psychological stress recovery between three stress recovery procedures – rumination, reappraisal and music listening. In doing so, participants were exposed to a stress task and assigned to one of three conditions. Their mood and physiological stress recovery were analysed and compared among conditions.

The analyses showed that the stress task significantly increased SBP, DBP, HR and made participants significantly more nervous, less relaxed, tenser, less calm, and more ashamed than at the baseline; thus, it was successful in causing stress in participants. Overall, although physiological, and, partially, psychological stress levels decreased to baseline following the stress and recovery procedures in all conditions, the experiment results showed no significant differences in stress recovery between conditions on all measured stress parameters. The findings of the present research will be further discussed in more details in the following sections. Firstly, the results on stress recovery will be discussed for each of the procedures separately. This will be then followed by a discussion of the comparison of stress recovery between the three conditions – rumination, reappraisal and music.

## Rumination and stress recovery

To begin the discussion of the experiment findings on rumination, the recovery D-score results will be interpreted first, and then discussed in relation

to the background literature. The first SBP recovery D-score had a negative value and was followed by the rest seven positively valued recovery D-scores. Whereas the negative value of the D-score in the results on physiological stress levels indicates that the stress levels have not recovered to the baseline, the positive value reflects a stress recovery and a drop of the measure below baseline.

The results demonstrated that participants in the rumination condition recovered their SBP to and below the baseline at the second recovery measure or, more specifically, the third minute of the recovery phase. The recovery D-scores also indicate that DBP and HR dropped below the baseline at the fifth and the first minute of the recovery phase, respectively. That is HR was the quickest to recover and was followed by SBP and DBP in recovery, respectively.

Whereas these findings do not necessarily mean that rumination contributed to stress recovery since the stress levels may have dropped as a result of a natural stress recovery, the stress levels lower than baseline might suggest that the intervention was successful. This area could be further investigated by examining a larger sample in a replication which also included a control condition. Comparing the control and the intervention conditions would show whether the decrease in stress levels below the baseline is the result of an intervention or of natural recovery.

The results are also inconsistent with the findings of the previous research that found participants' SBP and DBP were significantly higher during rumination than at the baseline (Glynn et al., 2007; McClelland et al., 2009). The discrepancy of the results may lay in the difference of the study designs. For example, the most salient difference between the present experiment and one of the previous studies (Glynn et al., 2007) is that in the present experiment participants ruminated almost immediately after the stress task procedure,

whereas this previous experiment had a 30-minute delay before the rumination phase. However, this discrepancy would only encourage an expectation of a negative effect of rumination on stress recovery in the present research. This is for a reason that a delay following the stress task in the previous experiment may have given participants a better chance to recover from stress. Participants' stress levels may have dropped as a result of a natural recovery during a 30-minute delay. In this case, the rises in SBP and DBP during the rumination phase of the previous study only provide stronger evidence for the negative effects of rumination. Thus, the discussed difference in the study designs does not provide an explanation for the differences in the findings.

Moreover, the number of participants in the rumination condition of the present experiment and the previous study was approximately the same; both studies used students as participants; and the stress tasks used were very similar. Thus, it is unlikely that the sample size, nature of sample, or the stress task design caused the differences in the findings, leaving the possible explanation of individual differences among the participants studied. For example, the previous study provided very limited information about the medication participants were taking, trait measures were not controlled, and, overall, the participant information was insufficient. Therefore, it may be that the negative impact of rumination on stress recovery found in the previous experiment was specific to the studied sample and may not generalise to wider populations. It is also equally likely that the results of the present research were specific to the studied sample where the relevant variables were controlled. For example, it is possible that when important variables that can potentially affect stress response are controlled for, rumination is not detrimental to stress recovery. The fact that Glynn et al's (2007) findings were not unique in the literature provides some support for this notion.

The present results also contradict other research findings (McClelland et al., 2009). The inconsistency of the present findings with the results of this previous study may be attributed to a more intense stress task in the latter experiment (McClelland et al., 2009) where participants' mini essays were verbally evaluated by a confederate who made the provocative comments. Whilst the participants in the present research were asked questions by a researcher, no provocative comments were made which may have provided an additional source of stress. Since the stress task used in the previous experiment may have been more stressful than the one used in the present research, the rumination about the stress task in the previous experiment may have also caused a higher SBP and DBP response. This may be accounted for the significant rise in SBP and DBP in the previous study in comparison to the present findings. However, not only was the effect of rumination in the present study non-significant, it actually had an effect in the opposite direction; stress levels dropped below baseline. This result may lead to assumption that there may have been something about the present task which produced such stress recovery. Nevertheless, the previous experiment by McClelland et al. (2009) did not seek to investigate a full stress recovery; there was only a two-minute period monitored post rumination. It is possible that stress levels dropped below baseline following this period. SBP and DBP levels dropped below baseline in the present experiment only on the third minute of the recovery. Therefore, the discrepancy in results may not have been caused by the specificity of the stress task, but by the research method employed.

The results on mood should be interpreted cautiously as the VAMS uses a scale from zero to 100 where higher scores reflect a higher intensity of emotion. Additionally, there were two mood dimensions that represented positive affect (relaxed and calm) and three that reflected negative affect (tense, nervous,

ashamed). Higher D-scores for positive affect items correspond to poorer recovery, whereas the opposite is the case for the negative affect items.

The mood D-scores in the rumination condition showed that participants fully recovered to baseline only in feeling nervous whereas scores on feeling relaxed, tense, calm and ashamed stayed above baseline; this suggests that participants generally did not reach their psychological baseline in this condition. However, the 'tense' and 'ashamed' D-score values indicate that participants were very close to recovering on these mood dimensions as well.

Nevertheless, psychological stress levels decreased from the stress task to rumination phase on all VAMS dimensions. These findings somewhat contradict the previous results where negative mood and intrusive memories stayed on the same level in the rumination phase as during the stress task or even increased during rumination (Ehring et al., 2009; Santa Maria et al., 2012). This difference in the results may be explained by the nature of the stress task. Since, in the previous research on rumination (Ehring et al., 2009; Santa Maria et al., 2012), the stress task constituted a free recall of the negative experience and the rumination was also a recall of experience in a negative manner, it can be argued that the free recall and the rumination phase of those experiments are relatively similar and, thus, may produce similar levels of psychological distress. If this is the case, it may not be surprising that the previous research found no difference in negative mood between these two experiment phases. Therefore, the use of the stress procedure that does not involve a free recall of the negative experience and is, overall, a very different procedure from the rumination procedure, may help to demonstrate the actual impact of rumination on stress recovery. This has been addressed by the present experiment that showed participants' mood decreased from the stress to the rumination phase. It is suggested that future research accounts for this by adopting a similar approach

to avoid potential confounds introduced by the use of recall based stress tasks and rumination.

The results, overall, demonstrate that participants' physiological state in the rumination condition fully returned to baseline in four minutes after the stress task, and participants' psychological state predominantly did not recover. It is suggested that individual differences, and the intensity and a type of a stress task may account for the discrepancies in the results between the present and the previous research.

## Reappraisal and stress recovery

As discussed in the introduction, previous research suggests two types of reappraisal that have different effects on physiological and psychological stress recovery – arousal reappraisal, and psychological reappraisal. The present research examined the effects of psychological reappraisal when individuals reinterpreted emotional stimuli of the stress situation through changing perspective. Previous research indicates that this type of reappraisal generally has a positive impact on psychological stress recovery whilst having an inconsistent effect on physiological recovery (Beltezer et al., 2014; Denson et al., 2014; Jamieson et al., 2011; Wolgast et al., 2011). The present findings largely support this inference; there was a full physiological stress recovery in two minutes in the reappraisal condition and a partial psychological recovery.

The D-scores demonstrate that participants in the reappraisal condition recovered to baseline levels of SBP on the third minute, and DBP and HR on the first minute of the recovery phase, demonstrating an almost immediate physiological recovery. These results are consistent with the previous findings (Wolgast et al., 2011) that indicated a positive physiological stress recovery

following a psychological reappraisal. As expected, the findings are also opposite to the previous literature (Jamieson et al., 2011; Beltezer et al., 2014; Denson et al., 2014) demonstrating a heightened physiological response following the arousal reappraisal directed at the reinterpretation of an individual's physiological response. The contrast in effects between these two different types of reappraisal suggests that there are instances when reappraisal can have a negative impact on physiological recovery. It also demonstrates that although, as mentioned earlier, the study design of the present experiment does not allow making conclusions on whether any of the studied stress recovery procedures have an overall positive impact on stress recovery, the present findings do demonstrate that psychological reappraisal did not have a negative impact on physiological recovery.

The findings also contradict the proposed earlier idea that reappraisal may be ineffective in reduction of physiological stress where a speech component is involved in a stress situation as the present experiment employed a speech task as a stress procedure and the findings demonstrated no negative effect of reappraisal on the physiological stress response.

With respect to psychological recovery, although previous research on reappraisal largely focused on the comparison of its effects with a control condition, the findings predominantly showed that subjective stress, negative mood and negative emotions were lower in the reappraisal than in the control condition (Beltezer et al., 2014; Wolgast et al., 2011; Denson et al., 2014). This indicates that reappraisal had a positive effect on psychological stress recovery and is largely consistent with the present findings that showed participants in the reappraisal condition recovered to baseline psychological stress levels on feeling relaxed, tense and nervous. However, scores on two of the mood dimensions (calm and ashamed) did not recover. Since the design of the present experiment

did not involve a control condition and the previous research did, the comparison of the present findings with the previous research is not entirely justified; and this may be the main reason for the difference in findings between the present experiment and the previous research. However, another possible reason for the discrepancies may be due to the measures of subjective stress employed.

The previous literature measured psychological stress using the Positive and Negative Affect scale which is a measure of subjective stress on 20 positive and negative mood dimensions producing an overall score on negative and positive mood. The present experiment, however, used five separate VAMS that produced five separate scores of psychological stress. Had they been combined into an overall positive and negative affect score, the measure would have been sensitive to the range of differences in multiple scores between the baseline and recovery among all of the mood dimensions. Although the use of the separate VAMS in the present experiment was intentional to observe the effects of stress recovery procedures on specific mood dimensions, the combination of scores into positive and negative affect scores could have produced slightly different results. For example, if the scores on the Relaxed and Calm VAMS and the scores on the Tense, Nervous and Ashamed VAMS are combined into an overall positive and negative affect score, respectively, this would show that positive affect score was 6.3 and negative affect score was 21.41 in the reappraisal condition. These results suggest that participants nearly recovered on positive affect and impressively recovered on negative affect to below the baseline. The present results in this perspective of view are consistent with the previous findings (Beltezer et al., 2014; Wolgast et al., 2011; Denson et al., 2014), and support the phenomenon proposed in the introduction that psychological reappraisal has a positive impact on psychological recovery.

## Music and stress recovery

The results in the music condition showed that participants' physiological stress levels did not fully recover by the end of the 15-minute long recovery period. However, participants demonstrated the strongest and full psychological stress recovery in this condition among those studied.

The D-score results on music effects provided the most interesting results. The music group exhibited SBP recovery on the third minute of the recovery phase, DBP recovery only on the 15th minute, and a HR recovery on the first minute; thus, music had a very inconsistent impact on the recovery of different physiological parameters of stress. Nevertheless, these findings are in line with previous research (Kushnir et al., 2012) that studied women who were about to undergo a cesarean section.

Since, in that experiment, participants were experiencing an anticipation of surgery stress at the baseline, the baseline response can be considered as a stress response, and the response following listening to music can be considered as a recovery phase. The results on SBP are relatively similar as the previous study, consistent with the present research, demonstrated SBP recovery and no recovery in DBP results. These findings are unexpected since these studies were conducted with very different samples. The previous study used a clinical sample and the present one used a non-clinical sample. Previous literature generally indicates different effects of music in clinical and non-clinical samples (Chafin et al., 2004; Twiss et al., 2006; Yamamoto et al., 2007), therefore, the ecological validity and the nature of the sample could have explained if the results of Kushnir et al.'s (2012) study were different from the present findings. Similarly, the difference in the results could have been explained by the different types of stressors in the studies, since a social stressor task was used in the present experiment and a natural stressor was used in this previous research. However,

since the findings of these studies are very similar despite these methodological differences, they indicate that there must be something besides the ecological validity of research, the nature of sample, and the type of stressor that plays a role in the effect of music on physiological stress recovery.

Perhaps the music genre itself is the key variable as there are certain similarities in the music genres selected between the previous and the present experiment. Both studies used classical music and popular tunes. Classical music has been reported to have a positive effect on specifically SBP but not DBP recovery (Chafin et al., 2004) which is consistent with the present results. Additionally, the previous study (Kushnir et al., 2012) used popular Israeli tunes as the research was conducted in Israel whereas, in the present experiment, popular music genres such as Hip-Hop, Rap and RnB were used. Therefore, the similarity in music style (classical and popular) may have produced similar results in the present and previous experiment.

The mood results showed that participants' scores recovered to baseline on all studied mood dimensions demonstrating the best psychological recovery among all of the studied conditions. These findings are somewhat inconsistent with the previous research showing no differences in anxiety levels between music and control conditions (Chafin et al., 2004) and no difference in anxiety levels between the stress and music procedure (Sokhadze, 2007). Interestingly, they also support the results in clinical samples where participants listening to music had lower subjective stress levels (Kushnir et al., 2012; Twiss et al., 2006; Zhang et al., 2012). These findings contradict the notion proposed in the introduction that individuals listening to music from a non-clinical population experience only physiological and no psychological stress recovery. Since it has been previously found that low tempo music possess better psychological stress reduction effects than the high tempo music (Yamomoto et al., 2007), the

present research used only low-tempo music in comparison with the previous studies that found no psychological stress reduction in non-clinical samples (Chafin et al., 2004; Sokhadze, 2007). Therefore, these findings suggest that music tempo may be an important variable in the effects of psychological stress reduction in individuals. It may be that low tempo music is perceived as more calming than high tempo music. If the particular tempo of music is an essential component of success in music's psychological stress reductive properties, then low tempo music should decrease psychological stress levels regardless of the nature of sample. This could be investigated in future research by comparing the effects of low and high-tempo music on psychological stress recovery in both clinical and non-clinical samples.

## Differences between interventions

According to the recovery D-scores, SBP recovered to and below the baseline at the second measure (third minute) of the recovery period and onwards for all conditions; this demonstrates a similar SBP recovery among conditions. However, the comparison of the first mean SBP recovery D-scores showed differences in the opposite direction to what was predicted; the first mean SBP recovery D-score in the rumination condition had the smallest value among all. Since previous research indicates that rumination is a detrimental stress recovery procedure (e.g. Glynn et al., 2007; Santa Maria et al., 2012), it was expected that the first mean SBP recovery D-score for rumination would have the largest negative value indicating that SBP was further from baseline. However, this was not the case and, in fact, the first mean SBP recovery D-score in the rumination condition had the smallest value among all conditions indicating the closest recovery to baseline. The music group demonstrated the

furthest SBP from the baseline, and thus had the poorest SBP recovery according to the D-score results; however, this difference was non-significant.

The results for DBP showed that it dropped below the baseline in the reappraisal group at the very start of the recovery phase. Interestingly, the music recovery D-scores held negative values up until the very last measure suggesting that it took music 14 minutes to return DBP to baseline in this condition; whilst it took only four minutes for rumination to return DBP to baseline. However, there were no significant differences found in DBP D-scores between conditions.

Results on HR D-scores demonstrated a positive recovery for all conditions beginning with the first recovery measure taken. The only findings that stood out in the HR results were negative values of the last two D-scores in the rumination condition suggesting a rise of HR above the baseline in the last three minutes of the recovery phase. However, the values of these D-scores were extremely low; and similarly to the results for SBP and DBP, all differences in HR D-scores between conditions were non-significant.

Overall, the findings on mean D-scores indicate that participants in the rumination condition had the best SBP and the worst HR recovery. The reappraisal group had the best DBP recovery and were second among the studied recovery procedures in the SBP and HR recovery. Finally, the music conditions had the worst SBP and DBP recovery whilst having the best HR recovery. Comparison of the results between the rumination and reappraisal conditions demonstrated that rumination was slightly better at recovering SBP but worse at recovering DBP and HR than reappraisal.

Nevertheless, when the physiological response was compared, no significant differences in D-scores of SBP, DBP, HR and MAP were found among

the conditions. The findings suggest that the studied stress recovery procedures had a similar effect on physiological stress recovery.

The findings are inconsistent with the results of the only previous study that investigated differences in physiological stress recovery between rumination and reappraisal (Ray et al., 2008) which found a significantly higher cardiovascular activity in the rumination than in the reappraisal condition. A possible explanation for such discrepancy may be attributed to differences in the nature and intensity of emotions experienced during the stress task. Whilst this previous study employed a task that was related to a specifically anger-evoking stress experience, the present experiment used a task that may have caused a broader spectrum of emotions with an overall negative affect since it was not designed to cause a specific affective response. Therefore, the task in the previous experiment may have caused higher physiological response due to higher intensity of emotions experienced by the participants, and rumination and reappraisal may have worked differently in that experiment due to a specificity of emotions experienced by participants. It is suggested that this area is investigated in future research by comparing the effects of rumination and reappraisal on stress recovery from the two different stress tasks, anger and a broad affect stress task, such as the one used in the present experiment.

The findings indicate that whilst the scores on the 'relaxed' dimension of the VAMS did not recover to baseline after the recovery period in the rumination group, they did so in the remaining two groups. The D-scores on feeling tense followed the same pattern. Participants' scores on feeling calm and ashamed recovered to baseline only in the music condition, leaving rumination as the least effective stress recovery technique on this mood dimension. Participants were less nervous after recovery than at baseline in all conditions, nevertheless, music

was the most and rumination was the least successful at stress recovery on feeling nervous among the conditions.

The data on mean recovery D-scores shows that participants' mood in the music conditions fully recovered, the reappraisal group recovered on three of the five mood dimensions, and those in the rumination group recovered on only one psychological measure. These findings suggest that the music condition produced the best environment for stress recovery, leaving reappraisal the second most, and rumination the least effective in psychological recovery. However, further analyses revealed only one significant difference in recovery among conditions; music made participants significantly more relaxed than rumination.

The mood results are inconsistent with previous research which found that negative affect returned to baseline levels only in the reappraisal condition (Grisham et al., 2011) and participants in the rumination condition had significantly lower positive, and higher negative affect than those in the reappraisal condition (Ray et al., 2008). The reason for the inconsistency between the findings of the present and previous studies may be due to differences in the methods of analyses. Whilst the previous research compared the means of measures within the different experiment phases (e.g. baseline, stress task) and the studied conditions, the present experiment used D-scores to analyse the data. Such methodology allowed for determining unbiased differences between conditions as D-scores are insensitive to individual differences such as hypertension or variations in baseline mood. In addition, the present research controlled for important variables such as hypertension, use of medications affecting physiological and psychological state and other relevant variables listed in the method section. Previous research (e.g. Grisham et al., 2011; Ray et al., 2008) has not controlled for these variables, except trait rumination and trait reappraisal measures in the experiment by Grisham et al.

(2011). However, the additional regression analyses in the present research showed that neither trait rumination nor trait reappraisal predicted any of the physiological and psychological measures in the conditions. Therefore, the findings of the present experiment suggest that these individual differences do not affect physiological and psychological stress responses to any of the studied stress recovery procedures.

As mentioned in the introduction, the conclusion made regarding the negative effects of rumination based on the previous research may not actually suggest that rumination is detrimental to stress recovery. The studies comprising that research (Glynn et al., 2007; Santa Maria et al., 2012) were designed in such way that the stress task was the recall of a negative experience and the rumination phase of the experiment was the instructed recall of the same experience. Therefore, the rumination experiment phase may have caused higher stress response simply as a reflection of a negative emotional response to the negative experience being recalled. To determine whether rumination is indeed detrimental to stress recovery, the impact of rumination was compared with the impact of reappraisal and music listening in the present experiment as the latter two stress recovery procedures were suggested to be better at stress recovery in the previous literature. Nevertheless, the findings of the present research which demonstrate no differences in stress response between rumination, reappraisal and music conditions suggest that rumination is not differentially effective as a stress recovery procedure in comparison with the other examined procedures. Therefore, these findings suggest that future research should avoid using similar procedures in the stress task and rumination experiment phases and instead employ a similar approach to the one used in the present study.

## Limitations and suggestions for future research

The present research demonstrated no differences in physiological and psychological stress recovery among rumination, reappraisal and music. However, it was not without limitations which should be accounted for in the interpretation of the findings.

There are two possible limitations in the music condition of the experiment. One of them relates to uncertainty regarding participants' cognition and psychological state during the recovery phase. It is unknown whether participants simply listened to the music or thought about the stress task or something else; and if they did engage in thinking about something, the content of this is unknown. It is possible that some other features of participants' thinking, and not the music, had some impact on stress recovery. However, participants were asked to rate their adherence to instructions of listening to the music, and the analyses showed the highest adherence to instructions in the music condition. In addition, participants were asked to report if any memories were evoked by music and, if so, asked to indicate their nature. Only a small number of participants reported having memories, and these were of an exclusively positive nature. Although this approach may not have provided a full account of what the participants were thinking about during the recovery, it was thought to be appropriate in terms of minimising the risk of participants employing additional recovery strategies in this condition. However, the possibility that they were doing so cannot be ruled out; and this may have partially accounted for the present findings of no significant differences between conditions. If participants were employing similar ways of thinking to the other two recovery procedures investigated, this could explain the lack of significant differences in the present study. The technique that has been used to control for participants' thinking in previous research (Grisham et al., 2011) is to use

thought diary whereby participants were asked to write down their thoughts, and the writing was analysed for adherence to the instructed way of thinking. However, there is a risk of the writing task interfering with the primary task which is to follow the specific instructions, or to listen to music in the context of the present study. An alternative way to control for the thinking style is a retrospective method whereby participants report what they were thinking about during the instructed phase at the end of it. Although this method has a limitation related to the potential unreliability of memory, it is the least interfering with the participant instructions and is suggested to be the most appropriate for the purpose of this particular research. Therefore, it is suggested that the retrospective technique is employed in future research to control for the content of participants' thinking.

Another limitation of the music condition involved the slight delay between the stress procedure and the recovery phase. Participants were asked to report their mood after the stress task and to select the music genre they wished to listen to during the recovery period in the music condition. Although this delay took only around a minute, participants' stress levels may have begun recovering during this time which may have resulted in lower stress levels documented during the recovery phase. An alternative method that was previously used in music research (e.g. Chafin et al., 2004) was to ask participants to choose the music genre at the beginning of the experiment. However, Konecni (1982) suggested that individuals choose different styles of music to improve their mood depending on the situation. Therefore, it was decided that it was best to let participants select the music genre shortly before the recovery phase to ensure that their music choice corresponded to their immediate psychological state. To address this limitation in future research, it is suggested to familiarise participants with the procedure of music selection and to give them an opportunity to preselect music based on their immediate mood so that

participants spend less time on this procedure between the stress task and music listening phases. However, additionally, participants should be given a chance to change the music genre if they feel their preference changed following the stress task. Such a technique would minimise the gap between the stress task and the music listening phases but would also give participants a chance to listen to the music genre that corresponds to their immediate psychological state.

The equipment used to obtain physiological measures was somewhat restricted with respect to the frequency at which measures could be taken. It took around 30 seconds to obtain one measure, and the measures had to be taken with a delay as a higher frequency could have potentially caused participants discomfort or even pain. Therefore, it would be useful to replicate the study using equipment that allowed for taking continuous measures without causing participants discomfort to account for subtle changes in physiological response. Such a technique might help to uncover subtle differences in physiological stress response between conditions which may have not been detected in the present study.

Although the present findings demonstrate no difference between rumination, reappraisal and music in physiological and psychological stress recovery, the absence of a control condition in the study design does not allow making conclusions on the effectiveness of the studied recovery procedures compared to no intervention. For example, the stress levels may drop as a result of a natural recovery following the stressor which cannot then be confidently attributed to the effects of the intervention. The present study sought to investigate the differences in stress levels between the three stress recovery procedures; however, it would be highly valuable to know whether these effects are any different from the effect of a natural stress recovery. Therefore, further research should be conducted to investigate this area with the inclusion of a

control condition. This, however, would require a larger sample to ensure the statistical analyses have enough power to detect differences in the experiment with four conditions (Coolican, 2009).

Finally, it could be argued that the study had a small sample and was under-powered to detect medium or large effects. However, the obtained effect sizes from the analyses were very low (close to zero). This suggests that any effects of interest are likely to be minimal, and, therefore, significant results may not have been obtained even in a larger sample.

# Implications and conclusions

The aim of the present research was to investigate differences in physiological and psychological stress recovery between rumination, reappraisal and music stress recovery procedures. The research presented here offers several methodological improvements that allow for addressing the limitations of previous research by controlling for such important variables as the use of oral contraceptives, anti-hypertensive and mood-altering medications, perceived stress, smoking, alcohol intake, intense exercise, depression and anxiety disorders as well as trait rumination and trait reappraisal. Additionally, it addressed whether significant physiological responses to rumination in previous research result from the specific way the negative event is recalled that is due to the rumination itself, and do not simply reflect a negative emotional response to the experience being recalled. This was achieved by comparing the effects of rumination to the effects of two other different recovery procedures – reappraisal and music listening.

The results showed that there were no differences among conditions in recovery on any of the studied physiological measures. Although the mean mood recovery scores indicated that music was the only condition where all of the studied mood dimensions recovered to below the baseline, only one significant difference in mood was found among all conditions; participants were significantly more relaxed in the music than in the rumination condition.

The research presented provides new information in the following areas. It suggests that, overall, all studied stress recovery procedures have a similar effect on physiological and psychological stress recovery. This may suggest that the choice of stress recovery procedure in applied settings should be left to individuals personal preferences as they all appear to be similarly effective. This

area, however, should be further investigated by comparing the effects of the studied stress recovery procedures with a no-intervention condition to determine if any of them are more effective than a natural stress recovery.

In addition, the similar recovery in rumination and reappraisal conditions suggests that previous research on rumination may have produced misleading results. Previous studies on rumination had a very similar design of the stress and rumination experiment phases; this may have produced similar responses and may have resulted in the faulty inference that rumination is detrimental to stress recovery when the higher stress responses in the rumination condition were simply a reflection of negative affective responses. This implication should be taken into account in future research to prevent faulty conclusions on the detrimental effects of rumination on stress recovery.

To conclude, the present study found no differences in psychological or physiological stress recovery between rumination, reappraisal and music listening stress recovery procedures where all the relevant variables were controlled for; this finding has implications for future research in the area, together with applications in medical and other settings where the management of stress is of critical importance.

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# Appendices

## *Appendix 1*

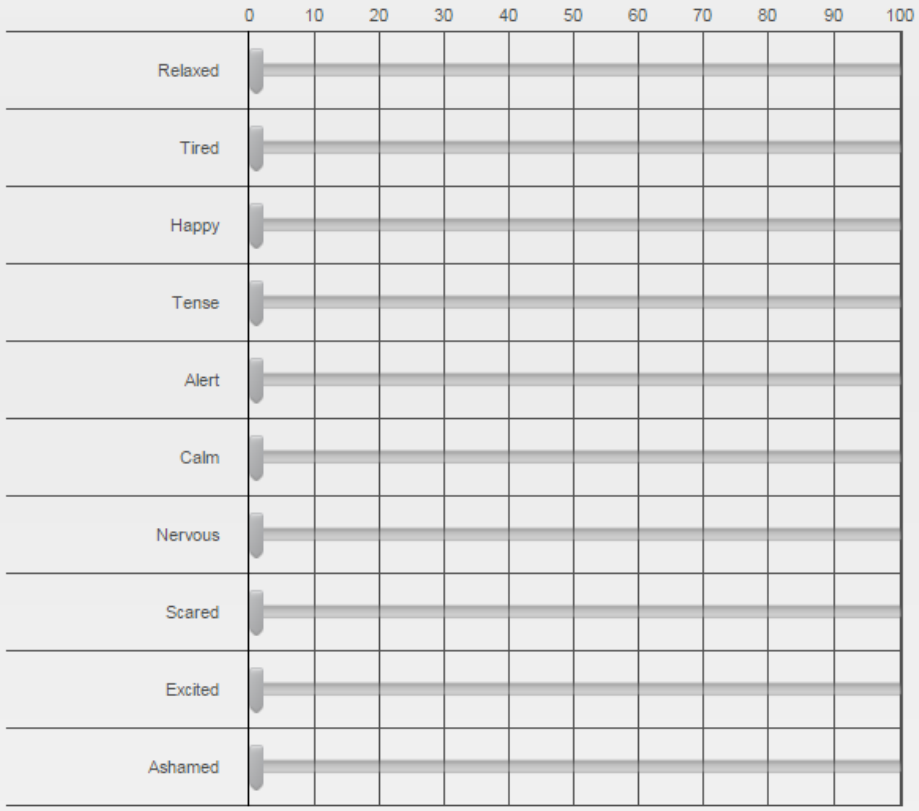
Self-report checklist

| | | Yes | No |
|---|---|---|---|
| Have you | consumed alcohol in the past 24 hours? | | |
| | smoked in the past hour? | | |
| | drunk coffee in the past hour? | | |
| | done any intense exercise in the past hour? | | |
| Do you currently use | any mood-altering medications? | | |
| | any anti-hypertensive medications? | | |
| | oral contraceptives? | | |
| Do you currently suffer from: | depression? | | |
| | anxiety disorder? | | |
| | psychotic disorder? | | |
| | conduct disorder? | | |
| | developmental disability? | | |
| | substance dependence? | | |

## *Appendix 2*

The Visual Analogue Scale (VAMS)

In the following scales, please drag the line where you feel it best represents how you are feeling at this moment on a scale from 0 ("not at all") to 100 ( "extremely").



## *Appendix 3*

Perceived Stress Scale

The questions in this scale ask you about your feelings and thoughts. In each case, you will be asked to indicate by circling *how often* you felt or thought a certain way.

Age _____ Gender (*Circle*): **M F** Other _____

0 = Never; 1 = Almost Never; 2 = Sometimes; 3 = Fairly Often; 4 = Very Often.

| | | | | | |
|---|---|---|---|---|---|
| 1. In the last month, how often have you been upset because of something that happened unexpectedly? | 0 | 1 | 2 | 3 | 4 |
| 2. In the last month, how often have you felt that you were unable to control the important things in your life? | 0 | 1 | 2 | 3 | 4 |
| 3. In the last month, how often have you felt nervous and "stressed"? | 0 | 1 | 2 | 3 | 4 |
| 4. In the last month, how often have you felt confident about your ability to handle your personal problems? | 0 | 1 | 2 | 3 | 4 |
| 5. In the last month, how often have you felt that things were going your way? | 0 | 1 | 2 | 3 | 4 |
| 6. In the last month, how often have you found that you could not cope with all the things that you had to do? | 0 | 1 | 2 | 3 | 4 |
| 7. In the last month, how often have you been able to control | 0 | 1 | 2 | 3 | 4 |

| | | | | | |
|---|---|---|---|---|---|
| irritations in your life? | | | | | |
| 8. In the last month, how often have you felt that you were on top of things? | 0 | 1 | 2 | 3 | 4 |
| 9. In the last month, how often have you been angered because of things that were outside of your control? | 0 | 1 | 2 | 3 | 4 |
| 10. In the last month, how often have you felt difficulties are piling up so high that you could not overcome them? | 0 | 1 | 2 | 3 | 4 |

## *Appendix 4*

Emotion Regulation Questionnaire (ERQ)

We would like to ask you some questions about your emotional life, in particular, how you control (that is, regulate and manage) your emotions. The questions below involve two distinct aspects of your emotional life. One is your emotional experience, or what you feel like inside. The other is your emotional expression, or how you show your emotions in the way you talk, gesture, or behave. Although some of the following questions may seem similar to one another, they differ in important ways. For each item, please answer using the following scale:

1----------2----------3----------4----------5----------6----------7

strongly disagree — neutral — strongly agree

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1. When I want to feel more *positive* emotion (such as joy or amusement), I *change what I'm thinking about*. | 0 | 1 | 2 | 3 | 4 | 6 | 7 |
| 2. I keep my emotions to myself. | 0 | 1 | 2 | 3 | 4 | 6 | 7 |
| 3. When I want to feel less *negative* emotion (such as sadness or anger), I *change what I'm thinking about*. | 0 | 1 | 2 | 3 | 4 | 6 | 7 |
| 4. When I am feeling *positive* emotions, I am careful not to express them. | 0 | 1 | 2 | 3 | 4 | 6 | 7 |
| 5. When I'm faced with a stressful situation, I make myself *think about it* in a way that helps me stay calm. | 0 | 1 | 2 | 3 | 4 | 6 | 7 |
| 6. I control my emotions by *not expressing them*. | 0 | 1 | 2 | 3 | 4 | 6 | 7 |
| 7. When I want to feel more | 0 | 1 | 2 | 3 | 4 | 6 | 7 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | *positive* emotion, I *change the way I'm thinking* about the situation. | | | | | | |
| 8. | I control my emotions by *changing the way I think* about the situation I'm in. | 0 | 1 | 2 | 3 | 4 | 6 | 7 |
| 9. | When I am feeling *negative* emotions, I make sure not to express them. | 0 | 1 | 2 | 3 | 4 | 6 | 7 |
| 10. | When I want to feel less *negative* emotion, I *change the way I'm thinking* about the situation. | 0 | 1 | 2 | 3 | 4 | 6 | 7 |

## *Appendix 5*

Perseverative Thinking Questionnaire

Please consider how well each statement below describes you. Indicate how typical or characteristic each item is of you on the following 6-point scale.

| | 1 - Not at all like me | 2 - Moderately unlike me | 3 - A little unlike me | 4 - A little like me | 5 - Moderately like me | 6 - Very much like me |
|---|---|---|---|---|---|---|
| 1. Things I've said or done always seem to be playing in my mind | ○ | ○ | ○ | ○ | ○ | ○ |
| 2. It's difficult for me to let go of things that have happened to me | ○ | ○ | ○ | ○ | ○ | ○ |
| 3. I can't help but rehash past events in my mind | ○ | ○ | ○ | ○ | ○ | ○ |
| 4. After a problem has long been resolved, my thoughts drift back to what happened | ○ | ○ | ○ | ○ | ○ | ○ |
| 5. I repeatedly second-guess the things I've done | ○ | ○ | ○ | ○ | ○ | ○ |
| 6. I often find myself repeatedly thinking about recent events, wishing they had gone better | ○ | ○ | ○ | ○ | ○ | ○ |

## *Appendix 6*

STOMP

For the following items, please indicate your basic preference level for the genres listed using the scale provided.

1----------2----------3----------4----------5----------6----------7

Strongly dislike neither like Strongly like

nor dislike

1. _____ Classical
2. _____ Blues
3. _____ Country
4. _____ Dance/Electronica
5. _____ Folk
6. _____ Rap/hip-hop
7. _____ Soul/funk
8. _____ Religious
9. _____ Alternative
10. _____ Jazz
11. _____ Rock
12. _____ Pop
13. _____ Heavy Metal
14. _____ Soundtracks/theme songs

## *Appendix 7*

Instructions for the researcher

1) During the interview, remain serious, maintain eye contact and take notes on participant`s speech. No smiles or unrelated talks should be introduced during these 5 minutes.
2) Let participant speak for the first three minutes. In most cases, the participant will come to the end of the talk even before 3 minutes have passed. Give time to formulate additional elaborations.
3) If the participant talks for longer than 3 min, then interrupt.
4) If participants want to proceed to interview before 3-mintue preparation period is over, say "Take your time. There is no rush! You still have some time left" (so stick to 3 minute preparation)
5) If participant stops before 3 minutes, wait for about 20s and then say: "You still have time". If participant does not continue, start asking questions (after 3 minutes of free speech):
    a. Why do you think you are especially well-qualified for this task?
    b. Why do you think you are better qualified then the other applicants?
    c. What do your family/friends especially appreciate about you?
    d. What do you appreciate about your friends?
    e. What do you appreciate about colleagues?
    f. You just pointed out that you were especially good at…, what other characteristics qualify you?
    g. You just mentioned you qualities in respect to…, what do you in particular think about…?
    h. You just spoke about…, what exactly do you then think about…?
    i. Please complete the following sentence: "I am the best at/in…"
    j. Please list your strengths!
    k. Please list your weaknesses!
    l. What kind of leading qualities do you have?
    m. What do you think about teamwork?
    n. Where do you see your position in a team?

o. What can you constructively add to a team?
p. You just mentioned that you really appreciate teamwork, what do you think about lone fighters?
q. What do you think about job interviews?
r. What do your employees appreciate about you most?
s. Would you be willing to work overtime without compensation?
t. Would you be willing to work on the weekends if this be deemed necessary?
u. What kind of leading qualities do you expect from your employees?
v. What kind of qualities to you expect from your co-workers?
w. Under what circumstances would you be willing to compensate for the mistakes your co-workers make?
x. Would you lie in order to gain an advantage?
y. What do you think about the saying "Everybody determines his own luck"

6) Only in rare instances, will the research participant be able to talk alone for the full five minutes. In this case, it is up to researcher whether he/she wants to intervene between the 3rd and 5th minute to ask questions or whether the participant is allowed to continue.

This should also be dependent on what is being said by the participant. For instance, it is not appropriate for the applicant to speak in great detail about specific lessons he/she may have learned in the course of training at university or elsewhere. In this case, the researcher should certainly intervene, for example by saying *"We believe you that you know how to execute a market analysis, but we would be more interested to find out why you were so involved in or drawn to this area*."

## *Appendix 8*

Job interview: Task instructions

Please imagine that you have applied for a job and have been invited for an interview.

In contrast to a real interview, however, you are supposed to give a talk, in which you are to convince the interviewer in five minutes why you think that you would be the best candidate for this position.

Please note that your speech will be recorded by a video camera for subsequent voice and behavioural analysis. The interviewer will also take notes during your speech.

You should try to leave the best possible impression, and assume the role of the applicant for the duration of the talk as best as you can.

The interviewer will reserve the right to ask follow-up questions in case of uncertainties to receive all necessary information from you.

You have three minutes to prepare and you can take some notes now, which you must not use during your talk.

Do you have any questions?

## *Appendix 9*

Information sheet and consent form

**Stress recovery**

**INFORMATION SHEET**

You are being invited to take part in this study. Before you decide to take part it is important that you understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with me if you wish. Please do not hesitate to ask if there is anything that is not clear or if you would like more information.

What is the study about?

The purpose of this study is to investigate the process of stress recovery. Unfortunately, this study is not for you if you are currently in a depressed state, have anxiety issues such as panic attacks and anxiety disorder, or have hearing problems.

**Do I have to take part?**

The participation in the study is entirely voluntary. If you decide to take part you will be asked to sign a consent form. You can withdraw from the study at any time and without giving a reason. You also can withdraw your data before February 28, 2015 (when the data analysis will be conducted) if you wish. A decision to withdraw or a decision not to take part will not affect you.

**What will I need to do?**

If you agree to take part in the research, you will be presented with a few questionnaires to complete. Please try to answer all questions and do so as truthfully as possible. It is your right to leave any question unanswered if you do not feel comfortable with answering it. You will be asked to do a task where you have to perform a job interview followed by a resting period. In a resting period, you will be asked to either listen to music or think about the previously

experienced task. Your physiological responses such as heart rate and blood pressure will be recorded before the task and continuously throughout the exeriment. You will be also required to complete a few additional questionnaires two times - after the task and after the resting period. The whole study will take approximately 45 minutes.

**Will my identity be disclosed?**

All information and experiment data will be kept confidential.

**What will happen to the information?**

All information collected from you during this research will be kept secure and entirely anonymous and confidential. All data will be kept for a period of five years at the University of Huddersfield after completion of the project. It is possible that the research may, at some point, be published in a journal or report. However, should this happen, your anonymity will be ensured.

**What should I do if I want to withdraw?**

You can withdraw from the experiment any time you wish to do so up until the point of data analysis February 28. You will be assigned a number to preserve anonimity that will ensure a fast and safe destruction of your data. Only the researcher and a supervisor will have an access to the data. In case you wish to withdraw, contact the researcher, state your assigned number that is given on the debriefing report and your data will be removed.

**Who can I contact for further information?**

If you require any further information about the research, please contact me on:

Darja Gromova

E-mail: darjagromova001@gmail.com

Telephone: 07771 257600

Academic Supervisor Dr Susie Kola-Palmer

e-mail: s.kola-palmer@hud.ac.uk

Telephone: 01484 471014

**What are the possible risks of taking part in this research?**

There are no foreseeable risks in participation; however, should you be adversely affected by it you can contact Student counselling services via:

E-mail: internalcounsel@hud.ac.uk

Telephone: 01484 472675

**Consent form**

It is important that you read, understand and sign the consent form. Your contribution to this research is entirely voluntary and you are not obliged in any way to participate, if you require any further details please contact your researcher. If you are satisfied that you understand the information and are happy to take part in this project please put a tick in the box aligned to each sentence and print and sign below.

**Title of the research project: Stress recovery**

☐ I have been fully informed of the nature and aims of this research

☐ I consent to taking part in it

☐ I understand that I have the right to withdraw from the research at any time

before the data analysis (March 20, 2015) and without giving any reason

☐ I understand that the information collected will be kept in secure conditions

for a period of five years at the University of Huddersfield

☐ I understand that no person other than the researcher and the supervisor will have an access to the information provided

☐ I understand that my identity will be protected by the use of number in the report and that no written information that could lead to my being identified will be included in any report

☐ I consent to being video recorded

| Signature of Participants:<br><br>Name:<br><br>Date | Signature of Researcher:<br><br>Name:<br><br>Date: |
|---|---|

## *Appendix 10*

Debriefing report

Stress is associated with cardiovascular disease and high mortality (Steptoe & Kivimaki, 2012). It has been also linked to higher levels of depression (Stewart et al., 2013) and maintenance of PTSD symptoms (Hu et al., 2013). Therefore, it is important to investigate what techniques promote stress recovery to improve well-being.

The research indicates that whilst rumination can be detrimental to stress recovery (Ray et al., 2008; Santa Maria et al., 2012; Stewart et al., 2013; Hu et al., 2013), reappraisal (Ray et al., 2008; Grisham et al., 2011; Santa Maria et al., 2012) and music (Chafin et al., 2004; Sokahadze et al., 2007; Zhang et al., 2012; Thoma et al., 2013) can promote stress recovery. Nevertheless, to the experimenter`s best knowledge, there is no research on whether some of these techniques are particularly effective in rapid stress recovery. This could be useful both in daily life and particularly in clinical settings where a rapidly- effective technique for stress recovery is often needed after a stressful procedure or surgery has taken place, to accelerate overall recovery. Therefore, the aim of the present study was to investigate what technique of dealing with stress is most effective in rapid stress recovery.

You were assigned to one of the three conditions - Music, Rumination or Reappraisal. The times taken to return to the physiological baseline (recover from stress) following the stressful task will be compared between conditions.