# **Understanding anhedonia: Investigating the role of mind wandering in positive emotional disturbances**

Submitted by Grace Elizabeth Jell to the University of Exeter

as a thesis for the degree of

Doctor of Philosophy in Psychology

September 2016



I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

Signature: ……………………………….

## Dedication

In memory of my lovely Grandad

# Acknowledgements

First and foremost, I would like to express my sincere gratitude to my two supervisors, Barney Dunn and Kim Wright, who have provided me with the utmost level of support, patience and guidance throughout the past four years.

I am indebted to Mahmood Javaid for his help with developing the smartphone applications and to CBS trials for allowing me to conduct my research online. Thank you to all the participants who gave up their time to take part in my studies and to the University of Exeter for the financial support that has allowed me to complete my PhD.

I am particularly grateful to some extremely special people I have met in Exeter: Sarah, Emma, Dale, Chloe, Denise, Claire, Becky, Heike, Het, Marco, Michael, Hans, Kat, Flic, Emily, Nikki, Rachael. Thank you all for making office life so much fun.

Also thank you to my friends from further afield who have consistently provided me with welcome distraction: Charlotte, Tim, Natalie, Lauren, Cat, Bex, Emmy, Rachel, Sophie, Maddy. Thank you also to my family for having faith in me and being there when times were tough.

A final and very special thank you must go to my wonderful husband Steve, for his love and friendship and whose constant encouragement and understanding has made this process much more bearable!

# Abstract

Depression is a highly debilitating illness for which there is currently sub-optimal treatment outcomes. Anhedonia (a loss of interest and pleasure) is a core symptom of depression that predicts poorer illness course and is currently not well repaired in psychological treatments. Acute and relapse prevention outcomes may be improved by clarifying which psychological mechanisms cause and maintain anhedonia, so that mechanisms can be systematically targeted in therapy.

Mind wandering (a shift in contents of thoughts away from an ongoing task and/or events in the external environment to self-generated thoughts and feelings) has previously been linked to lower levels of happiness in the general population (e.g., Killingsworth & Gilbert, 2010). However, it has yet to be established if mind wandering relates to reduced positive affect in the context of depression. Therefore, the purpose of this thesis was to further explore the role of mind wandering in driving anhedonic symptoms.

This thesis employed different research designs in order to establish if mind wandering is a causal mechanism driving anhedonia. Studies used a triangulation of measures to first establish correlational support (e.g. using self-report questionnaire measures, laboratory and real life positive mood inductions). Following this, studies aimed to examine if a causal relationship between mind wandering and positive affect exists by manipulating levels of mind wandering in the laboratory, real-world settings and using an empirically tested clinical intervention (Mindfulness Based Cognitive Therapy; MBCT).

Using self-report measures of mindfulness and anhedonic symptoms, studies 1a and 1b found that the acting with awareness facet of mindfulness (a measure of trait mind wandering) was uniquely related to anhedonic depression symptoms in both a large community (n=440) and treatment-seeking previously depressed sample (n=409). These unique relationships remained significant when controlling for other facets of mindfulness and general depression symptoms. Study 2 (n=70) examined the relationship between mind wandering and reduced positive affect in both controlled laboratory and real world environments. Levels of mind wandering were found to be unrelated to emotional reactivity to positive laboratory mood induction tasks, but greater levels of mind wandering were significantly correlated with reduced happiness and increased sadness change to real world positive events. Next, two experimental studies were conducted on unselected samples which attempted to manipulate levels of mind wandering to observe the effect on emotional reactivity. In study 3 (n=90), a

brief mindfulness manipulation of mind wandering proved unsuccessful, so it was not possible to determine how altering mind wandering impacted on positive reactivity. Analysis during the pre-manipulation mood induction revealed a significant correlation between greater spontaneous levels of mind wandering and lower self-reported happiness reactivity. In study 4 (n=95), participants followed audio prompts delivered via a smartphone application to manipulate mind wandering whilst completing everyday positive activities. This manipulation was successful but results revealed no significant condition differences in positive or negative emotional reactivity. Analysis during the pre-manipulation positive activity revealed greater mind wandering was trend correlated with reduced change in positive affect.

A final empirical study (study 5; n=102) was designed to investigate the mediating role of mind wandering on the effect of MBCT on change in positive emotional experience. Recovered depressed participants undertaking MBCT were compared to recovered depressed participants in a no-intervention control group. Correlational analysis pre-intervention revealed no support for an association between mind wandering and positive reactivity to the mood induction tasks but mind wandering measured during everyday life (using experience sampling methodology; ESM) did relate to lower positive affect and higher negative affect. Participants in the MBCT group demonstrated a reduction in trait and ESM mind wandering, relative to participants in the control group. Furthermore, participants in the MBCT group demonstrated a significant decrease in anhedonic symptoms and increase in daily levels of positive affect. Change in trait mind wandering was found to mediate changes in self-reported anhedonic symptoms when controlling for change in other mindfulness facets, however change in ESM mind wandering did not mediate change in daily positive affect. MBCT also had no impact on emotional reactivity to positive mood induction tasks.

Overall the findings from this thesis provide correlational support for the link between mind wandering and reduced positive affect in different testing environments. However, evidence of a causal relationship is currently limited. Consequently, a key recommendation from this thesis is to redirect attention to other driving mechanisms as targeting mind wandering in the treatment of anhedonic clients is unlikely to lead to large improvements. The theoretical, methodological and clinical implications of these findings are discussed along with suggestions for future research.

# Table of Contents

**Chapter Four: Study 2 - The relationship between mind wandering and positive affective experience in laboratory and real world settings**



**Chapter Five: Study 3 – The effect on emotional experience of a laboratory manipulation of mind wandering**

**Chapter Six: Study 4 – The effect on emotional experience of an ESM manipulation of mind wandering**



**Chapter Seven: Study 5 - Investigating if reductions in mind wandering mediate the effects of Mindfulness Based Cognitive Therapy on positive affect**

# List of Tables

**CHAPTER SIX**



**CHAPTER SEVEN**

# List of Figures

**CHAPTER TWO**



**CHAPTER FOUR**



**CHAPTER FIVE**



**CHAPTER SIX**

**CHAPTER SEVEN**

# Author Declaration

The research reported in this thesis was carried out at the University of Exeter between September 2012 and September 2016 and was supervised by Associate Professor Barney Dunn and Dr. Kim Wright.

The data presented in study 1a was collected by students at the University of Cambridge and University College London (Adele Pacini, Clem Edwards, Alicia Shephard, Darius Gadeikis, Mairi Stewart, Jo Hickey, Sarah Howley and Nina Brauer). With all researchers' permission, I merged the data from nine studies and formulated new hypotheses prior to carry out a full reanalysis. The data presented in study 1b was collected as part of the PREVENT research trial in the South West region of the UK. The protocol and full results of this trial have been published (Kuyken et al., 2010; Kuyken et al., 2015). I formulated new hypotheses and reanalysed the data from time point one only (pre-MBCT intervention) with the authors permission. Study 2 was designed and data collected by myself. The smartphone application was designed by myself and programmed by Dr Mahmood Javaid. The computer tasks were programmed by myself after training from my supervisor Barney Dunn. All data was analysed by myself. Study 3 was part of a third year undergraduate project in 2014-2015 and the students Louise Ord, Henry Sawdon-Smith and Sorcha Bolton helped to collect some of the data. All tasks and materials in this study were designed and programmed by myself and data was fully analysed by myself prior to presentation in this thesis. Study 4 was designed and programmed by myself. Two intern students (Lucy Porter and Jessie Bolam) were recruited to help with some of the data collection as part of a research intern scheme at the University of Exeter. These students collected data from 10 participants each and the remaining 75 participants were recruited by myself. The smartphone application was designed by myself and programmed by Mahmood Javaid. The ethics application for study 5 was completed by myself and Barney Dunn. All data for this study was collected and analysed by myself. The experience sampling app was programmed by Mahmood Javaid and online tasks programmed by Adam Hampshire from CBS trials.

Grace Jell
Exeter, September, 2016.

# Chapter 1: General Introduction

Major Depressive Disorder (MDD) is a highly debilitating and recurrent illness which, according to the World Health Organisation (2015), is the leading cause of disability worldwide and affects 350 million people globally. MDD results in substantial economic costs to society due to the care provision needed and absences from work. Despite this, current pharmacological and psychological treatments are not optimally effective with low initial response rates and rates of relapse of over 50% in two years for psychological treatments and 76% in 12 months following discontinuation of pharmacological treatments. There is a need to refine existing treatments and to develop novel interventions in order to improve MDD outcomes. A potentially promising way to improve MDD outcomes is to target symptoms which are central to the disorder but are currently relatively neglected in treatment. One such symptom is the inability to experience pleasure from previously rewarding activities, known as anhedonia. Anhedonia predicts a poor depression prognosis (including the presence of residual symptoms outside of depressed episodes and increased risk for future relapse). To improve the capacity to treat anhedonia with depression interventions, research is needed to further our understanding of this poorly understood symptom.

This general introduction chapter will provide a brief overview of depression and review literature to highlight a pressing need to improve current treatment outcomes *(section 1.1).* Next, the literature to date on anhedonia in depression will be reviewed, making the case that anhedonia is central to depression, is prognostically important, and is clinically neglected. *(section 1.2).* The third section (*section 1.3*) outlines the need to evaluate candidate mechanisms underlying anhedonia and reviews the literature for one potential mechanism: mind wandering. The fourth section (*section 1.4*) reviews literature evaluating the impact of current psychological interventions on anhedonia, notably Mindfulness Based Cognitive Therapy (MBCT) and the potential role of mind wandering in this relationship. The final section of this chapter (*section 1.5*) will summarise conclusions drawn from the review and proposes a mediation model between depression severity, mind wandering and positive affect.

## 1.1 Depression overview

This review will begin by briefly considering depression and the scope of the depression problem including its diagnosis, prevalence, costs of depression to society and the effectiveness of current treatments.

### *1.1.1 Diagnosis*

A diagnosis of Major Depressive Disorder (MDD) is made using the Diagnostic Statistical Manual of Mental Disorders (DSM-V; American Psychiatric Association, 2013). An individual must present with one of the two core symptoms for at least two weeks; depressed mood or markedly diminished interest or pleasure in activities they would normally enjoy (anhedonia). In addition to this, an individual must display at least five other symptoms which include significant change in appetite, insomnia or hypersomnia, psychomotor agitation or retardation, fatigue, feelings of worthlessness or excessive and inappropriate guilt, diminished ability to concentrate or indecisiveness and recurrent thoughts of death and suicide. Alternatively, a diagnosis can be made with the International Classification of Diseases (ICD-10; World Health Organisation, 1992). Patients must meet one of three core symptoms of depressed mood, anhedonia or fatigue and are then classified with a severity of depression depending on how many out of the total 10 symptoms are met. These symptoms are much the same as the DSM-V, except for the separation of low self-confidence and guilt into two distinct symptoms. Individuals diagnosed with MDD very often meet criteria for another mental disorder, most commonly anxiety disorders. Among patients diagnosed with major depression, approximately 58% will also suffer from an anxiety disorder within the same 12 months (Kessler et al., 2003). Whilst the use of such a categorical approach to diagnosis can be beneficial in clinical settings, there is a strong argument for utilising a dimensional approach in research and studying depression on a continuum of severity (Kraemer, 2007). For example, subthreshold symptoms have been found to predict future major depression (see Cuijpers & Smit, 2004). Therefore, a dimensional approach to depression will be predominantly adopted in this thesis.

### *1.1.2 Prevalence and course of depression*

According to the World Health Organisation (2016), depression is the leading cause of disability worldwide and it is estimated that 350 million people globally are affected by the disorder (WHO; 2016). At any one time it is estimated that approximately 2.5% of the UK population (which equates to 1.6 million people) are suffering from depression (Layard et al., 2006). Furthermore, the National Comorbidity Survey replication estimated the lifetime prevalence of MDD to be 16.6% using a sample representative of English speaking adult residents in the United States (Kessler et al., 2005). In the same sample, the median age of onset of MDD has been found to be 32 years of age with an interquartile range of between 19-44 years (Kessler et al., 2005). More recently published research found identical lifetime prevalence rates of 16.6% (Kessler, Petukhova, Sampson, Zaslavsky & Wittchen, 2012). The recurrence rates of MDD are high. For example, one observational follow-up study reported relapse rates as high as 85% over a 15 year period (Mueller et al., 1999). In addition, with each new MDD episode, the risk of relapse significantly increases (e.g., Kessing, Hansen, Andersen, & Angst, 2004).

### *1.1.3 Cost of depression*

It has been estimated that by 2020 depression will be the second leading cause of global economic healthcare burden with only heart disease causing a greater burden (Lopez & Murray, 1998). Based on the costs of prescribed medication, inpatient care, other NHS services, supported accommodation, social services and lost employment it was estimated that depression alone cost the UK £7.5 billion in the year 2007 and this is predicted to increase to £12.2 billion in 2026 (McCrone, Dhanasin, Patel, Knapp & Lawton-Smith, 2008). MDD is a significant economic burden in Europe with a total estimated cost of €118 billion in the year 2004, split into direct costs (outpatient care, medication, hospitalization) of €42 billion and indirect costs (morbidity and mortality costs) of €76 billion (Sobocki, Jönsson, Angst & Rehnberg, 2006). There are also significant personal and societal costs of depression as approximately 800,000 lives are lost worldwide due to suicide each year (WHO; 2015) and suicide is the most common cause of death for men aged 20-49 years in England and Wales (ONS; 2014). Such costs highlight the necessity of researching better detection, prevention, and treatment of depression.

### *1.1.4 Effectiveness of common treatments for depression*

#### *1.1.4.1 Pharmacological treatments*

Antidepressant medication is the most common form of treatment for major depression (Olfson, Marcus, Druss & Pincus, 2002). Pharmacological treatments for depression include selective serotonin/noradrenaline reuptake inhibitors (SSRIs and SRNIs), noradrenaline and specific serotonergic antidepressants (NASSAs), tricyclic antidepressants (TCAs) and monoamine-oxidase inhibitors (MAOIs). During the years 2005-2008, it was reported that one in ten Americans over the age of 12 took antidepressant medication with the highest rate in females aged 40-59 at 22.8% (Pratt, Brody & Gu, 2011). In the UK, published prescribing data has shown that in 2012 alone more than 50 million prescriptions for antidepressants were issued, up 7.5% from the year before (Health and Social Care Information Centre, 2015). However, current pharmacological interventions are not wholly effective with only small to moderate effect sizes found in antidepressant and placebo comparison studies (Undurraga & Baldessarini, 2012; Weitz, Hollon, Kerkhof & Cuijpers, 2014). Among patients with a lower depression score (Hamilton Depression Rating Scale (HDRS) of below 23) there was an effect size of 0.2, labelled as a small effect according to Cohen's *d* (Cohen, 1988) and suggesting antidepressants are not superior to placebo at lower levels of depression severity. This effect size does increase to above the threshold recognised by the National Institute of Clinical Excellence (NICE) for demonstrating superiority of antidepressants over placebo in patients with HDRS of 25 and over (Fournier et al., 2010). However, this effect size of 0.53 still demonstrates that antidepressants are only adequately effective and perhaps only in individuals with more severe levels of depression. Therefore, there is a debate as to whether antidepressant medication is superior to placebo conditions (Kirsch & Sapirstein, 1998). A further limitation of antidepressant treatment is high rates of relapse following discontinuation with reports of 76% during a 12 month follow up period (DeRubeis et al., 2005). There are also a number of unpleasant side effects associated with taking antidepressant medication including nausea, fatigue, insomnia, sexual dysfunction and weight gain and so not all patients want to take medications (Ferguson, 2001).

#### *1.1.4.2 Psychological treatments*

Many studies have also assessed the effectiveness of a range of psychological treatments for depression including cognitive behavioural therapy (CBT) and behavioural activation (BA) (for meta-analysis see Cuijpers, van Straten, Andersson & van Oppen, 2008). The most extensively studied psychological treatment for depression is CBT. A recent meta-analysis into the acute treatment effects of CBT compared to control found a high effect size (Hedges $g = 0.71$), however, the authors concluded this was an overestimation due to a strong indication of publication bias in low quality studies. In high quality studies the effect size of CBT was lower (Hedges $g = 0.53$) (Cuijpers et al., 2013). In terms of relapse prevention, a randomised controlled trial (RCT) comparing cognitive therapy with antidepressants found that patients treated with cognitive therapy were significantly less likely to have relapsed at

12 months follow up compared with those who had stopped antidepressant treatment (31% versus 76%; DeRubeis et al., 2005). According to a more recent meta-analysis, the mean proportion of patients who experience relapse after receiving acute phase CBT was 29% within one year and 54% within two years (Vittengl, Clark, Dunn, & Jarrett, 2007). An up to date meta-analysis also reports that patients who had received CBT are significantly less likely to relapse than patients withdrawn from pharmacotherapy (Cuijpers et al., 2013).

The effectiveness of an alternative treatment for depression, Behavioural Activation (BA), has also been examined. Behavioural Activation involves the use of event scheduling aimed at increasing activation, and contact with sources of reward whilst focusing on behaviours that inhibit activation such as avoidance (Lewinsohn & Graf, 1973). An up to date meta-analysis of 26 RCTs has reported a large acute treatment effect size when comparing BA with control (Hedges g = -.74) and moderate effect size in favour of BA when compared with antidepressant medication (Hedges g = -.42) (Ekers et al., 2014). A reanalysis of a large RCT (Dimidjian et al., 2006) has compared rates of relapse for prior BA, prior cognitive therapy and antidepressant withdrawal. Rates of relapse at one year follow up were 39% for prior cognitive therapy, 50% for prior BA and 59% for antidepressant withdrawal (Dobson et al., 2008). Most recently, a randomised controlled non-inferiority trial (the COBRA trial) has compared cost and outcomes of BA and CBT for depression. Results demonstrated BA had no lesser effect than CBT, illustrating that psychological therapy for depression can be effectively delivered by junior mental health professionals (Richards et al., 2016).

There have been similarly mixed findings for other psychological treatments for depression including interpersonal therapy (IPT) and psychodynamic therapy (de Mello, de Jesus Mari, Bacaltchuk, Verdeli & Neugebauer, 2005; Cuijpers et al., 2011; Driessen et al., 2010). Thus it is worth noting support for the ‘dodo bird verdict’ (Rosenzweig, 1936) as studies have reported equivalent outcomes across a range of different psychotherapies (e.g., Luborsky et al., 1999, 2002).

Altogether, the above literature highlights the sub-optimal acute and relapse prevention outcomes of current pharmacological and psychological treatments for depression. Therefore, there is a pressing need to refine existing treatments and to develop novel interventions in order to improve these outcomes. One way to achieve this goal is to target prognostically important symptoms of depression that are currently relatively neglected in treatments. One such symptom is anhedonia.

## 1.2 Introducing anhedonia

This chapter will now introduce the symptom of anhedonia in depression providing research evidencing the centrality of anhedonia in depression and the importance of studying anhedonia. Further, the relative neglect of positive affect disturbances within both research and psychological treatments will be discussed.

### *<u>1.2.1 Definition</u>*

The first recorded definition of anhedonia came from French psychologist Theodule Ribot in 1986 when he defined it as an absence of pleasure. It has previously been considered both a heritable personality trait predisposing a person to mental illness (Meehl, 1962) and subsequently a symptom of depression (Klein, 1974). The DSM-V has defined anhedonia in depression as a ‘markedly diminished interest or pleasure in all, or almost all, activities most of the day, nearly every day’ and is one of the two core symptoms an individual needs to present with in order to receive a diagnosis of MDD (American Psychiatric Association, 2013). It has been suggested that anhedonia reaches significant levels in 36.9% of depressed patients (Pelizza and Farrari, 2009), however it is likely the proportion is even higher than this due to extreme cut offs used to determine anhedonia in this study.

Anhedonia is seen as a deficit in the positive affect system outlined as consisting of subjective emotions (e.g. feeling happy), positive appraisals (e.g. judging a stimulus as rewarding), a behavioural response (e.g. approach behaviour towards a rewarding stimulus) and physiological responses (e.g. increased heart rate variability and high levels of skin conductance) (see Wacker, Dillon & Pizzagalli, 2009). In contrast, negative affect is associated with withdrawal behavioural and subjective feelings of sadness (Watson, 1988). In her influential work, Clark (2005) proposed that positive affectivity and negative affectivity form two fundamental yet separate temperament dimensions. These two dimensions are associated with different behaviours and emotions which at extremes can be risk factors for psychopathology. Negative affect tends to be linked to short-term action tendencies, e.g. escaping a fearful situation (Frijda, Kuipers & Schure, 1989). In contrast to this, positive affect tends to be linked to longer-term functions, e.g. building relationships with others. Therefore, anhedonia is not simply the opposite of negative affect and it is thus necessary for current MDD treatments to manage deficits in both of these dimensions. Indeed, the Research Domain Criteria (RDoC) initiative developed by the National Institute of Mental Health

(NIMH) considers dysfunction in the positive valence system to be a separate fundamental dimension across mental disorders.

Anhedonia can be considered a deficit in positivity in terms of two kinds of affective processes, firstly in terms of general background mood and, secondly the emotional response to specific stimuli. For example, Rottenberg defines mood as, “diffuse slow-moving feeling states that are weakly tied to specific objects or situations” compared to emotions defined as, “quick-moving reactions that occur when organisms encounter meaningful stimuli that call for adaptive responses” (Rottenberg, 2005, p1). Both of these affective processes will be studied in this thesis and in terms of measuring response to specific stimuli, the terms *affect* and *emotion* will be used interchangeably.

Anhedonia is also seen as part of a broader deficit in the positive affect system, regulated by the reward circuitry in the brain. In particular, basic neuroscience has identified sub-components of reward including the ability to pursue (‘wanting’), experience (‘liking’) and learn from pleasure (‘learning’) (see Berridge & Kringlebach, 2008).

### *1.2.2 Evidence of anhedonia in depression*

There is an abundance of literature evidencing the centrality of anhedonia in MDD. Findings from multiple methodologies will now be considered including self-reported data, laboratory data and experience sampling data.

#### *1.2.2.1 Self-report data*

There is a considerable amount of evidence to show that depressed individuals report reduced positive affect using a number of anhedonia self-report measures. The Snaith Hamilton Pleasure Scale (SHAPS; Snaith et al., 1995) is a measure of state pleasure experience during the past week, e.g. ‘I would find pleasure in my hobbies and pastimes (item three).’ Further validation of this scale has found significant negative correlations between depression symptom severity and scores on the SHAPS (Franken, Rassin & Muris, 2007; Nakonezny, Carmody, Morris, Kurian & Trivedi, 2010). An alternative scale measuring positive and negative mood is the Positive and Negative Affect Schedule (PANAS; Watson, Clark & Tellegen, 1988) and depression has previously been characterized by less positive mood using this scale (Crawford & Henry, 2004; Brown, 2007; Watson, Clark & Tellegen, 1988; Watson, Clark & Carey, 1988). As already mentioned, deficits in the positive affect system can also consist of a behavioural response such as reduced behavioural activation (e.g.

reduced appetitive motivation and positive affect) and this can be measured using the Behavioural Inhibition/Behavioural Activation Scale (BIS/BAS; Carver & White, 1994). Substantial evidence has linked depression with lower BAS (e.g. Kasch, Rottenberg, Arnow & Gotlib, 2002; McFarland, Shankman, Tenke, Bruder & Klein, 2006).

#### *1.2.2.2 Laboratory collected data*

Laboratory collected data has also demonstrated a link between depression and less positive affect when completing positive tasks such as viewing positive video clips or recalling positive memories (for meta-analysis see Bylsma, Morris, Rottenberg, 2008). Sloan et al., (2001) compared emotional reactivity of depressed and non-depressed females when viewing positive, negative and neutral images and found that depressed females showed less pleasantness and emotional arousal when viewing positive images. In further support of this, Dunn, Dalgleish, Lawrence, Cusack & Ogilvie, (2004) compared emotional reactivity between individuals with MDD and never depressed control participants. Results revealed a significant difference between groups in response to positive images with depressed participants rating the images with decreased happiness as well as increased sadness. It has also been found that depressed individuals report less amusement when watching funny films (Rottenberg et al., 2002). This has been expanded more recently with depression being related to lower scores on measures of happiness, pride and amusement when watching positive film stimuli (Gruber, Oveis, Keltner & Johnson, 2011). However, results are not necessarily consistent and some studies have reported no group differences in emotional ratings (see reviews by Treadway & Zald, 2011; Dunn, 2012).

#### *1.2.2.3 Experience sampling method (ESM) data*

Experience sampling method (ESM; Csikszentmihalyi & Larson, 1987) is used to measure a participant’s emotional response and behaviour at multiple time points in their daily lives (for a detailed description of this method refer to section 2.5). There have been altogether mixed findings with regards to positive affect deficits when using ESM (see review by Telford, McCarthy-Jones, Corcoran & Rowse, 2012). Surprisingly, research has demonstrated that when depressed individuals engage with positive activities in the real world they do not report reduced positive emotional reactivity (e.g. Thompson et al., 2012). Most recently, van Roekel et al., (2015) looked at anhedonia in adolescents and did find that depression was associated with a reduced number of reported positive events. However, they found no relationship between depression and emotional reactivity to positive events. More surprising are findings that depressed participants have sometimes reported higher levels of positive affect when using these ecological designs (Bylsma, Taylor-Clift & Rottenberg, 2011; Peeters, Nicolson, Berkhof, Delespaul & de Vries, 2003). There are however limitations to such studies, including the use of only idiographic (participant chosen) positive events and so results might reflect a difference in the type of positive events chosen between depressed and control groups. For example, a depressed participant may have utilized a more stringent set of criteria when choosing what counts as a “positive” event compared to a neutral event. Therefore, in studies that use idiographic stimuli we might expect to see elevated positive reactivity in depressed individuals to positive events relative to neutral events. Conversely, ESM research has also revealed evidence regarding reduced levels of positive affect in depression (e.g., Barge-Schaapveld, Nicolson, Berkhof & deVries, 1999; Myin-Germeys et al., 2003; Conrad et al., 2008; Bower et al., 2010). The reasons for these discrepant findings are not altogether clear and future research would benefit from combining laboratory mood inductions with ESM and using both idiographic and nomothetic stimuli to resolve this issue.

#### *1.2.2.4 Reward deficits in depression*

As previously mentioned, anhedonia is not a unitary construct and deficits can be observed in many different aspects of positive processing. The reward system (Berridge & Kringlebach, 2008) outlines three psychological components of reward each of which have distinct neurobiological mechanisms. The first component of reward is termed ‘wanting’ and represents an individual’s motivation and desire to work towards rewards. The next component is ‘liking’ defined as the actual experience of pleasure when a reward is attained. The final component of reward is termed ‘learning’, referring to an individual’s predictions about future rewards based on past experiences of rewards.

Previous literature has found each component of the reward system to be impaired in depression. Evidence of liking deficits in depression have already been discussed in section 1.2.2.1 of this review. Evidencing deficits in wanting, it has been found that depressed individuals are less willing to expend effort towards a reward than control participants (Treadway, Bossaller, Shelton & Zald, 2012; Yang et al., 2014). This has been supported by studies which have used the strength of handgrip squeeze as a measure of motivation (Clery-Melin et al., 2011). Additionally, compared to never depressed control participants, a clear dissociation has been found in depressed individuals between how much an individual likes a humorous cartoon and the amount of effort they are willing to exert in order to view the cartoon (Sherdell, Waugh & Gotlib, 2012). However, less consistent with the above findings is the recent discovery that individuals with social anhedonia (deficits in pleasure gained from social interactions) have intact motivation and effort for monetary rewards (McCarthy, Treadway & Blanchard, 2015).

Evidencing deficits in reward learning, it has been found that depressed individuals fail to develop a response bias towards a more frequently rewarded stimulus (Pizzagalli, Iosifescu, Hallett, Ratner & Fava, 2008). This is also the case in healthy individuals displaying high levels of anhedonic symptoms (Pizzagalli, Jahn & O’Shea, 2005) and in those recovered from depression (Pechtel, Dutra, Goetz & Pizzagalli, 2013). Reduced learning from rewards is also predictive of poorer treatment response in hospitalized inpatients (Vrieze et al., 2013). More recently, Liverant et al., (2014) found reward learning deficits were more pronounced in individuals with depression with higher levels of anhedonia. A study has also looked at the effect of pharmacological treatment on reward learning in depression and found equivalent deficits in medicated and unmedicated individuals (Herzallah et al., 2013). However, there were differential effects of medication on learning from negative and positive feedback with medicated individuals with MDD showing less sensitivity to negative feedback (punishment) compared to unmedicated individuals with MDD and healthy control subjects. However, there was no effect of medication on learning from positive feedback, as medicated and unmedicated MDD subjects were both less sensitive to positive feedback compared to healthy control subjects (see Admon & Pizzagalli, 2015, for recent review on reward dysfunction in depression).

There are also a number of neuroimaging studies that have linked depression to reduced activation in areas of the brain involved with reward processing. A number of brain regions have been implicated in the processing of reward, notably the basal ganglia and striatum (e.g. the nucleus accumbens, substantia nigra, amygdala, ventral tegmental area) (Treadway & Zald, 2011; Russo & Nestler, 2013; Heshmati & Russo, 2015; Whitton, Treadway & Pizzagalli, 2014). In a comparison of 10 unmedicated depressed participants and 12 healthy control participants, depressed participants demonstrated lower bilateral ventral striatal activation and decreased activation in the dorsomedial frontal region when viewing positive stimuli which further correlated with decreased interest and pleasure in activities (Epstein et al., 2006). Further, evidence for decreased activation in reward processing areas of the brain is provided by Keedwell and colleagues who reported that anhedonia (but not depression severity) was positively correlated with ventromedial prefrontal cortex activity and negatively correlated with amygdala and ventral striatal activity in response to happy stimuli (Keedwell et al., 2005). Additional support for neurological dysfunction during consummatory liking is the finding that relative to comparison subjects, depressed individuals show a reduced response to reward in the left nucleus accumbens and the caudate bilaterally. In addition, self-report anhedonic symptoms were associated with reduced caudate volume bilaterally (Pizzagalli et al., 2009). Neurological disturbances during depression are not limited to reward liking and have also been shown during both wanting (e.g., Yang et al., 2016) and reward learning (e.g., Kumar et al., 2008; Wacker, Dillon & Pizzagalli, 2009).

### *1.2.3 The importance of anhedonia*

Section 1.2.2 of this review has highlighted substantial evidence from multiple methodologies to support the view that anhedonia is a central component of MDD. This helps to validate the claim that anhedonia is a worthwhile symptom to target in treatments. Further support for this claim is evidence highlighting the prognostic importance of anhedonia in MDD. This review will now consider how the presence of anhedonia predicts the onset of depression, a poor depression prognosis, how the positive affect system can be adaptive, how residual symptoms of anhedonia remain after recovery and the relative uniqueness of this symptom to depression.

#### *1.2.3.1 Predicting the onset of depression*

An early psychiatric textbook noted how simple pathological depression is preceded by, “growing indifference to his former pursuits and pleasures: the ordinary duties of life become irksome and devoid of interest” (Bevan, 1899, p143). This view that anhedonia precedes the onset of MDD has been supported by more recent evidence. In a large prospective study of 1,507 adolescents it was found that individuals with subthreshold anhedonia were 3.76 times more likely to develop MDD during follow up (Georgiades, Lewinsohn, Monroe & Seeley, 2006). Similarly, a longitudinal study has reported that changes in anhedonia predicted an increased likelihood of subsequent MDD, however only in boys (Kouros, Morris & Garber, 2015). Deficits in reward function have also been noted in youths prior to onset of a depressive episode. Gotlib et al., (2010) compared never-disordered daughters at familial risk for depression and control participants (aged 10-14 years) and found reduced activation of the putamen and left insula in the at risk group when anticipating reward. Furthermore, adolescents with an increased familial risk of depression display diminished responding in the orbitofrontal cortex and anterior cingulate cortex when presented with rewarding stimuli

(McCabe, Woffindale, Harmer & Cowen, 2012). Altogether, this work proposes that a familial risk for depression in adolescents affects the neural mechanisms underlying the processing of reward and that anhedonia is a likely vulnerability factor in the development of the disorder.

#### *1.2.3.2 Predictor of poor depression outcomes*

Prospective data suggests that the presence of anhedonia is a predictor of poor outcome in depression. A study conducted in the Netherlands looked at predictors of poor outcome of DSM-III-R major depression in 7,076 community individuals and found anhedonia was significantly related to ongoing depression at one year follow up (Spijker, Bijl, de Graaf and Nolen, 2001). This has been supported by more recently published studies with extended follow ups. For example, it has been found that individuals with an absence of positive well-being are approximately seven times more likely to be depressed ten years later, even after controlling for prior depression (Wood & Joseph, 2010). Similarly, a trait tendency to experience decreased pleasure has been linked to greater depression over a 20 year period (Shankman, Nelson, Harrow & Faull, 2010). A review of prospective research including 28 published research studies (n= 3,708), has reported a consistent relationship between reduced positive emotion and poorer MDD course (Morris, Bylsma & Rottenberg, 2009). The presence of anhedonia is also a predictor of poor antidepressant response (Uher et al., 2012), poorer CBT treatment response in antidepressant resistant adolescents (McMakin et al., 2012), increased suicidal ideation (Winer et al., 2014) and increased completed suicide over a 12 month interval (Fawcett et al., 1990).

#### *1.2.3.3 Positive affect as a protective factor*

In addition to the above, the presence of positive affect can have a number of benefits. A meta-analysis has detailed how increased positive affect leads to greater success across multiple life domains (Lyubomirsky, King, & Diener, 2005). In a well-known study, positive emotional content in early life diaries was strongly correlated with longevity 60 years later, with a 2.5 fold difference in risk of mortality in participants in the lowest and participants in the highest quartile of positive emotional expression (Danner, Snowdon & Friesen, 2001). Within individuals vulnerable to depression, ESM has revealed that a greater ability to achieve positive affect from daily pleasant experiences is a predictor of increased resilience to later affective symptoms (Geschwind et al., 2010). Further work has found that in individuals with a history of depression, scoring highly on the ability to generate positive affect is associated with a more than 2.5-fold reduction in risk for future relapse (Wichers et al., 2010). Additionally, a further ESM study reported that daily increases in positive emotions are associated with a more favourable future course of depression (Wichers, Lothmann, Simons, Nicholson & Peeters; 2012). Bos et al., (2013) have also found that the presence of positive affect during pregnancy was a protector against postpartum depression.

A number of theories are put forward to explain the protective effects of positive affect. Riskind, Kleiman and Schafer (2013) described the ‘undoing hypothesis’ of positive affect and reported findings that baseline trait positive affect buffered the effect of baseline trait negative affect on gains in depressive symptoms six weeks later. However, the most recognised theory is Fredrickson’s (2001) Broaden and Build Framework which details how positive emotions help to foster resilience and adaptive coping strategies (see also Fredrickson, 2004; Fredrickson, Cohn, Coffey, Pek & Finkel, 2008; Cohn, Fredrickson, Brown, Mikels & Conway, 2009). Fredrickson states that positive emotions are able to divert attention to the external world and therefore bolster creativity and help individuals to become more pro-social. This has a consequence of building an individual’s personal resources to help them cope with potential adversity in the future. Evidence for the “broaden” hypothesis that positive emotions are able to widen thought-action repertoires is supported by early work from Isen and colleagues that predated the Broaden and Build framework. Increased positive affect was linked to thoughts that are more flexible (Isen & Daubman, 1984), creative (Isen, Daubman & Nowick, 1987) and efficient (Isen, Rosenzweig & Young, 1991). Later studies have provided further evidence for the broadening effect of positive emotions. Fredickson and Branigan (2005) found that participants who had viewed a positive film displayed broader thought-action repertoires by listing more activities they would like to complete when feeling positive. Further evidence has come from a study using facial EMG, as increased frequency of smiling was related to improved attentional breadth and flexibility (Johnson, Waugh & Fredrickson, 2010). Positive emotions are also found to broaden the scope of visual attention as a study using eye tracking technology reported that participants induced to feel a positive emotional state changed the focus of their gaze more frequently (Wadlinger & Isaacowitz, 2006). The broadening effect of positive emotions also extends to social domains (Dunn & Schweitzer, 2005; Nelson, 2009; Waugh & Fredickson, 2006).

Evidence for the “build” hypothesis, that positive emotions are able to spur the development of physical, intellectual and social resources is also ample. An example is a study by Mauss et al., (2011) who found that people who experience positive affect more frequently are more socially connected and more likely to be functioning at an optimal level. Furthermore, individuals who are said to be ‘flourishing’ are found to be different from their non-flourishing peers in terms of the magnitude of positive emotions they gain from everyday pleasant events (Catalino & Fredrickson, 2011). Interestingly, the frequency of positive emotional exchanges between partners (compared to negative emotional exchanges) prospectively predicts increases in relationship resources at two month follow up (Gable, Gonzaga & Strachman, 2006).

In summary, the argument that positive affect is adaptive has been well supported and so strengthens the claim that anhedonia is a highly important symptom to target in treatments for depression.

#### *1.2.3.4 Residual symptoms after recovery*

A further reason why it is important to study anhedonia in depression is evidence to suggest deficits in positive affect remain after recovery from a depressive episode. A study conducted over a two year period on a sample of 606 outpatients reported a stability of the behavioural activation/positive affect temperament, despite patients receiving treatment during this time (Brown, 2007). To support this, DiNicola et al., (2013) found reduced hedonic capacity in both euthymic bipolar patients and remitted major depressed patients, prompting a conclusion that altered hedonic capacity may represent an aspect of depression that is present beyond the confines of an acute depressive episode. There is also evidence to show blunted reward responsiveness in remitted depression (Pechtel, Dutra, Goetz & Pizzagalli, 2013; Whitton et al., 2016). Nevertheless, although the majority of research has found residual deficits, one study has reported a normalization of hedonic capacity in remitted MDD, as previously depressed subjects reported similar scores to a never depressed sample on a reward task (McFarland & Klein, 2009). Altogether, evidence to suggest residual deficits is important as these residual symptoms may put an individual at risk from future relapse (Conradi, Ormel & de Jonge, 2011).

#### *1.2.3.5 Uniqueness to depression*

A final indicator of the importance of targeting anhedonic symptoms in MDD interventions is the awareness that deficits in positive affect are relatively unique to depression. Although associations have been drawn between reduced positive affect and both social anxiety and schizophrenia, these associations are more pronounced in MDD (Watson & Naragon-Gainey, 2010). This is illustrated in the influential Tripartite Model (Clark & Watson, 1991) which led to the creation of the Mood Anxiety Symptom Questionnaire (MASQ; Watson & Clark, 1991). This model depicts three symptom dimensions; 'general distress' shared by depression and anxiety disorders, 'anxious arousal' which is anxiety specific and 'anhedonic depression' which is depression specific. This model was supported by later research as the same three dimensions emerged across five separate samples (Watson et al., 1995). Furthermore and consistent with this approach, anhedonic symptoms have been reported to be more related to a depressive diagnosis than schizophrenic diagnosis (Joiner, Brown & Metalsky, 2003). The specificity of anhedonia to depression once again emphasises the importance of effectively targeting this symptom in depression interventions.

### *1.2.4 The neglect of the positive affect system in depression treatments*

Despite the recognition of the centrality and importance of anhedonia in depression, it is still relatively neglected as a specific target of treatment (Dunn, 2012). For example, most antidepressant medications (e.g. selective serotonin or noradrenaline reuptake inhibitors; SSRIs or SNRIs) are known to target neurotransmitters linked to negative affect such as 5-hydroxytryptamine (5-HT), rather than neurotransmitters associated with positive affect (e.g. dopamine and opioids) (Argyropoulos & Nutt, 2013). It is known that current first line pharmacological treatment of SSRIs do not significantly improve deficits in positive affect and reward processing (see Nutt et al., 2007). Interestingly, it has been discovered that an early change in positive affect as a result of antidepressant treatment was associated with a better response to treatment, notably a 9-point decrease on the HDRS six weeks later (Geschwind et al., 2011). This suggests that an early assessment of positive affect change during antidepressant treatment will aid early identification of how a patient will respond.

Neglect of the positive affect system also extends to psychological treatments. Examples of this include gold standard therapies recommended by the National Institute for Health and Care Excellence (NICE) such as CBT and BA. Within these therapies there is little emphasis placed on positive affectivity and what specific mechanisms may prevent someone suffering with depression from enjoying positive experiences. For example, within CBT there is the use of activity scheduling and positive data logs, however the emphasis is placed on identifying and altering a client's negative cognitions that drive negative affectivity. This is further evidenced by the relatively little attention given to positive affect in core CBT texts (e.g., Beck, 2011). Similarly, a central component to BA is activity scheduling. However, the focus of this treatment is on a client's psychological barriers that impede taking part in these activities. Mechanisms that might reduce positive emotional experience during activity scheduling have been considered (e.g. rumination, avoidance), however there is still much more work to do in this domain as the full range of psychological mechanisms blocking pleasure experience are not fully targeted. Neither CBT nor BA treatment have so far evaluated in detail how well they deal with positive affect symptoms. A recent reanalysis of a large RCT of the effectiveness of BA (DeRubeis et al., 2005) has found that BA helps to repair negative affect more effectively than positive affect (Dunn, German, Hollen & DeRubeis; in prep). Several derivatives of CBT have been developed that specifically target positive affect including WellBeing Therapy (Fava, Rafanelli, Cazzaro, Conti & Grandi, 1998), Broad Minded Affective Coping (BMAC; Tarrier, 2010) and Goal-setting and Planning (GAP; see MacLeod, Coates & Hetherton, 2008). Whilst there is preliminary data to support these treatments, further robust evaluation is required using high quality RCTs that have active control conditions.

As discussed previously, pharmacological treatments, CBT and BA have suboptimal acute and relapse prevention outcomes (see section 1.1.4). We may hope to improve on these outcomes by targeting central and important symptoms of MDD, such as anhedonia, that are currently relatively neglected in treatments. However, a reason anhedonia is not yet specifically targeted in treatments is likely due to a lack of research into mechanisms that underpin reduced positive affect in depression. Furthermore, there is some debate as to whether hedonic capacity is partly heritable and thus a change in positive affect is expected to be harder to achieve (see Bogdan & Pizzagalli, 2009; Bartels, 2015). However, this research can be challenged by findings suggesting a significant increase in positive affect through psychological interventions (see section 1.4.3.1).

## 1.3 Identifying candidate mechanisms

In order to be able to treat anhedonia, it is essential to understand what psychological mechanisms underpin it. This approach of identifying and then explicitly targeting mechanisms in treatment has been used with success in the past. For example, mechanisms that were found to maintain PTSD such as excessive negative appraisals of the trauma (Ehlers & Clark, 2000) have since been successfully targeted in PTSD treatments (e.g., Ehlers, Clark, Hackmann, McManus & Fennell, 2005). In a similar way, identified mechanisms have been targeted in treatments for social phobia and panic disorder (e.g., Clark et al., 2003; Clark, et al., 1994). This approach of identifying candidate mechanisms is likely to improve our capacity to treat anhedonia in depression.

Very recently, an overarching conceptual framework of mechanisms that underlie the effectiveness of positive interventions has been published (see Quoidbach, Mikolajczak & Gross, 2015). Similarly, a number of promising anhedonia mechanisms are starting to emerge from the basic science literature (see Dunn & Roberts, 2016). One mechanism is the use of a ‘dampening’ appraisal style, defined as “effortful cognitive attempts to down-regulate positive feelings” (Raes et al., 2014, p65). Previous research has associated greater dampening with higher levels of anhedonia (e.g., Werner-Seidler, Banks, Dunn & Moulds, 2013; Raes, Smets, Nelis & Schoofs, 2012; Raes et al., 2014). Another potential mechanisms is a disconnection from bodily feedback that has potential to amplify positive emotional experience (e.g., Dunn et al., 2007; Dunn et al., 2010; Furnam, Waugh, Bhattacharjee, Thompson & Gotlib, 2013). One promising mechanism has emerged from the literature which merits further investigation and will form the focus of this thesis – mind wandering. This mechanism stems from the finding that depressed individuals often find it difficult to keep their attention on the present moment (Smallwood, O’Connor, Sudbery & Obonsawin, 2007). A large experience sampling study has found that this tendency for the mind to ‘wander’ is linked to reduced happiness in everyday life (Killingsworth & Gilbert, 2010). It therefore seems plausible that the elevated levels of mind wandering in depression could be a driver of anhedonic symptoms. This review will now examine the mechanism of mind wandering in more detail, including how it is measured and previous research linking mind wandering with depression and positive affect.

### 1.3.1 *Introducing mind wandering*

#### *1.3.1.1 Definition*

Mind wandering is defined as “a shift in the contents of thought away from an ongoing task and/or from events in the external environment to self-generated thoughts and feelings” (Smallwood & Schooler, 2015, p488). During mind wandering an individual’s attention strays from its current train of thought (often an external task) to mental content generated by the individual rather than cued by the environment (Smallwood & Schooler, 2015). Mind wandering is ubiquitous and has been found to cover 30-50% of our daily thoughts

(Killingsworth & Gilbert, 2010). In cognitive terms, mind wandering provides a perfect example of perceptual ‘decoupling’ (Schooler et al., 2011; Smallwood, McSpadden & Schooler, 2007) as during a state of mind wandering there is disparity between what an individual is currently doing and what they are thinking about. Specifically, attentional resources stop being constrained by external sources and instead become centred on information of an internal origin. Often this is unintentional and happens without our awareness, indicating that mind wandering also involves temporary failure in meta-awareness (Schooler, 2002). Mind wandering has previously been referred to as many different constructs in the literature including task-unrelated thought (e.g., Smallwood, Baracaia, Lowe & Obonsawin, 2003), stimulus-independent thought (e.g., Teasdale et al., 1995), zone outs (e.g., Schooler, McSpadden & Schooler, 2008) and daydreaming (Mar, Mason & Litvack, 2012). The ubiquity of mind wandering has prompted researchers to consider how these thoughts may impact our emotional wellbeing.

#### *1.3.1.2 Measuring mind wandering*

Mind wandering has previously been measured using self-report, behavioural and physiological/ neuroimaging measures. Researchers ideally use a triangulation of these measures in order to best make inferences about internal mental states (Schooler & Schreiber 2004). The most common measure of mind wandering is a self-report technique known as thought sampling, split into *probe-caught* and *self-caught* methods. The *probe-caught* measure of mind wandering comprises an individual being interrupted and asked to rate their experience (e.g., Killingsworth & Gilbert, 2010; Smallwood et al., 2004). The *self-caught* measure of mind wandering asks participants to monitor their awareness for off-task thinking and report when mind wandering occurs (e.g., Cunningham, Scerbo & Freeman, 2000; He, Becic, Lee & McCarley, 2011). Typically, *probe-caught* measures are favoured in research as they do not rely on a participant’s awareness of their current mental experience. A comparison of *probe-caught* and *self-caught* measures has highlighted that not all mind-wandering reaches conscious awareness (Sayette, Reichle, & Schooler, 2009). Thought sampling has been used in laboratory environments to measure mind wandering (e.g., Stawarczyk, Majerus, Maj, Van der Linden & D'Argembeau, 2011) but also using ESM (Killingsworth & Gilbert, 2010; McVay, Kane & Kwapil, 2009; Kane et al., 2007). Mind wandering can also be measured retrospectively by asking participants at the end of a task about their experience of mind wandering during the task. A previously used measure is the thinking content component of the Dundee Stress State Questionnaire (DSSQ; Matthews et al., 1999) (e.g., Smallwood, O'Connor, & Heim, 2005; Smallwood et al., 2004; Barron, Riby, Greer & Smallwood, 2011). Such retrospective measures have an advantage of minimising disruption to the task, however, memory constraints and a lack of awareness are strong limitations of this approach.

Mind wandering can also be measured indirectly using behavioural measures such as performance on a sustained attention to response task (SART; Robertson, Manly, Andrade, Baddeley & Yiend, 1997). Originally developed to measure deficits in attention in individuals with a traumatic brain injury (Robertson et al., 1997), the SART has since been used to index the frequency of mind wandering (e.g., Smallwood et al., 2004; Smallwood & Schooler, 2006; Stawarczyk et al., 2011; Deng, Li, Yuan-Tang, 2014). The SART follows a simple Go/No Go paradigm in that during the task, participants are told to respond to a frequent non-target by pressing a button (Go) whilst withholding a response to a non-frequent target (No Go) (for a full task description see section 4.4.3.1). This task paradigm exploits the fact that mind wandering is more likely to occur during simple and repetitive tasks (e.g., Cheyne, Carriere & Smilek, 2006). In order to perform well on the task, participants must maintain enough attention in order to press the button on the frequent Go trials but not press the button on a non-frequent No Go trial. Performance on the SART can be indexed in a number of ways, each of which has been accepted as a behavioural measure of mind wandering (e.g., Whyte, Grieb-Neff, Gantz & Polansky, 2006; Cheyne, Solman, Carriere & Smilek, 2009). Measures include; errors of commission (responding when a target is presented), errors of omission (not responding when a non-target is presented) and reaction time variability (with an increased variability demonstrating greater inattention to the task).

An additional objective measure of mind wandering is through measurement of the default mode network (Raichle et al., 2001) known as the brain's 'resting state'. Research using a combination of thought probes and brain imaging techniques have discovered mind wandering to be associated with increased activity within cortical networks such as the ventral anterior cingulate cortex, the precuneus and the temporoparietal junction (Mason et al., 2007; Christoff, Gordon, Smallwood, Smith & Schooler, 2009). Therefore, such neurological evidence could be included in future research to strengthen the measurement of mind wandering occurrences.

Within this thesis, atriangulation of measures of mind wandering is important (e.g. combination of probe caught measures, retrospective measures and objective behavioural measures) in order to obtain a measure of mind wandering that is not directly tied to one particular methodology and is likely to be most reflective of an individual’s inner mental state.

### *1.3.2 <u>The deleterious effects of mind wandering</u>*

The negative outcomes associated with mind wandering have been well documented including impaired performance whilst reading (Smallwood, 2011), during memory tasks (Smallwood et al., 2003), during reaction time tasks (Smallwood et al., 2004) and when driving (He, Becic, Lee & McCarley, 2011). There is also sufficient research to indicate elevated levels of mind wandering correlate with increased negative affect (Stawarcyk, Majerus & D’Argembeau 2013; Smallwood, Fitzgerald, Miles & Phillips, 2009). In addition to this, mind wandering has been linked to depression.

#### *1.3.2.1 Mind wandering and depression*

Early research found mind wandering to be the most commonly reported concentration problem among a sample of depressed patients (Watts, MacLeod and Morris, 1988; Watts & Sharrock, 1985). The insight into mind wandering as a potential marker for depressive thinking was more recently introduced by Smallwood and colleagues who reported increased mind wandering in dysphoria (defined as a sense of unease and dissatisfaction with life) (Smallwood, O'Connor, Sudbery & Obonsawin, 2007). Further correlational studies have supported this link with both self-reported measures of mind wandering (Carrier, Cheyne & Smilek, 2008; Stawarczyk, 2012), behavioural measures (Deng, Li & Tang, 2014) and using a combination of both self-report and behavioural measures (Farrin, Hull, Unwin, Wykes & David, 2003). It has also been found that individuals reporting high levels of daydreaming also report lower life satisfaction (Mar, Mason & Litvack, 2012). However, the above studies are correlational and fewer studies have looked at the causality in this relationship. A first set of studies have manipulated mood to observe how this influenced levels of mind wandering. These studies have found mind wandering to be a detrimental consequence of negative mood (e.g., Seibert & Ellis, 1991; Smallwood, Fitzgerald, Miles & Phillips, 2009; Stawarczyk, Majerus & D’Argembeau, 2013). Although not causal evidence, mind wandering has also be found to be the precursor to lowered mood (Killingsworth & Gilbert, 2010), later replicated in a lab study (Ruby, Smallwood, Engen & Singer, 2013). Therefore the direction of the relationship between mind wandering and negative mood remains unclear. One attempt to answer the above question found sad mood to be a predictor of mind wandering (Poerio, Totterdell & Miles, 2013), however when taking into account the affective content of mind wandering the direction of this relationship was reversed. Thoughts of a sad nature during mind wandering resulted in a sad mood afterwards, even after controlling for previous mood. However, the above research is limited as the relationship between mind wandering and mood could be as a result of a third uncontrolled variable (see Mason, Brown, Mar & Smallwood, 2013).

#### *1.3.2.2 Mind wandering and reduced positive affect*

Despite the well-established link between mind wandering and depression, there is more limited research studying the link between mind wandering and anhedonia. Correlational research has studied the link between questionnaires measuring the tendency to mind wander and questionnaires measuring positive affect. A common self-report measure of mind wandering is the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003), measuring the frequency of attention to and awareness of the present moment. In its original validation study, higher scores on this questionnaire were correlated with increased positive affect measured using the PANAS (Watson, Clark & Tellegen, 1988), later supported with Chinese versions of the same questionnaires (Brown & Ryan, 2003; Deng et al., 2012). More recently, in a sample of 450 health care professionals, lower scores on the MAAS were linked to lower levels of positive affect (Atanes et al., 2015). Initial evidence has also linked scores on the MAAS with fewer anhedonic symptoms in depression (Zvolensky et al., 2006), the first study to look at the MAAS and positive affect within a depression context. Therefore, questionnaire data using the MAAS provides initial evidence for the link between mind wandering and positive emotion disturbances.

A further questionnaire that has been used to measure mind wandering is the ‘acting with awareness’ subscale of the five facet mindfulness questionnaire (FFMQ; Baer et al., 2006). The ‘acting with awareness’ subscale measures an individual’s trait ability to maintain attentional focus on the present moment and consists of items such as, “when I do things, my mind wanders off and I’m easily distracted (item 5).” A study utilising a large community sample in Sweden (N= 1,000) has previously reported a strong positive correlation between this acting with awareness subscale and a ‘positive state of mind’ (Bränstrom, Duncan & Moskowitz, 2011). However, a positive state of mind was measured on items of productivity, restful repose, sharing and responsible caretaking, (see Adler, Horowitz, Garcia & Moyer, 1988), and so less a measure of positive emotional experience. Since, the acting with awareness subscale has been found to be uniquely correlated with anhedonic symptoms in a sample of 187 adults (Desrosiers, Klemanski & Nolen-Hoeksema, 2013), however this relationship was not significant when the authors conducted a parsimonious path model. A selection of other measures of mind wandering/present moment awareness have been utilised in research and correlated with measures of positive affect including the SART (Ruby, Smallwood, Engen & Singer, 2013), Imaginal Process Inventory (Carciofo, Du, Song & Zhang, 2014) and the ‘Be Present’ component of the Emotion-Regulation Profile – revised (Quoidbach, Berry, Hansenne, Mikolajczak, 2010)

The relationship between mind wandering and reduced positive affect has also been studied using ESM (e.g., McVay, Kane & Kwapil, 2009). The most cited study by Killingsworth & Gilbert (2010), used a smartphone application to collect a very large database (N=2,250) of real-time reports of thoughts, emotions and levels of mind wandering. Participants were asked to rate questions at random times during the day including, “How are you feeling right now?” (from 0 “very bad” to 100 “very good”), “What are you doing right now?” and “Are you thinking about something other than what you’re currently doing?” Participants were able to rate mind wandering experience as pleasant, neutral or unpleasant. A core finding from this study was that participants engaged in mind wandering very frequently (46.9% of samples). Importantly, it was found that people reported feeling less happy when their minds were wandering than when they were not and this was true of all activities. However, possibly most interesting was the finding in this study that participants felt no happier when thinking about pleasant topics than when thinking about their current activity. Therefore, from these results there is a strong suggestion that mind wandering may contribute to anhedonia.

However, the link between mind wandering and positive affect is far from clear cut as several studies have reported no relationship between measures of mind wandering and positive emotion (see Brooker, Julian & Webber, 2013; Black, Semple, Pokhrel & Grenard, 2011). However, the reported studies that found no relationship were conducted on specific smaller samples (e.g. workers in the disability sector, first year medical students) which may have contributed to the null results. Furthermore, previous laboratory work has found that completion of the simple and repetitive SART task (designed to provoke mind wandering) leads to significant reductions in positive mood (Marchetti, Koster & De Raedt, 2012). As expected, there was a significant increase in mind wandering from the first to the second half of the SART task. However, positive affect during the second half of the task measured using the PANAS did not correlate with either the behavioural measure of mind wandering (number of commission errors; pressing a button when you shouldn't) or self-reported thought probes. Therefore conclusions that reduced positive affect was driven by mind wandering cannot be fully confirmed as an alternative factor such as fatigue or boredom might have been responsible.

Perhaps more intriguing are studies that have reported a relationship between increased mind wandering and higher positive affect. Although consistent with prior research in that mind wandering was associated with lower mood, Franklin et al., (2013) report a 'silver lining' to mind wandering in that there are specific instances when mind wandering enhances mood relative to on-task thinking. It was found that mind wandering to interesting topics was associated with more positive mood, suggesting not all mind wandering has detrimental consequences. Further to this, social daydreaming (imagining interactions and relationships with others) is associated with increasing happiness (Poerio, Totterdell, Emerson & Miles, 2015). This research highlights how specific instances of mind wandering may have differing effects on emotional well-being.

In summary, research studying the link between mind wandering and positive affect has produced mixed findings (see Table 1.1 for summary). All research to date has been correlational in nature and thus the causal relationship between these constructs is unknown. Moreover, there has also been a lack of studying this relationship within the context of depression, highlighting a pressing need to do so.

Table 1.1. *Summary of previous studies relating mind wandering to positive affect*

| **Study** | **Sample type** | **Sample N** | **Study design** | **Main finding** | **Limitations** |
|---|---|---|---|---|---|
| Brown & Ryan, 2003 | Non-clinical student and community | 1,253 | Questionnaire correlational | Greater mind wandering = lower PA | Lacks ecological validity. Not in context of depression. |
| Deng et al., 2012 | Non-clinical student | 263 | Questionnaire correlational | Greater mind wandering = lower PA | Lacks ecological validity. Not in context of depression. |
| Atanes et al., 2015 | Non-clinical health professionals | 450 | Questionnaire correlational | Greater mind wandering = lower PA | Lacks ecological validity. Not in context of depression. |
| Zvolensky et al., 2006 | Non-clinical community | 170 | Questionnaire correlational | Greater mind wandering = greater anhedonic symptoms | Lacks ecological validity. |
| Bränstrom, Duncan & Moskowitz, 2011 | Non-clinical community | 1,000 | Questionnaire correlational | Greater mind wandering = lower PSOM | Lacks ecological validity. Vague measure of PA. Not in context of depression. |
| Desrosiers, Klemanski & Nolen-Hoeksema, 2013 | Treatment-seeking adults | 187 | Questionnaire correlational | Mind wandering unrelated to anhedonic symptoms | Lacks ecological validity. |
| McVay, Kane & Kwapil, 2009 | Non-clinical student | 72 | SART and ESM correlational | Greater mind wandering = lower happiness | Do not use behavioural indices. Not in context of depression. |
| Smallwood, Engen & Singer, 2013 | Non-clinical community | 85 | Thought probes during behavioural task & correlational | Mind wandering preceded lower mood | Do not use behavioural indices. Not in context of depression. Mood measured during completion of a cognitive task. |
| Carciofo, Du, Song & Zhang, 2014 | Non-clinical student | 270 | Questionnaire correlational | Greater mind wandering = lower PA | Lacks ecological validity. Not in context of depression. |
| Quoidbach, Berry, Hansenne, Mikolajczak, 2010) | Non-clinical university workers | 282 | Questionnaire correlational | Greater mind wandering = lower PA | Lacks ecological validity. Not in context of depression. Less validated measure of mind wandering. |
| Brooker, Julian & Webber, 2013 | Non-clinical workers in disability sector | 34 | Longitudinal observational study (non-experimental) | Positive affect increased after an adapted mindfulness training programme, levels of mind wandering did not change. | Did not correlate measures pre-intervention. Not in context of depression. Small sample. Lack of control group. |
| Black, Semple, Pokhrel & Grenard, 2011 | Non-clinical medical students | 31 | Questionnaire correlational | Mind wandering unrelated to levels of positive affect. | Lacks ecological validity. Not in context of depression. Small sample. |

| | | | | | |
|---|---|---|---|---|---|
| Franklin et al., 2013 | Non-clinical students | 105 | ESM correlational | Greater mind wandering (to interesting topics) = higher PA | Not in context of depression. |
| Poerio, Totterdell, Emerson & Miles, 2015 | Non-clinical student and community | 101 | ESM correlational | Greater (social) daydreaming = increased happiness | Affect measured on a single bipolar scale. Not in context of depression. |
| Killingsworth & Gilbert, 2010 | Non-clinical community | 2,250 | ESM correlational | Greater mind wandering = less happiness | Not in context of depression. |
| Marchetti, Koster & De Raedt, 2012 | Non-clinical student | 80 | Longitudinal observational study | Mind wandering increased during completion of SART but levels of positive affect did not change. | Lacks ecological validity. Not in context of depression. Mood measured during completion of a cognitive task. Lack of control group. |

*Note*- PA = positive affect. ESM = experience sampling methodology. SART = Sustained Attention to Response Task. PSOM = Positive state of mind.

In conclusion, section 1.3 of this review has considered the need to understand mechanisms underlying anhedonia and has presented preliminary evidence for the mechanism of mind wandering. A further indication that mind wandering may be an important mechanism to consider is the emerging literature linking positive affect with mindfulness. A key skill learnt in mindfulness is that of present moment awareness, notably the inverse of mind wandering. It is currently unknown how changes in levels of mind wandering as a result of mindfulness practice mediate the relationship between MBCT and improved positive processing.

## 1.4 Mindfulness and mind wandering

The next section of this review will introduce the concept of mindfulness and the current research base of Mindfulness Based Cognitive Therapy (MBCT; Segal, Williams & Teasdale, 2002). The evidence linking mindfulness with positive affect will then be discussed. The review will then highlight current gaps in this literature and how future research will help to address these gaps and answer the following questions: 1) is an increase in positive affect a mechanism of change in MBCT? 2) Does mind wandering mediate any beneficial effects of mindfulness?

### *1.4.1 Introducing mindfulness*

Mindfulness has previously been defined as, “paying attention in a particular way: on purpose, in the present moment, and non-judgementally” (Kabat-Zinn, 1994, p. 4). Put differently, mindfulness is a way of connecting to our present moment experience in an accepting way. During mindfulness, the aim is to focus on the ‘here and now’ and to redirect attention when it has wandered to distracting thoughts and worries. It has been proposed that mindfulness is the antithesis of the construct of mind wandering (Mrazek, Smallwood & Schooler, 2012) and research has supported this claim as mindfulness training reduces levels of mind wandering (Mrazek, Franklin, Phillips, Baird & Schooler, 2013). Mindfulness is a modern movement with roots in ancient eastern practice. The founder of modern day mindfulness in clinical psychology is Jon Kabat-Zinn who in the 1970s developed a Mindfulness Based Stress Reduction (MBSR) programme, as a “training vehicle for the relief of suffering” (Kabat-Zinn, 2003). MBSR was originally developed to alleviate symptoms of chronic physical health problems such as chronic pain or cancer. More recently, mindfulness practice has been applied to help people suffering from a variety of psychological conditions. Zindel Segal, Mark Williams and John Teasdale developed MBCT for individuals suffering from recurrent depression (MBCT; Segal, Williams & Teasdale, 2002).

#### *1.4.1.1 What is MBCT?*

MBCT is a group-based clinical intervention designed to reduce relapse of MDD using a combination of mindfulness meditation and cognitive-behavioural techniques (Segal, Williams & Teasdale, 2002). MBCT is delivered across eight weekly two hour sessions with approximately 8-15 participants in a group. MBCT draws upon many of the techniques used in the original MBSR program, predominately training in mindfulness meditation through exercises such as a body scan, breathing meditation and mindful movement. Participants completing MBCT are taught to become aware of thoughts, emotions and bodily sensations and relate to these non-judgementally, even when thoughts and sensations may be difficult. An overarching goal of MBCT is for participants to learn that distressing thoughts and feelings come and go, helping participants to remain in the present moment without ruminating on past worries or future concerns. MBCT also teaches cognitive-behavioural techniques such as psychoeducation regarding the role of cognition in MDD and how thoughts, emotions, bodily sensations and action tendencies are linked and help to maintain depressive symptoms. A further focus of MBCT is the development of a care plan and how participants might take care of themselves when noticing a downturn in their mood. MBCT is the psychological intervention of choice for depressive relapse prevention as recommended by the National Institute for Clinical Excellence (NICE; 2015). Since its development in 2002, MBCT has been adapted for several other psychological disorders and health conditions including bipolar disorder (Miklowitz et al., 2009), generalised anxiety disorder (Evans et al., 2008), insomnia (Heidenreich, Tuin, Pflug, Michal & Michalak, 2006) and tinnitus (Philippot, Nef, Clauw, de Romrée & Segal, 2012).

### *1.4.2 <u>The efficacy of MBCT</u>*

There is now substantial evidence that MBCT is an effective treatment for reducing rates of relapse into depression (Kuyken, Crane & Dalgleish, 2012). Two thorough meta-analyses have assessed the effectiveness of MBCT. The first meta-analysis considered the effect of MBSR and MBCT treatments on symptoms of anxiety and depression across different clinical samples. Nine studies found a large pooled within-group effect size (Hedges g = 0.85) for the decrease in depressive symptoms after MBCT (Hofmann, Sawyer, Witt and Oh, 2010). A further meta-analysis of six RCTs (n=593) looked at MBCT in the context of depressive relapse prevention and calculated that MBCT reduced the risk of depressive relapse with a risk ratio of 0.66 for MBCT compared to treatment as usual (Piet & Hougaard, 2011). A further subgroup analysis found a relative risk reduction of 43% for individuals with three or more previous depressive episodes, with no risk reduction for participants with two episodes. However, more recently MBCT has been observed to reduce residual depressive symptoms irrespective of number of previous episodes (Geschwind, Peeters, Drukker, Van Os & Wichers, 2012).

In contrast, a large RCT comparing MBCT with cognitive psychoeducation found that MBCT did not have a significant effect on risk of relapse to MDD over 12 months follow up (Williams et al., 2014). However, although no overall superiority, MBCT did provide protection against relapse for participants who had experienced childhood trauma. This finding was later replicated in the recently published PREVENT trial (see Kuyken et al., 2010 for trial protocol and Kuyken et al., 2015 for trial results) which compared MBCT treatment plus tapering support with maintenance antidepressants. Results of this trial revealed that time to relapse and recurrence of depression did not differ between the two groups. In other words, completion of MBCT was *as effective* as the use of antidepressants, however MBCT was not superior to antidepressants as was predicted. Once again, MBCT did provide protection against relapse for participants who had experienced childhood trauma. In support of these trials, a recently published study has found that although MBCT did significantly reduce levels of depressive symptoms and improve life satisfaction, there was no difference between MBCT and an active control condition in terms of depression relapse rates or time to relapse over a 60 week period (Shallcross et al., 2015). However, a very recent RCT comparing MBCT and antidepressant medication (the MOMENT study; Huijbers et al., 2012; Huijbers et al., 2016) has found a significantly shorter time to relapse for participants in the antidepressant arm of trial.

There is a suggestion that mindfulness based interventions might be effective for acute depression. A meta-analysis of 12 RCTs (n=578) found there was a significant post-intervention between-group benefit of mindfulness based interventions compared to control groups for people with current depressive disorder (see Strauss, Cavanagh, Oliver & Pettman, 2014). In support of this, a recently published meta-analysis of individual patient data (n=1258) found a larger effect of MBCT in participants with greater severity of depressive symptoms prior to treatment (Kuyken et al., 2016). However the evidence is mixed as another published study has found no difference between MBCT and treatment as usual in reducing depressive symptoms in sample of 106 chronically depressed participants (Michalak, Schultze, Heidenreich & Schramm, 2015).

### *1.4.3 Mechanisms of change in MBCT*

Compared to the extensive level of research looking at the efficacy of MBCT, there is a relative paucity of research to date that has studied how MBCT works to produce beneficial outcomes. It is imperative to understand the mechanisms of a treatment as enhancing its active ingredients can lead to further improvements and a streamlining of its delivery. An important stage of research in establishing mechanisms of action is to identify variables that mediate the effects of a given treatment on outcome (Kazdin, 2007).

There are a number of theoretical reviews that have proposed hypothesised mechanisms of change in mindfulness based interventions (see reviews by Gu et al., 2015; van der Velden et al., 2015). A heavily cited review (Shapiro, Carlson, Astin & Freedman, 2006) offers a theory based on what are stated to be the three core components of mindfulness; intention, attention and attitude (IAA). These three components are highlighted in the popular definition of mindfulness given above; mindfulness is “paying attention” (attention), “on purpose” (intention) and in a “particular way” (attitude) (Kabat-Zinn, 1994, p4). The authors state that through understanding IAA and the essential building blocks of mindfulness we can deduce how it might work. Shapiro and colleagues proposed a meta-mechanism of “reperceiving”, or a shift in perspective that overarches four direct mechanisms of mindfulness. These four proposed mechanisms are *self-regulation* (being better able to use a more adaptive range of coping skills), *values clarification* (a recognition of what is truly meaningful), *emotional, cognitive and behavioural flexibility* (being able to flexibly respond to the environment by seeing our current situation with greater clarity as it is in that moment) and *exposure* (being able to experience strong emotions with greater objectivity and less reactivity). A more recent theoretical review combined evidence from both neurological, self-report and experimental data to put forward four distinct but interacting mechanisms of mindfulness; attention regulation, body awareness, emotion regulation and change in perspective on the self (Hölzel et al., 2011).

An early study conducted to look at the mediating role of mechanisms in terms of relapse reduction after MBCT was published by Kuyken et al., (2010). The development of reliable measures of mindfulness (e.g. the Kentucky Inventory of Mindfulness Skills or KIMS, Baer, Smith & Allen, 2004) has allowed researchers to test if a development of mindfulness skills during MBCT causes the positive outcomes that have been observed. Based on an RCT comparing MBCT with maintenance antidepressants (Kuyken et al., 2008), it was found that MBCT treatment effects were mediated by an enhancement of mindfulness and self-compassion (Kuyken et al., 2010). Additionally, greater cognitive reactivity to a sad mood induction predicted worse outcome in those in the antidepressant arm but not in those that had undertaken MBCT. Therefore, it was concluded that the mechanisms of change in MBCT were an increase in mindfulness skills, an increase in self-compassion (kindness towards one self in times of difficulty; Neff, 2003) and a decoupling of the relationship between reactivity of depressive thinking and poor outcome. Consistent with this study is the finding that reductions in rumination and increases in mindfulness independently and uniquely mediate the effects of MBCT on depressive symptoms (Shahar, Britton, Sbarra, Figuerdo & Bootzin, 2010). Furthermore, an exploratory analysis conducted as part of an RCT comparing MCBT with treatment as usual (TAU), found that specifically the mindfulness component of “accept without judgement” mediated the effectiveness of MBCT (van Aalderen et al., 2012). Additional mediating mechanisms that have been considered in the literature are those of memory specificity (Hargus, Crane, Barnhofer & Williams, 2010; Crane, Winder, Hargus, Amarasinghe & Barnhofer, 2012), goal specificity (Crane et al., 2012) and meta-awareness

(Teasdale et al., 2002; Hargus, Crane, Barnhofer & Williams, 2010). Most recently, a systematic review of 23 clinical trials investigating mechanisms of change in MBCT has reported that alterations in mindfulness skills, rumination, worry, self-compassion and meta-awareness are associated with, predicted or mediated the effect of MBCT on treatment outcome (see van der Velden et al., 2015).

#### *1.4.3.1 The mediating role of positive affect*

There is emerging preliminary evidence that mindfulness interventions lead to increased positive processing and higher levels of positive affect. Advanced meditators have been shown to experience more daily positive emotions than novice meditators using an ESM design (Easterlin & Cardena, 1998). Moreover, mindfulness practice in novice practitioners completed in the laboratory increased recall of positive adjectives (Roberts-Wolfe et al., 2012) and subjective positive affect experience when watching a positive video clip (Erisman & Roemer, 2010). Furthermore, participants practicing a loving-kindness meditation have been found to report increased positive affect over time, compared to control participants (Fredrickson et al., 2008). MBCT has also been found to increase a participant’s capacity for the experience of positive affect (Garland et al., 2010). Similarly, an RCT utilising ESM found that individuals with residual depression symptoms undergoing MBCT experienced increased momentary positive emotions as well as increased engagement in positive activities, compared to a waitlist control condition (Geschwind, Peeters, Drukker, van Os & Wichers, 2011). Furthermore, a secondary analysis of this trial has found that MBCT stimulates an upward spiral of positive affect by increasing daily positive affect and positive cognitions (Garland, Geschwind, Peeters, Wichers, 2015). Moreover, changes in positive affect are seen to mediate the benefits of MBCT on reducing depression symptoms, over and above other mediators like negative affect and rumination (Batink, Peeters, Geschwind, van Os & Wichers, 2013). However, it should be noted that this study by Batink et al did not meet temporal precedence criteria for mediation as change in levels of positive affect was measured at the same time as change in levels of depression.

Altogether, the above research suggests that MBCT may in part generate its beneficial effects by increasing levels of positive affect. However, to further test this theory a longitudinal follow up is needed in order to assess if changes in positive emotional reactivity contribute to the relapse prevention effects of MBCT. In addition, while MBCT increases positive affect, it is not yet understood if it does so by increasing present moment awareness. This is of central importance to the current thesis as present moment awareness is proposed to be the inverse of mind wandering. Therefore, if present moment awareness is found to significantly mediate changes in positive affect after MBCT, this will suggest causal evidence for the link between increased mind wandering and anhedonic symptoms.

To conclude, an improved understanding of how changes in levels of mind wandering as a result of mindfulness practice mediate the relationship between MBCT and improved positive processing will help to inform anhedonia treatment approaches.

## 1.5 Summary of review

In summary, it has been shown that current treatments for depression have sub-optimal outcomes and considering the high prevalence, high costs and recurring nature of depression there is demand to improve these outcomes. There is a substantial volume of evidence to show that anhedonia is a central component to MDD and deficits in positive affect have been displayed across a number of different methodologies. Despite the centrality of anhedonia and its prognostic importance, there is a relative neglect of the positive affect system in current interventions. A probable reason for this neglect is a lack of understanding of mechanisms that drive reduced positive affect and how to correct these mechanisms. Therefore research is needed to further explore anhedonia and to evaluate potential candidate mechanisms. A mechanism that has emerged from the literature which merits further investigation due to its link with depression is mind wandering. Preliminary work has found mind wandering to be related to reduced positive affect however, limited work has tested this link in the context of depression. A further way to improve understanding of anhedonia in depression is to evaluate the impact of current psychological treatments on positive affect. The final part of this review has focused on the current evidence base for MBCT. Although the efficacy of MBCT has been well-established there is a paucity of research looking at mediating mechanisms between MBCT and its beneficial outcomes. One hypothesised mechanism is an increase in positive affect; however current research is yet to determine if a reduction in mind wandering (proposed to be the antithesis of mindfulness) mediates the relationship between MBCT and positive affect and indeed if positive affect contributes to the relapse prevention effects of MBCT. Altogether, research is needed to thoroughly investigate the role of mind wandering in driving anhedonia in order to develop novel ways to correct anhedonia in treatments.

# Chapter 2: General Methodology

This chapter will review the general methodology used across studies in this thesis. First, an overview of the design for each study will be provided with an emphasis on how all studies work together to evaluate if mind wandering is a mechanism causing anhedonia. Second, the risk and distress management protocols followed during experimental testing will be outlined. Third, a review of psychophysiological concepts relevant to the thesis will be provided followed by details regarding how psychophysiology measures were recorded and analysed. This will be followed by a review of experience sampling methodology including the justification for this method, strengths and limitations. The final part of this chapter will provide a description of the data checking procedure used across studies.

## 2.1 Overview of methods

### *2.1.1 __Thesis Framework__*

The studies in this thesis deploy different research designs to examine if an elevated tendency to mind wander is a causal mechanism driving anhedonia. Studies triangulate a variety of different ways of measuring mind wandering (e.g. self-report and behavioural) and positive emotional reactivity (e.g. self-report, behavioural, and psychophysiological) to maximise the chances of robust findings emerging (cf. Schooler & Schreiber 2004).

Studies 1a and 1b of the present thesis analysed previously collected questionnaire data to examine if there is an association between a trait self-report measure of mind wandering and self-reported symptoms of anhedonia. Study 2 extends Studies 1a and 1b by using a cross-sectional design to explore if any observed association between increasing depression symptoms and reduced positive emotional reactivity (to both nomothetic and idiographic emotional stimuli) is mediated by increases in mind wandering (administering self-report, psychophysiology and behavioural measures in a controlled laboratory and real world context). Study 3 examines if causally manipulating mind wandering (using adaptations to brief mindfulness exercises) in the laboratory alters positive affect experience when recalling positive memories. Study 4 extends this method into a more ecologically valid domain, examining if manipulating mind wandering using a smartphone application alters subjective emotional experience when completing positive activity scheduling. Finally, study 5 examines the impact of mind wandering on positive affect in the context of the treatment of depression. The effect of sustained mindfulness practice (completing an eight week MBCT course) on the positivity system in depression in vulnerable individuals is indexed, using laboratory controlled measures and ESM. The study focuses on whether changes in mind wandering (measured using both self-report and behavioural measures) mediate any beneficial effects of mindfulness and if any change in positive emotional reactivity contributes to the relapse prevention effects of MBCT. The flow of studies in the present thesis is depicted in Figure 2.1.

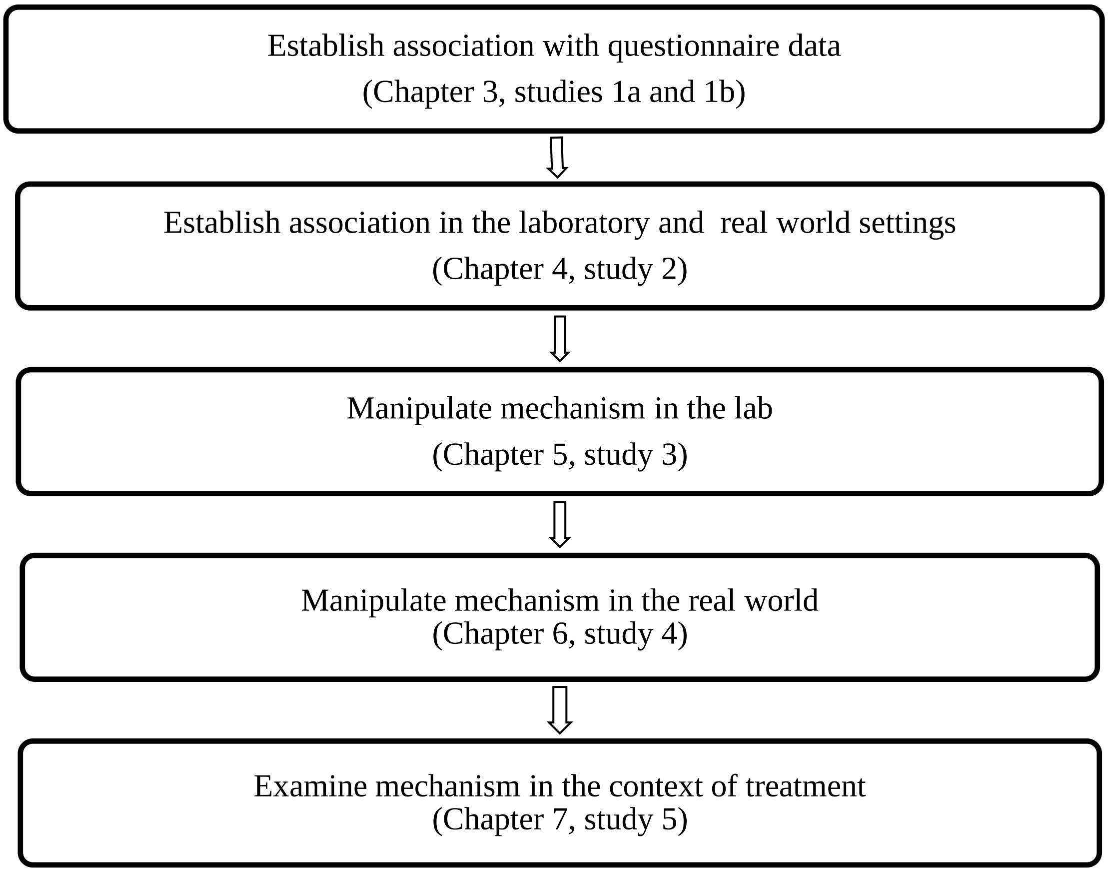



*Figure 2.1.* A flow diagram depicting the overall framework of studies within PhD thesis.

## 2.2 Risk and Distress Management Protocols

As participants were deliberately recruited to have a range of depression scores across the studies, it was necessary to have both suicide risk and distress management protocols in place for studies 2 to 5. These protocols were approved by the Exeter Research Ethics Committee and were supplemented by the Mood Disorders Centre Risk Protocol (MDC; 2012).

All studies administered the BDI-II questionnaire, item nine of which asks participants about thoughts of suicide over the past two weeks. As questionnaires were administered online (in the presence of the experimenter in studies 2, 3 and 4, and remotely from home in study 5), scores were emailed directly to the experimenter upon completion in order to be able to assess level of risk immediately. If participants scored a zero on item nine ("I don't have any thoughts of killing myself") they continued participating in the research study. If participants scored a one on this item ("I have thoughts of killing myself but I would not carry them out") then the participant was reminded of the right to withdraw from the research and was observed carefully throughout the experiment for signs of distress. Participants were also given a self-help sheet of relevant contacts such as the University wellbeing service, local Samaritans, Depression Alliance and SANEline. This was particularly important in study 2 due to use of a negative mood induction and in studies 3 and 4 for participants randomly allocated to conditions where the intention was to increase levels of mind wandering (which we believed would have a transient detrimental effect on mood). If the participant scored a two on item nine ("I would like to kill myself") or three on item nine ("I would kill myself if I had the chance") then the study was terminated sensitively and the full Mood Disorders Centre Risk Protocol was carried out (see Appendix 1). Across studies 2 to 4 of this thesis the full risk protocol was enacted three times with no adverse consequences. Participants in study 5 were also assessed on the telephone using the Structured Clinical Interview for DSM-IV Axis 1 Disorders (SCID-1; First et al., 1994). The SCID-1 was used to assess current depression status including whether they had experienced thoughts of their own death or suicide ideation during the past month. If participants answered yes to this question then the full Mood Disorders Centre Risk Protocol was enacted as in previous studies. In study 5, the full risk protocol was enacted a total of three times. The outcome of the full assessment varied according to the level of risk reported but often resulted in advice to visit their GP or making contact with the participant's GP on the participant's behalf via faxed letter or telephone. An approved distress management protocol was also in place for studies 2, 3 and 4 should a participant have become distressed or upset whilst completing the experimental procedure (for example, when undergoing the negative mood induction in study 2 or in conditions intentionally increasing mind wandering in studies 3 and 4). The distress management protocol was as follows:

1) Participant reminded at the start of the study that they may withdraw at any time during the study and without any negative consequences.
2) If the participant became distressed at any point during the study then the experimenter reminded the participant of their right to withdraw and asked if they would like to stop participation. If the participant wished to continue with the study then they were carefully monitored for further signs of distress.
3) If the participant wished to stop the study then they were asked to rate how distressed they were currently feeling from 1 (not at all distressed) and 100 (most distressed I have ever been).
4) Appropriate steps were taken by the experimenter to ensure the participant had calmed down before leaving. This was judged to be when the participant rated their level of distress as below 50. Appropriate actions involved offering the participant a drink or offering the participant a chance to talk.
5) Participants were provided with contact details of the lead experimenter and were advised to get in touch if they needed to talk to someone.
6) An adverse reaction during the study was followed up 24 hours after completing the experiment. If the participant still reported high levels of distress (over 50) then the experimenter advised use of the University wellbeing service or local GP. The participant was also reminded of the experimental team contact details.

## 2.3 Review of Psychophysiology

The following two sections of this chapter (sections 2.3 and 2.4) will review specific methodologies used in this thesis. First, psychophysiological methods were used in studies 2 and 3 in order to provide an objective measure of emotional responding which is less subject to demand effects. The chapter will then move on to review ESM which was used in studies 2, 4 and 5 in order to introduce more ecologically valid measures. It is important to understand the conceptual basis and advantages and disadvantages for each of these methods and so the next two sections will briefly cover this.

### *2.3.1 Definition of psychophysiology*

Psychophysiology is the division of psychology concerned with understanding the physiological basis of psychological processes. The field of psychophysiology works on the assumption that all psychological processes are embodied (Larson, Bernton, Pochlmann, Ito & Cacioppo, 2008) and so responses in the brain and body are able to shed light on psychological processes. According to Blascovich and Seery (2007) a psychophysiology researcher must follow a set of principles in order to make an inference that a physiological measure is an index of a psychological process. The first principle involves clear specification of the psychological construct of interest, the second principle is clear specification of the physiological index and the third principle is specification of the theoretical mechanisms and processes that link the physiological index with the psychological construct.

### *2.3.2 Electrodermal Activity Measurement*

Electrodermal activity (EDA) is also referred to by its now outdated name of galvanic skin response (GSR) and is a common measure of autonomic activity. EDA is a measure of eccrine sweat gland secretions which are found all over the human body but are densely populated in the palms of hands and soles of feet. There are two main types of sweat gland; eccrine and apocrine. The apocrine glands are primarily activated by emotional stress and sexual excitement whereas eccrine sweat glands play an important role in controlling body temperature and the removal of waste products from the body.

Skin conductance is a measure of EDA and involves passing a small current through the skin via a bipolar placement of sensors and the resistance to this current is then measured. There are two main ways of quantifying EDA data. The first looks at phasic activity or the *response* and is used when examining EDA in relation to a specific stimulus. The second method examines tonic responses or *level* of EDA and is used when data is not associated with a particular stimulus but rather the interest is in mapping changes within the participant over time. In this thesis, EDA data was quantified as the mean response to a particular mood stimulus. In all analyses residual change in EDA was calculated using the mean response during pre-stimulus baseline and mean response during the stimulus. EDA is measured in microsiemens (μS).

EDA provides an index of a wide range of psychological concepts including arousal (e.g., Williams et al., 2001; Reynaud, Khoury-Malhame, Rossier, Blin & Khalfa, 2012), emotion (e.g., Khalfa, Isabelle, Jean-Pierre & Manon, 2002; Larson et al., 2008) motivation (e.g., Pessiglione et al., 2007; Cléry-Melin et al., 2011) and attention (Frith & Allen, 1983; Nagai, Critchley, Featherstone, Trimble & Dolan, 2004). Skin conductance has also been previously used within the context of emotional distress (Kappeler-Setz, Gravenhorst, Schumm, Arnrich & Tröster, 2013). Following the guidelines outlined by Blascovich and Seery (2007), EDA was recorded in studies 2 and 3 of this thesis in order to provide an objective measure of emotional response during the laboratory positive mood induction procedures (principle one). EDA has previously been outlined as a measure of arousal (Williams et al., 2001; Reynaud et al., 2012) (principle two). EDA is therefore expected to increase (due to an increase in arousal) in response to a positive emotion induction such as watching a positive video clip and recalling a positive memory (principle three). However, it must be noted that this hypothesis is made with some caution due to the currently unclear nature of the relationship between EDA and changes in positive affect and the low specificity of this measure. For example, change in EDA may be dependent on the type of positive affect experienced (e.g. calm/relaxed vs. excitement/joy; Gilbert et al., 2008).

An advantage of EDA measurement is that it reflects a relatively pure measure of sympathetic activity compared to heart rate measurement which reflects both sympathetic and parasympathetic activity. Additionally, the collection of EDA data is safe, easy to record and it is relatively easy to determine if a response has occurred. However, the disadvantage of EDA measurement is that changes in EDA can result from a wide range of psychological processes making data hard to interpret (for a review of EDA measurement see Roth, Dawson & Filion, 2012).

### *2.3.3 Heart rate measurement*

The electrical impulses that stimulate the heart to contract can be measured via an electrocardiogram (ECG). The ECG of a single cardiac cycle begins with an electrical impulse from the sinoatrial node (this is not detected on the ECG wave), which triggers depolarisation of the atria (known as the P wave). The largest and most recognisable component of the ECG is the R-wave which is the large positive deflection in the centre of what is known as the QRS complex (see Figure 2.2). The QRS complex reflects the depolarisation of the heart ventricles and the final T wave is reflective of repolarisation of the ventricles. Due to the large size of R-wave and its relatively easy detection this is used to calculate heart rate measurements. A heart period is the interval between the R-waves of each cardiac signal and this measure is the inverse of heart rate measured in beats per minute (bpm).

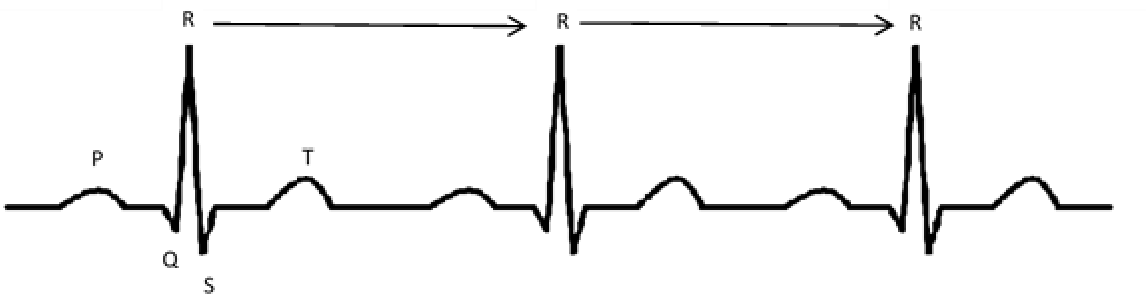



*Figure 2.2:* The ECG waveform depicting the QRS complex and the determination of BPM as a measure of distance between R-waves.

An ECG is recorded through placement of electrodes placed on the surface of the skin and measuring the difference in voltage between these electrodes using an amplifier. The intrinsic rate of the heart (i.e. without additional input from the nervous system) can range from 80-120 (mean 104) bpm. In healthy individuals the resting heart rate is lower and typically between 60-80 bpm. Control of the heart is through two systems: the neuronal system (via the vagus nerve) and the neuroendocrine system (via interactions of the sympathetic and parasympathetic branches of the autonomic nervous system). Increases in sympathetic nervous activity are associated with heart rate increase and relative increases in parasympathetic nervous activity are associated with heart rate decrease.

Following the guidelines above, heart rate was recorded in studies 2 and 3 of this thesis in order to provide an objective measure of emotional response during the laboratory positive mood induction procedures (principle one). Previous research has outlined heart rate as a simple psychophysiogical measure of valence (see Cacioppo, Tassinary & Berntson, 2007) and an increase in sympathetic nervous activity (activated by increased joy and excitement) is known to increase heart rate (principle two). Heart rate is therefore expected to increase in response to the positive emotion inductions (principle three). However, once again this hypothesis is made with extreme caution due to the low specificity of heart rate measurement and the possibility that high arousal positive affect (e.g. excitement) and low arousal positive affect (e.g. relaxation) has previously been found to correlate with increased/decreased heart rate respectively (van Oyen Witvliet & Vrana, 1995).

The advantages of using ECG measurements are that it is safe and easy to record and it is known to be sensitive to changes in psychological phenomena such as emotional experience during a mood induction task. However, a disadvantage of collecting ECG data is that it is hard to interpret the changes as an increase in heart rate can be due to both an increase in activity of the sympathetic nervous system or a decrease in activity of the parasympathetic nervous system.

### *2.3.4 Psychophysiological recording*

The thesis will now review the specific method used in studies 2 and 3 for collecting psychophysiological measures. As previously mentioned, the psychophysiological measures of EDA and ECG were recorded in study 2 during the positive mood induction task and in study 3 during the mind wandering manipulation task as objective measures of emotional responding. The below methodology was based on previously published guidelines (Fowles et al., 1981; Jennings et al., 1981; Cacioppo, Tassinary & Berntson, 2007).

#### *2.3.4.1 Equipment Setup*

Psychophysiological measures (EDA, ECG) were recorded using a BIOPAC™ MP150 system connected to a computer running commercially available software AcqKnowledge 4.1 (BIOPAC Systems; Goleta, CA). Equipment included 1 EDA 100C amplifier and 1 ECG 100C amplifier. The EDA amplifier is a single channel, high gain, differential amplifier designed to measure skin conductance via the constant voltage technique. The EDA amplifier was set to have a sensitivity of 10 μS/V with a 1.0Hz low pass filter and both high pass filters were set to DC. The ECG amplifier is a single channel, high gain, differential input, biopotential amplifier designed for monitoring the heart's electrical activity. The ECG amplifier gain was set at x 1000, the R-wave detector was switched to Norm with a 35 Hz low pass filter and 0.05Hz high pass filter. The sampling rate was 500 samples per second for both EDA and ECG acquisitions in study 2 but was increased to 1000 samples per second for ECG/500 samples per second for EDA in study 3. This higher ECG sampling rate was implemented in study 3 to allow for possible calculation of heart rate variability (HRV) in future analyses outside the scope of this thesis (in order to calculate HRV guidelines suggest recording ECG data at 500-1000Hz; Berntson & Stowell, 1998). The MP150 was connected through the Comm port to a Dell OptiPlex GX620 computer. The computer tasks were presented to the participant on a separate computer with a Samsung Syncmaster 943N LCD monitor with 19 inch display. The task computer connected with the digital input ports of the MP150 through the parallel port of the computer enabling the use of task markers which indicated what was occurring during the experimental tasks. Figure 2.3 shows an example Acqknowledge record for study 2 and Figure 2.4 shows an example Acqknowledge record for study 3.

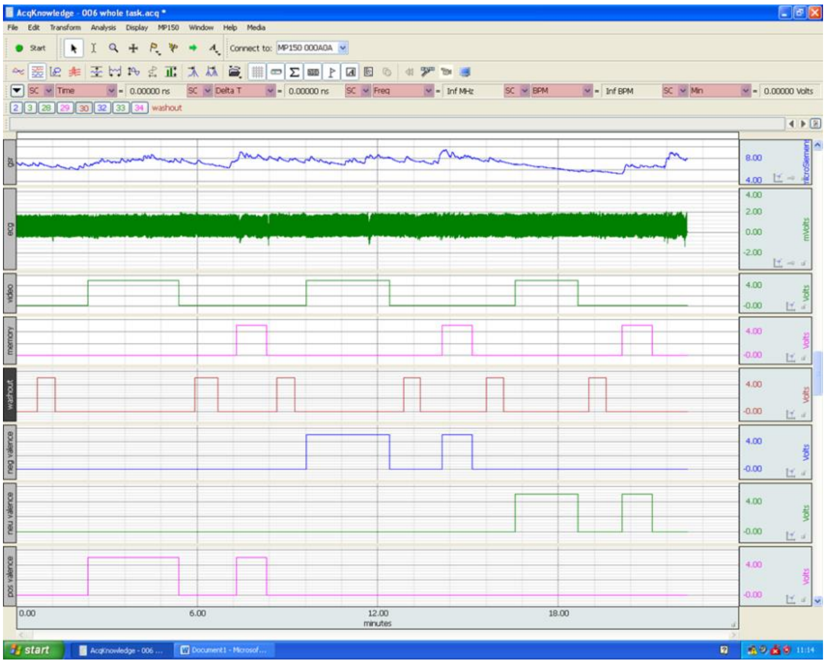



*Figure 2.3* An example Acqknowledge record for study 2 depicting two analogue channels (ECG and EDA) and six digital channels for task markers (video, memory, washout, and positive, negative and neutral). A change from 0-5v indicates which specific task component is active.

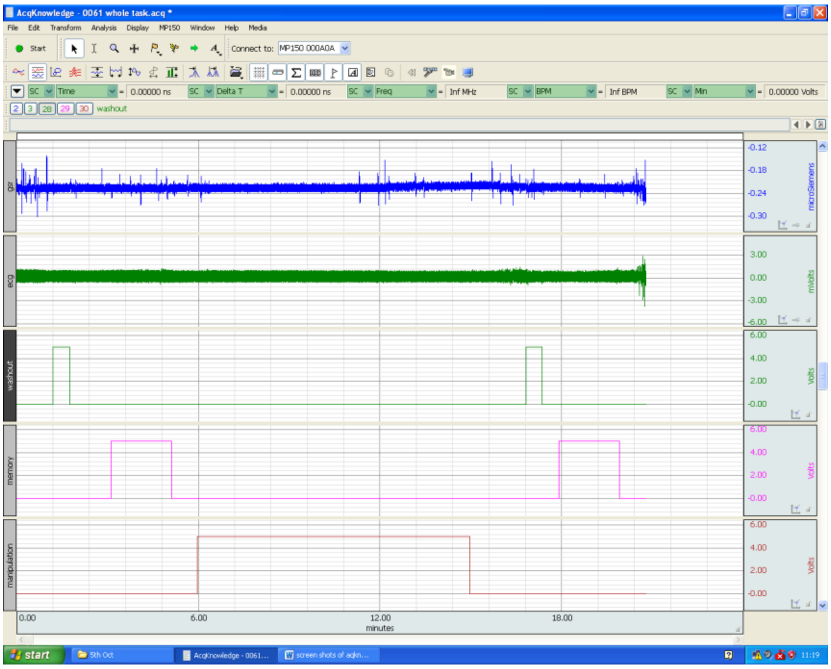


*Figure 2.4.* An example Acqknowledge record for study 3 depicting two analogue channels (ECG and EDA) and three digital channels for task markers (washout, memory and manipulation phase).

#### *2.3.4.2 Electrode placement*

Prior to attachment of electrodes, the ECG sites were cleaned with an alcohol surgical wipe. Participants washed their hands with a mild, non-abrasive soap prior to attachment of EDA electrodes. EDA was recorded using two grounded Ag–AgCl electrodes, secured on the medial phalanges of the distal index and middle finger of the nondominant hand, with BIOPAC isotonic electrode gel (with a NaCl concentration of 0.05 M) as the electrolyte. Sensors were placed on adjacent fingers in such as a way as to be innervated by the same spinal nerve (Venables and Christie, 1973). For ECG recording, two pre-gelled disposable Ag–AgCl ECG electrodes (11mm diameter with 35mm vinyl backing) were placed on the right collarbone and left forearm with clip-on shielded leads attached to the participant's clothing. Before beginning recording, the experimenter checked for sensor sensitivity and made adjustments if necessary.

#### *2.3.4.3 Psychophysiology data processing*

All psychophysiology data was initially visually inspected to assess for recording errors and a channel was excluded if a clear signal had not been recorded. An error was determined as a response with an extreme outlier (i.e. three standard deviations or more from the mean).

Software was developed in Microsoft Visual Basic 2010 Express to automatically process the psychophysiology data. This software worked by searching through each participant's Acqknowledge file to find when experimental events occurred (e.g. when a positive video clip was presented to the participant in study 2). These events had previously been marked using digital markers in the Acqknowledge file. The software then worked to produce summary variables for the ECG and EDA variables including the mean response when the stimulus was displayed and the mean response during a 30 second pre-stimulus baseline.

Psychophysiology data can be reported as both an absolute response (i.e. mean value of the channel when the stimulus occurred) or as a relative response (i.e. mean value of the channel during the pre-stimulus baseline subtracted from the mean value of the channel when the stimulus occurred, divided by the pre-stimulus mean). For a discussion of these psychophysiology measures see review by Stern, Ray and Quigley, (2001). Within this thesis, absolute (i.e. mean level) responses were used as these are used in much of the psychophysiology depression literature.

### *2.3.5 Methodological issues related to psychophysiology*

It is important to take into account a range of issues when interpreting and analysing psychophysiology data. The first consideration is how to interpret group differences. This is particularly relevant to study 3 where physiological responses are compared across experimental conditions. Interpreting a group difference in psychophysiology presents a problem as group differences may be due to the experimental manipulation but could also be caused by natural pre-existing differences in psychophysiology. In order to manage this issue, a baseline measure of psychophysiology was recorded. A second consideration is the lack of specificity of physiological measurements, particularly heart rate. As previously mentioned, an increase in heart rate can be due to both elevated sympathetic or reduced parasympathetic activation which complicates interpretation of any changes found.

## 2.4 Experience Sampling Methodology

Studies 2, 4 and 5 of this thesis also utilise real world data collection as pure laboratory studies can be criticised for their lack of ecological validity. It is therefore necessary to observe how participants behave and respond in their natural environment (Csikszentmihalyi

& Larson, 1987). The next section of this chapter will review the conceptual basis, advantages and disadvantages of real world data collection.

A data collection method known as the ‘experience sampling method’ (ESM) can be used to map an individual’s variation in multiple domains including their affective experience. This methodology was introduced into psychological research in the 1970s with Csikszentmihalyi et al.’s (1977) work monitoring adolescents in their natural environments. Typically, this methodology involves asking participants questions at time points during the day over a specific time period. Due to technological advances, this methodology has now been employed using palm computers (Kane et al., 2007), watches (Moberly & Watkins, 2008) and more recently smartphone technology (Killingsworth & Gilbert, 2010).

There are three types of experience sampling methodology (Reis & Gable, 2000). ‘Interval-contingent’ sampling involves participants completing questions at set intervals (e.g. every hour, every day) and for a set amount of time. ‘Event-contingent’ sampling involves participants completing questions when a pre-designated event occurs. The third method which is most referenced as ESM is ‘signal-contingent’ sampling where participants complete questions when they are prompted by a randomly timed signal. Signal-contingent sampling is advantageous over interval-contingent sampling as it avoids expectancy effects from the participant knowing when they will be completing the questions. Studies 2 and 4 used an event-contingent sampling design as here we were interested in emotional reactivity to a specified positive event. Study 5 used a signal-contingent design to observe within-person changes in mood as they go about their daily lives pre/post MBCT.

The strengths and weakness of ESM have been outlined in previous reviews (see Scollon, Kim-Prieto & Diener, 2009; Hektner, Schmidt, Csikszentmihayli, 2007). Particular strengths of using ESM in research include the testing of psychological phenomena in multiple contexts and observing complex interactions of participants with their environment. For example, Miner, Glomb and Hulin (2005) were able to observe how different types of work activity were correlated with fluctuations in mood in the workplace. A further advantage of ESM is the ability to generalize findings to the real world due to high levels of ecological validity. As a result, researchers are able to validate their theoretical concepts within real-life settings away from the laboratory (e.g., Moberly & Watkins, 2008). Another important advantage of ESM is the ability to examine within-person processes which can often be masked when taking between-person averages. This advantage has been utilised previously by research investigating which emotions commonly occur together (e.g., Zelenski and Larsen, 2000) where it was found that related emotions were only weakly correlated at the within-person level but were strongly correlated at the between-person level. A further clear advantage of using ESM is a reduction in memory bias that results from retrospective reports. This is often managed in ESM by the setting of a time limit between signal and participant report. Often a limit of 15 minutes is set after which data is excluded as data after 15 minutes is deemed less reliable (e.g., Geschwind et al., 2011; Moberly & Watkins, 2008, 2010). Overall, ESM is advantageous in research as it allows for the collection of large datasets and, due to technological advances, this is now relatively easy to conduct. The data collected through ESM is able to provide fine-grained detailed accounts of everyday experiences.

However, ESM does not come without its limitations. Firstly, the use of ESM is both time and resource intensive and is therefore potentially burdensome to participants. This relatively high burden in turn increases the likelihood of missing data and attrition rate. Specifically, non-responding to ESM has been found to be significantly higher in those with depression (Silvia, Kwapil, Eddington & Brown, 2013). Secondly, ESM still relies on participant self-report and so there may be an element of socially desirable responding. It is therefore advantageous to combine ESM with objective measures. Thirdly, ESM may produce what is known as the ‘reactivity effect’ whereby the repeated measurement of a given phenomenon may in turn cause the phenomenon under study to change. For example in this thesis, the repeated measurement of levels of mind wandering using ESM may lead a participant to pay more attention to their experience and, due to this increased attention, they may report a lower level of mind wandering.

### *2.4.1 ESM equipment setup*

ESM was conducted through the use of three specially developed smartphone applications. Participants were lent a phone for the duration of each study. The devices used were a HTC Desire C operating on Android version 4.0 (Ice Cream Sandwich) or a Huawei Ascend Y330 operating on Android version 4.2 (Jelly Bean). An advantage of using smartphone technology is the ability to timestamp responses, often a criticism of paper diary ESM studies. Additionally, smartphone technology is easily adaptable and allows for the collection of a large volume of data from each participant in a relatively easy and non-obtrusive manner.

## 2.5 Statistical assumptions and tests of model fit

Statistical analysis was carried out using IBM SPSS Statistics 21 for Windows (IBM Corp, 2012). Alpha was set to 0.05 to indicate statistical significance and an alpha of between 0.05 and 0.10 was used to indicate a trend. Prior to analysis, the data was carefully inspected to check it met the normality, homogeneity of variance and sphericity assumptions of parametric statistics. Where no violations were found, parametric statistics were conducted and are reported in this thesis. However, if data was found to be skewed, then either a log or square root transformation was applied depending on direction of skew. When transformed data have been used this is highlighted clearly in the text. In the instance where a transformation failed to normalise a variable then non-parametric analyses were conducted. Model fit was assessed using the $R^2$ statistical test (defined as the proportion of variance in the response that is predicted by the model) and with residual plots.

# Chapter 3: Study 1a and 1b – Associations between facets of mindfulness and anhedonic depression

## 3.1 Introduction

The aim of this chapter is to examine whether trait mind wandering is cross-sectionally related to positive affect disturbances in depression by secondary analysis of data collected from two samples: a large community sample with varying levels of depression and in a recovered-depressed treatment-seeking sample.

### 3.1.1 ***Introducing the self-report measures of mindfulness***

Mindfulness self-report measures provide a well validated and psychometrically robust measure of the inverse of mind wandering – present moment awareness. The most commonly used self-report measures of mind wandering are the Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003) and the Five Facet Mindfulness Questionnaire (FFMQ; Baer, Smith, Hopkins, Krietemeyer & Toney, 2006, Baer et al., 2008; Williams, Dalgleish, Karl & Kuyken, 2015). The MAAS is a 15 item questionnaire which assesses the frequency of open and receptive attention to and awareness of ongoing events and experiences during day to day consciousness. Items include, “I find it difficult to stay focused on what’s happening in the present” and a higher score on this questionnaire is indicative of less trait mind wandering. The FFMQ proposes that mindfulness consists of five clear measurable facets: *acting with awareness* (staying focused and aware of your present moment experience), *observing* (noticing your current bodily and sensory experience), *describing* (finding words to describe how you feel), *nonreacting to inner experience* (perceiving thoughts and feelings without having to react to them) and *nonjudging of experience* (not judging ourselves for our thoughts and feelings). Higher scores on the acting with awareness facet have previously been utilised in research to represent less trait mind wandering (see Seli, Carriere & Smilek, 2015; Murphy, Macpherson, Jeyabalasingham, Manly & Dunn, 2013). Work examining how these self-report questionnaires correlate with depression will now be discussed.

### 3.1.2 ***Correlations between measures of mindfulness and global depression severity***

Greater scores on the MAAS have been found to correlate with lower levels of depression (Deng, Li & Tang, 2014). Similarly, a wide range of studies have already examined associations between the FFMQ and global measures of depression severity (e.g., Barnhofer, Duggan & Griffith, 2011; Cash & Whittingham, 2010; Bohlmeijer, Peter, Fledderus, Veehof & Baer, 2011; Branstrom, Duncan & Moskowitz, 2011). It has generally been found that greater scores on all facets relate to lower levels of depression, with the exception of the observe facet, which is less consistently related to depression outcomes (e.g., Baer et al., 2006, 2008; Barnhofer, Duggan & Griffith, 2011, Cash & Whittington, 2010; Branstrom, Kvillemo & Brandberg, 2010). It is likely that relationships between observing and depression vary due to differences in levels of meditation experience (see Baer et al., 2008). So far, only a limited number of studies have examined how measures of mindfulness relate specifically to positive affect.

### 3.1.3 ***Correlations between measures of mindfulness and positive affect***

Research studies that have correlated the MAAS with measures of positive affect have so far yielded inconsistent results. First, Deng et al., (2012) found the MAAS to be positively correlated with the positive affect subscale and negatively correlated with the negative affect subscale of the Positive and Negative Affect Schedule (PANAS; Watson, Clark & Tellegen, 1988). In support of this, Atanes et al., (2015) found the MAAS to positively correlate with both the positive affect and satisfaction with life subscales of the Brazilian version of the Subjective Wellbeing Scale (Diener et al., 1994) in a sample of 450 health care professionals. However, inconsistent with these studies, the MAAS did not correlate with either subscale of the PANAS in an earlier study (Black, Semple, Pokhrel & Grenard, 2011). However, this latter study was conducted on an extremely small sample of 28 medical students which limits the external validity of this finding. Therefore, it appears from the results of these three studies using the MAAS that trait mind wandering is correlated to reduced positive affect.

Mindfulness facets measured using the FFMQ have previously been correlated with the Positive State of Mind scale (PSOM; Adler, Horowitz, Garcia & Moyet, 1998). In a large community based sample in Sweden (N = 1,000), all facets were positively correlated with PSOM total score, with strongest associations with acting with awareness, nonreacting and describe (Bränström, Duncan & Moskowitz, 2011). However, despite the use of a large sample, participants were not required to have depressive symptoms upon recruitment into the study and so it is questionable how these findings might generalise to a depressed population. Further to this, the PSOM scale includes only six questions originally designed to assess broad aspects of positive functioning such as productivity, restful repose and sharing. The PSOM is therefore not a precise measure of anhedonic symptoms. The authors also failed to report whether the association with acting with awareness was statistically larger in size compared to correlations between other facets and the PSOM.

A further study conducted by Bohlmeijer, Peter, Fledderus, Veehof and Baer (2011) has correlated a short form of the FFMQ (24 items) with the Mental Health Continuum–Short Form (MHC-SF; Keyes, 2002) in a sample of 376 participants displaying some depression and anxiety symptoms. The MHC-SF is a 14 item questionnaire measuring emotional wellbeing as well as psychological wellbeing and social wellbeing. Results of this study revealed significant positive correlations between all facets on the FFMQ and greater total scores on the MHC-SF. However, once again it should be noted that the MHC-SF is a global measure of mental health functioning and the authors did not look at correlations with the emotional wellbeing subscale which is the most directly analogous to anhedonic symptoms (e.g. item one: during the past month, how often did you feel happy?). In addition, although the authors sought to recruit participants experiencing depressive symptoms, participants with extremely high depression scores (≥ 39 on the Centre of Epidemiological Studies- Depression Scale; Radloff, 1977 and people with a severe depression episode assessed using a telephone interview) were excluded at the data analysis stage. This study is therefore potentially subject to range restriction effects. As with the study by Bränström and colleagues, the authors also did not compare the magnitude of correlations with each individual facet, however data suggested that the MHC-SF was most related to facets of observe and describe. Therefore, taken together the above two studies imply that acting with awareness is related to generic measures of positive affect (although not to a clearly greater extent than other facets).

In summary, measures that have utilised the MAAS and FFMQ have found fairly robust correlations between increased trait mind wandering and reduced positive affect. However, this research did not look at anhedonic symptoms specifically.

### 3.1.4 ***Correlations between measures of mindfulness and anhedonic symptoms***

A different method of testing how measures of mindfulness correlate with positive affect is to utilise a self-report measure that differentiates anhedonic symptoms from other components of depression. The Mood and Anxiety Symptom Questionnaire (MASQ; Watson & Clark, 1991) was designed to assess the three symptom components as described in the tripartite model. The tripartite model (Clark, Watson, & Mineka, 1994) proposes that the symptoms of depression and anxiety are captured by three dimensions. Common to both anxiety and depression is the ‘general distress’ component, which measures non-specific negative affect symptoms (e.g. depressed mood, anxious mood, insomnia). Somewhat unique to anxiety is the ‘anxious arousal’ component, which measures symptoms of arousal and somatic tension (e.g. dizziness, shortness of breath). Somewhat unique to depression is the ‘anhedonic depression’ component, which measures ‘reduced positive affect’ symptoms of anhedonia and apathy (e.g. loss of interest, feeling nothing is enjoyable). The MASQ is therefore an excellent measure as it contains a specific anhedonia subscale and analyses are able to covary out remaining depression symptoms in order to test if measures are anhedonic specific. Research has shown that these different symptom components relate differently to cognitive-affective phenomena associated with depression (e.g., Larson, Nitschke & Davidson, 2007; Yovel & Mineka, 2005; Dunn et al., 2009, Dunn et al., 2010; Werner-Seidler et al., 2013).

Only one study has correlated the MAAS with the MASQ. Zvolensky et al., (2006) looked at how the MAAS correlated with the anhedonic depression subscale using a hierarchical linear regression analysis. The dependent variable used was levels of anhedonic depression measured using the MASQ. At level one, the authors entered measures of positive and negative affect as covariates indexed using the PANAS. At level two, the authors entered trait mind wandering, indexed using the MAAS. This nested structure was used to ensure that any observed effects of mind wandering at level two were unique and not attributable to variance shared with variables at level one. Results revealed that the addition of the MAAS at level two predicted a significant amount of variance in anhedonic depression, with greater scores on the MAAS correlated to fewer anhedonic symptoms. Therefore, research using the MAAS suggests a role of mind wandering in the experience of anhedonia in depression.

Furthermore, only one study has correlated the MASQ with the FFMQ. This study examined relationships between the FFMQ and symptom components on the MASQ in a sample of 187 adults seeking treatment for mood and anxiety disorders (Desrosiers, Klemanski & Nolen-Hoeksema, 2013). Greater nonreacting, nonjudging, describing and acting with awareness (but not observing) all correlated with lower scores on all three components of anxiety and depression. In this study, path analyses revealed unique relationships (i.e. correlations controlling for remaining four mindfulness facets) between greater nonjudging and nonreacting and lower anhedonic depression. The a*cting with awareness* (trait mind wandering) was only trend uniquely associated with anhedonic depression (p = .067), however when a more parsimonious path analysis was conducted (examining only significant or marginally significant relationships) the relationship between acting with awareness and anhedonic depression no longer approached significance (p = .15). This study by Desrosiers, Klemanski & Nolen-Hoeksema (2013) therefore adds to the literature base as it uses an anhedonic specific measure and has studied the unique correlations between each facet of mindfulness and each symptom component. However, this study is potentially underpowered and unique analyses only controlled for the remaining mindfulness facets and not other symptom components. Therefore, the authors cannot conclude that mindfulness facets are anhedonic specific, over and above general depression severity. An improved analysis would be to conduct these unique correlations in two ways; the first way controlling for remaining mindfulness facets only and the second way using a more stringent approach controlling for remaining mindfulness facets and remaining symptom components.

### 3.1.5 ***The present studies***

In summary, so far there is inconclusive evidence that the acting with awareness subscale of the FFMQ is linked to anhedonia. Therefore, the first two studies in this thesis aims to more robustly test the link between acting with awareness (trait mind wandering) and anhedonia. Compared to previously conducted studies, study 1a utilised a much larger community sample (pooling secondary data from nine studies) and Study 1b utilised a large recovered-depressed treatment seeking sample taking part in a robust randomized controlled trial. These studies, in conjunction with prior research, will enable more reliable conclusions to be drawn regarding which facets of mindfulness correlate with anhedonic depression. Specifically, these studies will assess whether present moment awareness, over and above other mindfulness facets, is related to anhedonic depression. Improving previously published research, additional analyses within the current studies will compare the magnitude of the correlation between acting with awareness and anhedonic depression with correlations between other facets and anhedonic depression. Furthermore, unique analyses controlling for both remaining mindfulness facets and general depression severity will help to determine which facets are anhedonic specific.

Study 1a
Community sample

## 3.2 Hypotheses

Based on a review of the empirical literature it is predicted that;

1. Higher levels of the acting with awareness facet of mindfulness (lower trait mind wandering) will correlate with lower anhedonic depression.
2. The magnitude of the correlation with anhedonic depression will be greater for the acting with awareness subscale relative to other FFMQ facets.
3. The association between greater acting with awareness and lower anhedonic depression will hold when co-varying for other mindfulness facets.
4. The association between greater acting with awareness and lower anhedonic depression will hold when co-varying for other mindfulness facets and other components of depression.

Further exploratory analyses will examine relationships between other mindfulness facets and symptom dimensions.

## 3.3 1a) Methods

### *3.3.1 Participants*

Data were pooled from a variety of studies run in Cambridge, UK and London, UK that all collected depression and trait mindfulness measures as part of broader experimental protocols. Participants from these studies were recruited from either a database of community research volunteers held in Cambridge, UK (MRC Cognition and Brain Sciences volunteer research panel) or a similar one held in London, UK (University College London psychology research pool). This resulted in a final sample of 440 adults (274 women, 62%) aged 18-69 years (M = 34.3, SD = 14.5). 321 participants (73%) were of White British ethnic origin. In all studies participants completed other measures not reported here.

### *3.3.2 __Measures__*

#### *3.3.2.1 Measure of Mindfulness*

The Five Factor Mindfulness Questionnaire (FFMQ; Baer et al. 2006) was used to index the different facets of mindfulness. Participants were asked to rate each of the 39 items on how much the item is generally true for them from one (never or very rarely true) to five (very often or always true). The FFMQ consists of five subscales which reflect the five facets of mindfulness. The acting with awareness facet (8 items) is entirely reverse scored and refers to the tendency to staying present and aware (e.g. “When I do things, my mind wanders off and I’m easily distracted”) and is therefore used as a measure of trait levels of mind wandering. Scores on this facet range from 8 to 40 with a high score representing greater present moment awareness and therefore less mind wandering in everyday life. Observing (8 items) refers to an individual’s ability to notice their present moment experience (e.g. “When I’m walking, I deliberately notice the sensations of my body moving”). Describing (8 items) refers to being able to put thoughts and feelings into words (e.g. “I’m good at finding words to describe my feelings”). The nonjudging facet (8 items) is reverse scored and refers to not judging oneself for our thoughts and feelings (e.g. “I criticize myself for having irrational or inappropriate emotions”). The nonreacting facet (7 items) refers to the ability to perceive thoughts and feelings without having to react to them (e.g. “I perceive my feelings and emotions without having to react to them.”). All facet scores range from 8 to 40 (except for the nonreactivity facet which ranges from 7 to 35), with higher scores on each facet indicating a higher level of mindfulness. In this study all facets were found to have good to excellent internal consistency (observing Cronbach’s $\alpha$ = .80, describing $\alpha$ = .91, acting with awareness $\alpha$ = .89, nonjudging $\alpha$ = .91, nonreactivity $\alpha$ = .80).

#### *3.3.2.2 Measure of Depression Symptoms*

The Mood and Anxiety Symptom Questionnaire – Short Form (MASQ-S; Watson & Clark, 1991) is a 62 item self-report questionnaire and was used to assess symptoms of anxiety and depression. Participants are asked to assess to what extent they felt the way described in each question for the past week, ranging from one (not at all) to five (extremely). The MASQ-S comprises three factors. The general distress (GD) subscale has 11 items reflecting anxious mood (e.g. “felt uneasy”) and 12 items reflecting depressed mood (e.g. “felt worthless”). These GD items reflect the comorbidity of anxiety and depression symptoms as they do not differentiate between the two disorders (scores range from 0-115). The anxious arousal (AA) subscale comprises 17 items which measure somatic symptoms related to acute fear more than chronic worry (e.g. “hands were shaky”; scores range from 0-85). This AA subscale is believed to be a unique marker of anxiety. The anhedonic depression (AD) subscale has eight questions which assess experiences believed to be a unique marker of depression, including items measuring loss of pleasure and interest (e.g. “felt like there wasn’t anything interesting or fun to do”) and 14 reverse scored items assessing positive emotional experience (e.g. “felt really happy”; scores range from 0-110). The subscales of the MASQ-S have previously been found to have high internal consistency (α range .84 - .93) (Hughes et al., 2006). In this study the subscales of the MASQ-S were found to have excellent internal consistency (general distress Cronbach’s α = .94, anhedonic depression α = .95, anxious arousal = .89).

### 3.3.3 Procedure

In all cases, participants gave written, informed consent, the studies were approved by relevant ethics committees, and participants were given an honorarium of £5 per hour for their time. In each study, demographic information was taken before the questionnaires were completed. In all cases, participants completed additional measures not described here, with these varying between experiment and site. The order of the questionnaire administration varied between studies and recruitment site but they were always completed at the start or at the end (following a break) of the experimental session, so are relatively free from contamination from other experimental procedures.

### 3.3.4 Data Analysis overview

Alpha was set at .05 and the results of two tailed statistical tests are reported throughout. The distribution of all variables was examined prior to analysis. All FFMQ facets were normally distributed. The MASQ variables showed positive skew and so were log transformed in order to normalise the data. Therefore as all variables were satisfactorily normally distributed, parametric analyses were conducted. To test H1, zero-order analyses were conducted using Pearson’s correlations to examine the links between MASQ anhedonia and the FFMQ facets.

To test H2, the magnitude of the zero order correlation between the acting with awareness facet and anhedonic depression was compared to the magnitude of correlations with remaining mindfulness facets using a test calculating the difference between two dependent correlations with one variable in common (developed by Lee & Preacher, 2013). This web utility works by converting each correlation coefficient into a z-score using Fisher's r-to-z transformation. The utility then uses Steiger's (1980) equations 3 and 10 to compute the asymptotic covariance of the estimates. These values are used in an asymptotic z-test. To test H3 and H4, a regression approach was used producing both a partial correlation and beta weight. Beta-weights produced via this approach are identical to the path analysis estimated beta-weights reported in Desrosiers et al., (2013) paper. Both partial correlations and beta weights will be reported in the text to allow for comparison with both previous work conducted by Desrosiers et al., (2013) and broader literature that has not used path analysis.

## 3.4 1a) Results

### ***3.4.1 <u>Zero order correlations</u>***

Descriptive statistics for questionnaires are presented in Table 3.1. There was a satisfactory spread for both the MASQ and FFMQ, comparable to other correlational studies (Baer et al., 2008, Reidy & Keogh, 1997; Dunn et al., 2010). This indicates that there is sufficient variation on both measures of mindfulness and depression to carry out correlational analyses unhindered by range restriction effects. To first check for potential covariates to control for in analyses, a Pearson’s correlation was run between the continuous variable of age and MASQ-AD and FFMQ acting with awareness variables which revealed no significant relationships, Ps> .11. Categorical demographic variables (gender, ethnicity) were analysed using a one way ANOVA. There was no significant effect of gender on levels of anhedonic symptoms or acting with awareness, Ps> .81. Furthermore, there was no effect of ethnicity, Ps> .23. Therefore, as age, gender and ethnicity were not associated with levels of acting with awareness or anhedonic symptoms, these potential covariates were not controlled for in subsequent analyses.

Table 3.1. *Means, standard deviations and zero order correlations between FFMQ mindfulness facets and MASQ symptom scales in study 1a community sample (N=440)*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1 Observe | - | | | | | | | |
| 2 Describe | .27*** | - | | | | | | |
| 3 ActAware | .07 | .42*** | - | | | | | |
| 4 Nonjudge | -.01 | .31*** | .53*** | - | | | | |
| 5 Nonreact | .26*** | .23*** | .24*** | .33*** | - | | | |
| 6 MASQ AA | .01 | -.24*** | -.40*** | -.39*** | -.33*** | - | | |
| 7 MASQ AD | -.13** | -.27*** | -.41*** | -.28*** | -.35*** | .36*** | - | |
| 8 MASQ GD | -.01 | -.26*** | -.49*** | -.43*** | -.38*** | .69*** | .71*** | - |
| Mean | 25.86 | 27.43 | 26.02 | 27.30 | 20.80 | 23.97 | 59.94 | 42.73 |
| SD | 5.92 | 6.80 | 5.76 | 7.55 | 4.72 | 8.40 | 18.17 | 17.77 |

*Note* - ** $p$ < .01. *** $p$ < .001. AA = anxious arousal; AD = anhedonic depression, GD = general distres. MASQ variables were log transformed prior to analysis.

Table 3.1 also presents the Pearson's zero order bivariate associations between the FFMQ facets and MASQ-S symptoms. These analyses revealed that acting with awareness, nonreacting, nonjudging and describing facets were highly positively correlated with one another, Ps< .001. In contrast, observing was positively correlated with describing and nonreacting, Ps< .001, but was not significantly associated with acting with awareness or nonjudging, Ps> .12. In support of H1, reduced MASQ anhedonia was significantly associated with greater acting with awareness ($r$ = -.41, $p$< .001). In other words, reduced mind wandering is correlated with fewer anhedonic symptoms. Reduced MASQ anhedonia also correlated with greater levels on all remaining mindfulness facets, Ps< .01. Additionally, lower MASQ anxious arousal was correlated with greater acting with awareness ($r$ = -.41, $p$< .001) as was lower MASQ general distress ($r$ = -.49, $p$< .001). Therefore, lower trait mind wandering also correlated with reduced anxiety and general distress symptoms. MASQ anxious arousal and general distress were also related to nonreacting, nonjudging and describing, Ps< .001, but were not significantly related to the observe facet, Ps> .88.

In partial support of H2, results revealed a significantly larger correlation of acting with awareness with anhedonia than observing (z = -4.61, *p* <.001), nonjudging (z = -3.05, *p* = .002) and describing (z = -2.96, *p* = .003). However, the magnitude of the correlation coefficient between acting with awareness and anhedonia did not differ compared to the correlation between nonreacting and anhedonia (z = -4.61, *p* = .26).

### *3.4.2 Unique correlations*

Next, to test H3 the unique correlations between each symptom dimension on the MASQ and each FFMQ mindfulness facet when controlling for intercorrelations between mindfulness facets were examined in a series of multiple regressions. Standard beta weight estimates and partial correlations for these calculations are displayed in Table 3.2.

Table 3.2. *Partial correlations and standardised beta estimates for facets of mindfulness regressed onto MASQ symptom scales in study 1a community sample (N=440)*

| | | Anhedonic Depression | General Distress | Anxious Arousal |
|---|---|---|---|---|
| Observe | $r_p$ | -.03 | .11* | .10* |
| | β | -.03 | .10* | .10* |
| Describe | $r_p$ | -.07 | -.04 | -.07 |
| | β | -.07 | -.04 | -.07 |
| ActAware | $r_p$ | -.28*** | -.32*** | -.21*** |
| | β | -.32*** | -.34*** | -.23*** |
| Nonjudge | $r_p$ | -.01 | -.15** | -.16** |
| | β | -.01 | -.15** | -.17** |
| Nonreact | $r_p$ | -.25*** | -.28*** | -.23*** |
| | β | -.24*** | -.26*** | -.23*** |

*Note* - * $p < .05$, ** $p < .01$, *** $p < .001$. $r_p$ = unique relationship between each FFMQ facet and MASQ symptom component, controlling for other FFMQ facets. β = standardized beta estimate. MASQ variables were log transformed prior to analysis.

In support of H3, lower anhedonic depression was significantly related to greater acting with awareness ($r_p = -.28$, $p< .001$), even when controlling for remaining mindfulness facets. Thus as predicted, reduced mind wandering was uniquely correlated to reduced anhedonic symptoms. Lower anhedonic depression also significantly correlated to greater nonreacting ($r_p = -.25$, $p< .001$), but was not significantly related to describing, nonjudging or observing facets, Ps> .15.

Lower general distress was uniquely correlated to greater acting with awareness ($r_p = -.32$, $p< .001$), but also greater nonreacting and nonjudging, Ps< .01. Similarly, lower anxious arousal was uniquely correlated with greater acting with awareness ($r_p = -.21$, $p< .001$), and greater nonreacting and nonjudging, Ps< .01. Interestingly, both lower general distress and anxious arousal were also uniquely associated with *lower* levels of the observing facet, Ps < .05.

Overall, mindfulness facets accounted for 24% of the total variance in anhedonic depression symptoms, 34% of the total variance in general distress symptoms and 25% of the total variance in anxious arousal symptoms. The acting with awareness facet alone accounted for 7% of the total variance in anhedonic depression symptoms, 8% of the total variance in general distress symptoms and only 3% of the total variance in anxious arousal symptoms.

In order to test H4, the above regression models were run again with the addition of MASQ general distress and MASQ anxious arousal symptom components as covariates. This stringent partial correlation approach tested if the acting with awareness facet is anhedonic specific by also controlling for general depression severity. Standard beta weight estimates and partial correlations for these calculations are displayed in Table 3.3.

Table 3.3. *Partial correlations and standardised beta estimates for facets of mindfulness regressed onto MASQ symptom scales controlling for remaining depression symptoms in study 1a community sample (N=440)*

| | | Anhedonic Depression | General Distress | Anxious Arousal |
|---|---|---|---|---|
| Observe | $r_p$ | -.11* | .12* | .02 |
| | β | -.08* | .07* | .01 |
| Describe | $r_p$ | -.07 | .04 | -.07 |
| | β | -.06 | .03 | -.06 |
| ActAware | $r_p$ | -.12* | -.12* | -.06 |
| | β | -.10* | -.08* | -.05 |
| Nonjudge | $r_p$ | .08+ | -.10* | -.07 |
| | β | .07+ | -.07* | -.06 |
| Nonreact | $r_p$ | -.12* | -.07 | -.11* |
| | β | -.09* | -.04 | -.09* |

*Note* - * $p < .05$, + $p < .10$. $r_p$ = unique relationship between each FFMQ facet and MASQ symptom component, controlling for other FFMQ facets and remaining MASQ symptom components. β = standardized beta estimate. MASQ variables were log transformed prior to analysis.

In support of H4, lower anhedonic depression was significantly related to greater acting with awareness ($r_p$ = -.12, *p* = .02), even when co-varying out other mindfulness facets and other components of depression. Once again, lower anhedonic depression also significantly correlated to greater nonreacting ($r_p$ = -.12, *p* = .02) and this time also greater observing ($r_p$ = -.11, *p* = .02). Anhedonic depression was trend significantly related to the nonjudging facet ($r_p$ = .08, *p* = .09) but was not related to levels of describing ($r_p$ = -.07, *p* = .14). When using this more stringent approach, the acting with awareness facet was found to account for only 0.4% of the total variance in anhedonic depression.

Lower general distress was uniquely correlated to greater acting with awareness ($r_p$ = -.12, *p* = .02) when controlling for remaining mindfulness facets and MASQ symptom components, but also greater nonjudging and lower observing, Ps< .03. When conducting stringent partial correlations, lower anxious arousal was only uniquely correlated with greater nonreacting ($r_p$ = -.11, *p* = .02).

## 3.5 1a) Discussion

Consistent with H1, there was a significant positive association between greater acting with awareness (less trait mind wandering) and reduced anhedonia. Further in partial support of H2, it was found that the magnitude of the correlation between acting with awareness and anhedonia was stronger than relationships with observe, nonjudging and describe. However, the magnitude of the association with acting with awareness did not statistically differ from the association between nonreacting and anhedonia. In support of H3, it was found that greater levels of acting with awareness were uniquely correlated with lower anhedonic depression when controlling for all remaining mindfulness facets. This unique relationship still held when controlling for general depression severity, thus supporting H4 that the facet of acting with awareness is anhedonic specific. The nonreacting facet was also found to be anhedonic specific as it was also uniquely related to anhedonia when using this more stringent approach. Furthermore, the correlation between the observe facet and anhedonia became significant using the stringent approach, despite being non-significant in zero-order and unique correlations controlling only for mindfulness facets. This finding could be because observe is less highly correlated to other FFMQ facets (see Table 3.1). Anhedonia therefore cannot be called mind wandering specific as it is also related to the nonreacting and observe facets of mindfulness.

The data from study 1a therefore fully support the study predictions that mind wandering will be related to anhedonic depression. These findings do not fully support those presented by Desrosiers et al., (2013). This previous study conducted on a treatment seeking sample found no link between acting with awareness and anhedonia. A potential reason for these discrepant findings is that the sample used here (a large sample of community volunteers with varying levels of depression severity) differs from the smaller treatment seeking population of patients used by Desrosiers et al. (2013).

Given these mixed findings, study 1b aimed to repeat this study on a different treatment seeking sample taking part in a randomised control trial (RCT) conducted in the South West region of the UK – the PREVENT trial. The PREVENT trial was a rigorously conducted RCT and participants within the trial were screened using a structured clinical interview and therefore participants were a robustly diagnosed group of people with a clear depression history. This improves on the heterogeneous and poorly specified sample described in the Desrosiers et al., (2013) study. The MASQ was not available in study 1b and so this study uses an anhedonia factor extracted from the Beck Depression Inventory second edition (BDI-II; Beck, Steer & Brown, 1996).

Study 1b
Recovered depressed sample

## 3.6 Hypotheses

Mirroring the hypotheses from study 1a it is predicted that;

1. Higher levels of the acting with awareness facet of mindfulness (lower trait mind wandering) will correlate with lower anhedonic depression.
2. The magnitude of the correlation with anhedonic depression will be greater for the acting with awareness subscale relative to other FFMQ facets.
3. The association between greater acting with awareness and lower anhedonic depression will hold when co-varying out other mindfulness facets.
4. The association between greater acting with awareness and lower anhedonic depression will hold when co-varying out other mindfulness facets and general depression severity.

Further exploratory analyses will examine relationships between other mindfulness facets and symptom dimensions.

## 3.7 1b) Methods

### *3.7.1 Participants*

Data was used from a randomized controlled trial examining if Mindfulness Based Cognitive Therapy with support to taper or discontinue antidepressant treatment (MBCT-TS) was superior to maintenance antidepressants for prevention of depressive relapse (see Kuyken et al., 2010 for trial protocol; Kuyken et al., 2015 for trial results). Participants were recruited from four sites in the South West region of the UK (Bristol, Exeter, Plymouth/South Devon and North Devon). This resulted in a sample of 424 adults (325 women) aged 20-79 years (M = 50.16, SD = 11.80). 410 participants (96.7%) were of white British ethnic origin. Complete baseline FFMQ and BDI-II data (prior to clients receiving any MBCT) were available for 409 of these participants. In all cases, participants gave written, informed consent and the studies were approved by relevant ethics committees. Participants were given an honorarium of £10 for their time for each research assessment during the trial.

### *3.7.2 Measures*

#### *3.7.2.1 Measure of Mindfulness*

The FFMQ was as described in study 1a. In this study reliability of all facets was satisfactory or better (observing Cronbach's $\alpha$ = .77, describing $\alpha$ = .91, acting with awareness $\alpha$ =.86, nonjudging $\alpha$ = .89, nonreacting $\alpha$ = .82).

#### *3.7.2.2 Measure of Depression symptoms*

Depression symptoms in study 1b were measured solely using the BDI-II (Beck, Steer & Brown, 1996). In order to generate an anhedonia specific measure, items 4 (loss of pleasure) and 12 (loss of interest) were extracted. This procedure of using a two factor anhedonia factor from the BDI-II has previously been used (see Beck, Steer & Brown, 1996; Ward, 2006). The remaining 19 items from the BDI-II were then used to create a global measure of depression severity. In this sample the reliability of the BDI-total score (all 21 items) (Cronbach's $\alpha$ = .92), BDI-II anhedonia factor ($\alpha$ = .77) and BDI-II other score ($\alpha$ = .91) were all at least satisfactory (>.70; cf Bland & Altman., 1997).

### *3.7.3 Procedure*

The questionnaires were administered as part of an intake assessment battery for all participants (i.e. prior to the MBCT intervention starting in the active trial arm).

### *3.7.4 Data Analysis overview*

Alpha is set at .05 and the results of two tailed statistical tests are reported throughout. The distributions of all variables were examined prior to analysis. All FFMQ facets were normally distributed. The BDI-II (and its component scores) was log transformed prior to all analyses to correct for positive skew. Therefore as all variables were satisfactorily normally distributed, parametric analyses were conducted. The same sequence of analyses was conducted as in study 1a.

## 3.8 1b) Results

### *3.8.1 Zero order correlations*

To first check for potential covariates, a Pearson's correlation was run between the continuous variable of age and the BDI-II anhedonia factor and FFMQ facets which revealed no significant association between age and acting with awareness ($r$ = .05, $p$ = .33), but a trend relationship with anhedonia ($r$ = .09, $p$ = .08). There was a trend for older participants in this sample to report greater levels of anhedonic symptoms. Categorical demographic variables (gender, ethnicity) were analysed using a one way ANOVA. Results revealed a significant effect of gender on anhedonic symptoms, F(1, 408) = 8.77, $p$ = .003, with females reporting lower anhedonic scores compared to males. There was also a trend effect of gender on levels of acting with awareness, F(1, 408) = 3.74, $p$ = .054, with females reporting less acting with awareness/greater mind wandering compared to males. Furthermore, there was a trend significant effect of ethnicity on anhedonic symptoms, F(1, 408) = 3.00, $p$ = .08, as those of a white British ethnicity reported higher anhedonic scores than participants of other ethnicities. There was also a significant effect of ethnicity on levels of acting with awareness, F(1, 408) = 7.29, $p$ = .01, with those of a white British ethnicity reporting less acting with awareness/greater mind wandering compared to participants of other ethnicities. However, these ethnicity analyses should be interpreted with caution due to extremely unequal sample sizes (96.7% of the sample was white British as reported previously). Given these trends, the variables of age, gender and ethnicity were controlled for in all subsequent analyses.

Table 3.4 presents descriptive statistics and zero order correlations between the FFMQ facets and the BDI-II, controlling for age, gender and ethnicity. It is important to note that while none of the sample met diagnostic criteria for a major depressive episode, there was still sufficient variation in BDI-II total score to allow for correlational analyses. Specifically, according to cut-offs on the BDI-II (Beck et al., 1996), 215 participants were in the minimal range (BDI-II<14), 72 individuals were in the mild range (BDI-II 14 to 19), 83 individuals were in the moderate range (BDI-II 20 to 28), and 39 individuals were in the severe range (BDI-II>28). There was also sufficient spread in FFMQ facet scores, comparable to other published studies (e.g., Baer et al., 2008).

These zero-order correlations revealed that acting with awareness, nonreacting, nonjudging and describing facets were all positively correlated with one another, Ps< .01. In contrast, observing was positively correlated with describing, nonreacting and nonjudging, Ps< .05, but was not significantly associated with acting with awareness ($r$ = -.04, $p$ = .49). The BDI-II anhedonia and BDI-II other symptom measures were strongly positively correlated with one another ($r$ = .69, $p$< .001)

Supporting H1, reduced BDI-II anhedonia was significantly associated with greater acting with awareness ($r$ = -.38, $p$ = <.001). Reduced BDI-II anhedonia also significantly correlated with greater describing, nonjudging and nonreacting, Ps< .01 and correlated with the observing facet at the level of a non-significant trend ($r$ = -.09, $p$ = .09).

Additionally, lower BDI-II other symptoms and total BDI-II were correlated with greater acting with awareness, Ps< .001, and so reduced levels of mind wandering also correlate with fewer general depression symptoms. Lower BDI-II other symptoms and total BDI-II were also related to nonreacting, nonjudging and describing, Ps< .001, but were not significantly related to the observe facet, Ps> .70.

*Table 3.4. Means, standard deviations and zero order correlations between FFMQ mindfulness facets, and BDI-II in study 1b clinical sample (n=409)*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1 Observe | - | | | | | | | |
| 2 Describe | .26*** | - | | | | | | |
| 3 ActAware | -.04 | .34*** | - | | | | | |
| 4 Nonjudge | -.11* | .20*** | .40*** | - | | | | |
| 5 Nonreact | .38*** | .31*** | .20*** | .16** | - | | | |
| 6 BDI-II total | -.02 | -.27*** | -.43*** | -.39*** | -.22*** | - | | |
| 7 BDI-II anhedonia | -.09+ | -.23*** | -.38*** | -.27*** | -.17** | .73*** | - | |
| 8 BDI-II other | -.02 | -.27*** | -.43*** | -.40*** | -.23*** | .99** | .69*** | - |
| Mean | 24.06 | 25.96 | 20.86 | 24.98 | 19.61 | 14.10 | 1.28 | 12.82 |
| SD | 5.65 | 6.81 | 4.79 | 6.63 | 4.83 | 10.13 | 1.27 | 9.14 |

*Note* - + $p$< .10. * $p$ < .05. ** $p$ < .01. *** $p$ < .001. BDI-II total = total of all BDI-II items, BDI-II anhedonia = two factor anhedonia scale (items 4 and 12), BDI-II other = remaining 19 items. All BDI variables were log transformed prior to analysis. Analyses are controlling for age, gender and ethnicity.

As in study 1a, to test H2 and investigate if the magnitude of the zero order correlation with the BDI-II anhedonic factor is greater for the acting with awareness facet relative to other FFMQ facets, an online web utility was used to compare these correlations (Lee & Preacher, 2013).

In full support of H2, results revealed a significantly larger correlation of BDI-II anhedonia with acting with awareness than observing, (z = -4.44, $p$ <.001), describing (z = -2.81, $p$ = .01), nonjudging (z = -2.17, $p$ = .03) and nonreacting (z = -3.55, $p$ = < .001). These comparisons reveal that the correlation between acting with awareness and the BDI-II anhedonia factor is greater in magnitude compared to correlations with all other mindfulness facets.

### ***3.8.2 Unique correlations***

Next, the unique correlations between the BDI-II anhedonia, BDI-II other and BDI-II total with each FFMQ mindfulness facet when controlling for intercorrelations between mindfulness facets and demographic variables (age, gender and ethnicity) were examined in a series of multiple regressions. Standard beta weight estimates and partial correlations for these calculations are displayed in Table 3.5.

Table 3.5. *Partial correlations and standardised beta estimates for facets of mindfulness regressed onto BDI-II scales in clinical sample (N=409)*

| | | BDI-II anhedonia | BDI-II other |
|---|---|---|---|
| Observe | $r_p$ | -.08 | .02 |
| | β | -.08 | .02 |
| Describe | $r_p$ | -.07 | -.11* |
| | β | -.07 | -.10* |
| ActAware | $r_p$ | -.28*** | -.26*** |
| | β | -.30*** | -.27*** |
| Nonjudge | $r_p$ | -.13** | -.26*** |
| | β | -.14** | -.25*** |
| Nonreact | $r_p$ | -.04 | -.11* |
| | β | -.04 | -.10* |

*Note* - * $p$ < .05, *** $p$ < .001. $r_p$ = unique relationship between each FFMQ facet and BDI-II, controlling for other FFMQ facets. β = standardized beta estimate. BDI- II variables were log transformed prior to analysis. Analyses are controlling for age, gender and ethnicity.

Consistent with H3, lower BDI-II anhedonia was significantly related to greater acting with awareness ($r_p$ = -.28, $p$< .001), when controlling for remaining mindfulness facets. Therefore, reduced mind wandering was uniquely correlated with fewer anhedonic symptoms. Lower BDI-II anhedonia also significantly correlated with greater nonjudging ($r_p$ = -.13, $p$ = .01), but was not significantly related to describing, nonreacting or observing facets, Ps> .13.

Lower BDI-II other was also uniquely correlated to greater acting with awareness ($r_p$ = -.26, *p*< .001), but also greater describing, nonreacting and nonjudging, Ps< .05. BDI-II other was not uniquely associated with levels of observing ($r_p$ = .02, *p*= .75).

In total, mindfulness facets accounted for 21% of the total variance in BDI-II anhedonia and 29% of the total variance in BDI-II other symptoms. The acting with awareness facet alone accounted for 6% of the total variance in BDI-II anhedonia and 5% of the total variance in BDI-II other symptoms.

To investigate H4, the above partial correlations were run again with the addition of the BDI-II other scale. Age, gender and ethnicity were also controlled for as covariates. Standard beta weight estimates and partial correlations for these calculations are displayed in Table 3.6.

Table 3.6. *Partial correlations and standardised beta estimates for facets of mindfulness regressed onto the BDI-II scales controlling for remaining depression symptoms in study 1b clinical sample (N=409)*

| | | BDI-II anhedonia | BDI-II other |
|---|---|---|---|
| Observe | $r_p$ | -.11* | .08 |
| | β | -.09* | .06 |
| Describe | $r_p$ | .00 | -.08+ |
| | β | .00 | -.06+ |
| ActAware | $r_p$ | -.14** | -.12* |
| | β | -.12** | -.09* |
| Nonjudge | $r_p$ | .03 | -.22*** |
| | β | .03 | -.17*** |
| Nonreact | $r_p$ | .04 | -.11* |
| | β | 03 | -.08* |

*Note* - * *p* < .05, *** *p* < .001. $r_p$ = unique relationship between each FFMQ facet and BDI-II anhedonia/BDI-11 other controlling for remainder of depression symptoms. β = standardized beta estimate. BDI- II variables were log transformed prior to analysis. Analyses are controlling for age, gender and ethnicity.

In support of H4, lower anhedonic depression was significantly related to greater acting with awareness ($r_p$ = -.14, *p* = .004), even when co-varying out demographic variables, other mindfulness facets and the BDI-II other scale. However, when using this more stringent approach, the acting with awareness facet was found to account for only 1% of the total variance in anhedonic depression.

Thus as predicted, reduced mind wandering was found to be uniquely related to anhedonic depression but was also uniquely related to BDI-II other symptoms. These analyses revealed that lower anhedonic depression no longer significantly correlated to greater nonjudging when controlling for remaining depression severity ($r_p$ = .03, *p* = .50) but did correlate with greater observing ($r_p$ = -.11, *p* = .03). Anhedonic depression was also unrelated to the nonreacting and describe facets, Ps> .48.

Lower BDI-II other symptoms was uniquely correlated to greater acting with awareness ($r_p$ = --.12, *p* = .02) when controlling for remaining mindfulness facets and BDI-II anhedonia, but also greater nonjudging and nonreacting, Ps< .03.

## 3.9 Overall Discussion

Studies 1a and 1b of this thesis aimed to replicate and extend previously published research to examine which facets of trait mindfulness (measured using the FFMQ) are uniquely related to the anhedonic symptoms of depression in a community sample with varying levels of depression severity (study 1a; n = 440) and a treatment seeking sample of recovered depressed individuals taking part in a randomised controlled trial of MBCT (study 1b; n = 409).

Zero-order correlations provided full support for H1 as in both studies greater levels of acting with awareness (reduced trait mind wandering) were found to be significantly associated with lower anhedonia. Largely supporting H2, the magnitude of this relationship between acting with awareness and anhedonia was greater than relationships with all other facets across both studies with the exception of the relationship between nonreacting and anhedonia in study 1a which was not statistically different in magnitude. Consistent with H3, in both samples greater levels of acting with awareness (reduced trait mind wandering) was uniquely associated with lower levels of anhedonia, over and above remaining mindfulness facets. Furthermore, in both studies a unique relationship between greater acting with awareness and lower anhedonic depression held when covarying out mindfulness facets and general depression severity (supporting H4).

Previously published research correlating the FFMQ with symptoms of depression has so far produced mixed findings. A study using a treatment seeking sample (Desrosiers, Klemanski & Nolen-Hoeksema, 2013) found that although the relationship between mind wandering and anhedonia was present at a trend level, the relationship did not approach significance in a more parsimonious path model. However, newer research published since the analyses conducted in the present studies is in conjunction with our findings. Raphiphatthana, Jose and Kielpikowski (2016), correlated the FFMQ with measures of anxiety (Beck Anxiety Inventory; Beck & Steer, 1993) and negative affect/anhedonia (Centre of Epidemiological Studies Depression Scale; Radloff, 1977) using a non-clinical sample (N = 284). This study found a robust link between trait mind wandering and anhedonia. Unique analyses controlling for remaining mindfulness facets found greater acting with awareness and greater nonjudging were uniquely related to reduced anhedonia.

The present studies 1a and 1b have found support for the link between trait mind wandering and anhedonia in both a large community sample and treatment-seeking sample therefore reconciling the difference between these two previously published articles. The difference in findings (notably the significance of the relationship between acting with awareness and anhedonic depression) between the current studies and Desrosiers et al., (2013) could in part be attributed to sample differences (study 1a used a large community sample compared to a smaller treatment-seeking sample in Desrosiers et al., 2013). However, that study 1b (using a similar treatment seeking sample of recovered depressed individuals), also failed to replicate Desrosiers seems to make this explanation reasonably unlikely. Given that mind wandering uniquely related to anhedonia in both studies 1a and 1b, in two independently collected samples in different geographical locations, it is likely that this finding is generalizable. Furthermore, the null findings reported by Desrosiers may be attributable to statistical power. The authors report a beta weight for the relationship between acting with awareness and anhedonic depression of -.23 ($p$ =.15), whereas the beta weight in the present study 1a was -.32 and in the present study 1b was -.30. These somewhat comparable beta weights suggest that the non-significant relationship reported by Desrosiers may be attributable to the smaller sample size.

The replicability of the relationship between trait mind wandering and anhedonia in both studies in this chapter (and that it supports work by Raphiphatthana, Jose and Kielpikowski, 2016) is particularly important given the current replication crisis in psychological research (see Klein et al., 2015 for review). The Many Labs project formed by Richard Klein has looked at the replicability of 100 research findings with a conclusion that only 39% of findings could be reproduced. This therefore highlights a necessity for replicating research on different samples and to do this within the same paper is particularly advantageous.

In summary, of four existing studies correlating the FFMQ with the MASQ (including two studies here), three studies have found a significant positive correlation between mind wandering and anhedonia and only one study does not replicate this. On this basis, it can be concluded that there is a reasonably robust association between anhedonia and mind wandering.

The finding that greater acting with awareness facet uniquely correlates with reduced anhedonia is consistent with previous literature on mind wandering. For example, it has previously been found that people report feeling less happy when their minds are wandering than when they are not, even if their mind has wandered to pleasant topics (Killingsworth & Gilbert, 2010). In addition to this, higher scores on a different self-report measure of mind wandering, the Mindful Attention Awareness Scale (MAAS), indicating greater present moment awareness, have been found to correlate with increased positive affect (Brown & Ryan, 2003; Deng et al., 2012) and increased subjective wellbeing (Atanes et al., 2015). The present studies extend on this literature by examining associations between mind wandering and positive affect within the context of depression. However, it must be considered that when testing H3 in both studies, the acting with awareness facet was found to predict only 7% of variance in anhedonic depression symptoms (in study 1a) and 6% of variance in anhedonic depression symptoms (in study 1b). This relatively small proportion of variance highlights how mind wandering is only one of possibly many other mechanisms implicated.

In addition to the above findings, in the community sample (study 1a), but not recovered depressed sample (study 1b), levels of nonreacting (noticing thoughts and feelings without reacting to them) were uniquely associated with lower levels of anhedonia. There was also a unique relationship between greater levels of nonjudging (not judging ourselves for the thoughts and feelings we have) and reduced anhedonia in study 1b, but this relationship was not apparent in study 1a. Using the most stringent correlational approach (controlling for both remaining mindfulness facets and depression severity) there was a unique relationship between observing (being aware of sensory and bodily experience) and anhedonia in both studies. For this significance to only emerge in stringent partials could be reflective of the less strong correlations between observing and other mindfulness facets. There were no unique relationships between describing (finding words to describe how we feel) facets and anhedonic symptoms in either study. These findings highlight the potential of building nonreacting and nonjudging mindfulness skills when targeting anhedonia, however further work is needed in order to replicate these findings.

There are a number of limitations with the present studies that need to be held in mind. First, data analysed in study 1a was pooled from a range of studies conducted at the University of Cambridge and University College London. It is therefore possible that studies were not consistent with how measures were delivered and the exact reliability of these studies is unknown. However, it was ensured that all measures were either completed at the start or at the end of the experimental session (following an adequate break) and so measures should be relatively free from contamination from other experimental procedures. Second, these studies provide only cross-sectional correlational evidence for the link between mind wandering and anhedonia, so care should be taken not to infer any causal relationships on the basis of the current data. Third, the studies in this chapter solely relied upon self-report measures of mind wandering and depression and it is conceivable that participants lack sufficient insight to accurately report on these variables. In particular, it has previously been reported that mind wandering often occurs outside of conscious awareness (Sayette, Reichle, & Schooler, 2009), which limits the ability of the FFMQ to index the real occurrence of mind wandering in everyday life. Research has previously used alternative methods of measuring mind wandering from the use of thought probes that interrupt a participant’s experience to rate levels of mind wandering in the moment (e.g., Killingsworth & Gilbert, 2010; Smallwood et al., 2004), to indirect behavioural measures (e.g., Smallwood & Schooler, 2006; Stawarczyk et al., 2011; Deng, Li, Tang, 2014) and retrospective measures that are administered immediately after a given task (e.g., Smallwood, O’Connor, & Heim, 2005; Smallwood et al., 2004; Barron, Riby, Greer & Smallwood, 2011). A combination of these measures is likely to produce a more reliable index of mind wandering tendency. Fourth, study 1b relied on a relatively insensitive measure of anhedonia (two items extracted from the BDI-II). Nevertheless, both studies found an identical finding regarding the link with acting with awareness, with the only differences lying in how the nonjudging and nonreacting facets of mindfulness related to anhedonia. Fifth, the partial correlation approach used in both studies can be criticised. It is possible that after covarying out remaining mindfulness facets and general depression severity the amount of variance left to explain within a construct is negligible.

Finally, the current studies lack ecological validity, notably in their measurement of positive affective experience. Anhedonia can be considered a deficit in positivity in terms of both general background mood and the emotional response to specific stimuli. Rottenberg (2005, p1) has previously defined mood as, “a diffuse slow-moving feeling states that are weakly tied to specific objects or situations” whereas emotions have been defined as, “a quick-moving reactions that occur when organisms encounter meaningful stimuli that call for adaptive responses.” Using this distinction by Rottenberg (2005) it can be concluded that the present studies have found a robust link between mind wandering and mood however it is unknown how mind wandering relates to emotional responding to positive stimuli.

In summary, the secondary analyses presented in this chapter are consistent with the notion that mind wandering underlies positive affect disturbances in depression. It is thus conceivable that an inability to maintain focus on the present moment is an underlying mechanism of anhedonia and a potential target for treatment.

However, caution is needed before accepting this conclusion and it requires replication using different methodologies. In particular, a next logical step is to examine if mind wandering correlates with pleasure experience during positive laboratory mood inductions (e.g. positive autobiographical memory recall, positive video clips) and when completing everyday positive events. Moreover, it is important to measure mind wandering using both subjective self-report and more objective experimental measures. Measurement of the relationships between depression severity, positive emotional experience and mind wandering will enable examination of the mediating role of mind wandering in the relationship between depression and lower positive affect. This is the focus of the subsequent chapter.

# Chapter 4: Study 2 – The relationship between mind wandering and positive affective experience in laboratory and real world settings

## 4.1 Introduction

The aim of this chapter is to extend the findings of studies 1a and 1b, by using a cross-sectional design to examine whether any observed relationship between greater depression symptoms and reduced positive affect reactivity (to both nomothetic and idiographic emotional stimuli) is mediated by increased levels of mind wandering. It is important to extend previous research to observe how mind wandering correlates with emotional responding to positive stimuli (as opposed to just background mood) to gain a fuller understanding of how anhedonic clients can be treated in psychological therapies. This study uses a triangulation of different measures (self-report, behavioural, psychophysiology) to examine this mediation model in both controlled laboratory and real world settings. Triangulating measures of mind wandering is an important extension to ensure that the measure used is not tied to any one particular methodology and is likely to be most representative of a participant's inner mental experience. This chapter will begin by reviewing the existing literature on the relationship between mind wandering and positive affect. In particular, research using behavioural measures of mind wandering and ESM will be reviewed and gaps in this research will be highlighted prior to describing how the present study aims to address these gaps.

As reviewed in the previous chapter, self-report measures of mind wandering have been found to correlate with measures of positive affect. However, the studies presented can be criticised for being low in ecological validity, as it can be argued the extent to which findings from self-report questionnaires can be generalised to real-life settings. Further, it has been found that mind wandering often occurs outside of our awareness (Sayette, Reichle, & Schooler, 2009), and so in addition to a lack of ecological validity, self-report measures of mind wandering can be critiqued for their reliance on a participant's own conscious awareness that their mind wanders. This therefore suggests a need to examine how objective measures of mind wandering (measured using behavioural tasks) correlate with positive affective experience.

### *4.1.1 Behavioural measures of mind wandering and positive affect*

A couple of research studies have used behavioural measures of mind wandering to observe the relationship between off-task thinking and positive affect. Ruby, Smallwood, Engen & Singer (2013) used a simple choice reaction task (as used as a measure of mind wandering in Smallwood Ruby & Singer, 2013; Baird et al., 2012). Participants were presented with a sequence of black or coloured digits on the computer screen and were asked to indicate if the number was odd or even only on coloured digit trials. Thought probes were placed intermittently during the task to ask participants about their thought content, including whether thoughts were related or unrelated to the task. Participants also rated separately how positive and negative they felt at each thought probe on a scale of zero (not at all) to nine (completely). The authors used time lag analysis to see how self-reported mind wandering during the task correlated with subsequent mood at the next thought probe. Results revealed that mind wandering preceded a decrease in mood, especially when previous mood had been positive. This therefore provides evidence that mind wandering precedes lowered mood. However, the study presents with a number of limitations that should be considered. Firstly, despite measuring mind wandering during a behavioural task, the authors failed to report how behavioural indices of mind wandering (e.g. number of errors on the task) correlated with mood. Instead, the authors present only how self-reported mind wandering assessed during thought probes relates to subsequent mood measures. Reporting the correlations between behavioural measures of mind wandering and mood would have extended the literature base to consider the relationship between objective measures of mind wandering and positive affect. Second, although discovering that mind wandering precedes a negative mood, this was only the case when mood had previously been positive. It is possible therefore that this result is due to a ceiling effect (i.e. mind wandering only precedes a negative mood when mood was not too low to begin with). Finally, this study looked at the relationship between mind wandering and mood within the context of completing a monotonous cognitive-experimental task. Future work would benefit from assessing how mind wandering relates to mood experience during an actual mood induction task.

A further study has utilised the Sustained Attention to Response Task (SART; Robertson et al., 1997) as a behavioural measure of mind wandering. Marchetti, Koster & De Raedt, (2012) observed changes in mood as a result of completion of the SART. During the SART, participants are requested to respond to a frequent non-target by pressing a button, whilst maintaining enough attention on task to withhold from making a response to a non-frequent target. Errors (e.g. pressing a button when a target is presented) and reaction time variability have been found to be associated with higher levels of mind wandering (Smallwood, Beech, Schooler, & Handy, 2008). Due to the simple and repetitive nature of the SART, it has been found to increase levels of mind wandering. In concurrence with this, Marchetti and colleagues found a significant increase in behavioural errors from the first to second half of the task. However, contrary to the original study prediction, the authors found no main effect of time in terms of negative affect before and after the SART. However, the SART was found to significantly reduce levels of positive affect. This result suggests that an increase in mind wandering as measured behaviourally is related to a reduction in positive affect. Nevertheless, this study does exhibit a number of limitations which should be improved upon in future research. Once again this study did not examine positive affect within the context of depression, so it is still unknown how mind wandering correlates specifically to anhedonia. Furthermore, this study lacks ecological validity as mind wandering was correlated to mood during the SART as opposed to during a positive mood induction either in the laboratory or naturalistic settings.

### *4.1.2 The relationship between mind wandering and positive affect using ESM*

The relationship between mind wandering and positive affect in real-life settings has previously been examined using Experience Sampling Methodology (ESM; Csikszentmihalyi & Larson, 1987). To date research in this field has been consistent, finding elevated mind wandering to be correlated with reductions in mood. Using two separate samples (74 community participants and 92 student participants), Brown & Ryan (2003) observed how scores on the MAAS correlated with momentary affect. The original MAAS was completed as a trait measure of mindfulness (predominately measuring mind wandering) prior to the ESM procedure. State affect was measured using nine separate adjectives (happy, worried/anxious, frustrated, pleased, angry/hostile, enjoyment/fun, unhappy, depressed/blue, joyful) on a scale from 0 (not at all) to 6 (extremely). In both the community and student samples, greater trait MAAS correlated with lower unpleasant affect but was found to be unrelated to levels of pleasant affect. However, within the student sample participants were also asked to rate levels of state mindfulness at each ESM assessment point (using five items from an adapted MAAS). Results revealed a significant correlation between reduced state mindfulness and greater momentary pleasant affect/lower momentary unpleasant affect. The authors therefore concluded that trait mindfulness correlated more with unpleasant affect whereas state mindfulness correlated with both unpleasant and pleasant affect.

Similar findings were reported in a study by Franklin et al., (2013) who used signal-contingent experience sampling. During signal-contingent sampling, participants are prompted to answer questions (in this case using a small handheld palm computer) at random time points during everyday life (see section 2.4 for further detail regarding different experience sampling methods). Participants were randomly probed and asked, "were you off task?" prior to reporting on a five-point scale, "how positive is your mood at the moment?" and "how negative is your mood at the moment?" As predicted, on-task reports had higher positive ratings compared to off-task reports. This study is comparable to that published by Killingsworth & Gilbert (2010), who concluded that, "a wandering mind is an unhappy mind." The use of experience sampling in this study allowed for an extremely large sample size of 2250 participants. Participants were asked, "Are you thinking about something other than what you're currently doing?" and were given the options of no, yes something pleasant, yes something neutral, yes something unpleasant. Participants also rated their mood on one continuous scale from 1 (very bad) to 100 (very good). Results indicated that participants were less happy when their minds were wandering than when they were not. Therefore, this study provides strong evidence for the link between mind wandering and reduced mood in an ecologically valid setting. However, similar to previously discussed studies, Killingsworth & Gilbert (2010) did not examine the relationship between mind wandering and reductions in positive affect in the context of depression. This study is also limited by its sole reliance on self-report measures of mind wandering.

One study in the published literature has attempted to bridge the gap between laboratory and ESM methodology when studying the link between mind wandering and positive affect. McVay, Kane & Kwapil (2009), used a behavioural SART task with thought probes followed by ESM for one week. Thought probes were placed after 60% of no-go screens on the SART and participants were asked, "What were you thinking about?" with the options of; the task, task performance, everyday stuff, current state of being, personal worries, daydreams and other. The authors counted only the latter five answer options as task unrelated thought. The ESM procedure then took place 1-63 days after completion of the SART. Results revealed a correlation between task-unrelated thought during the SART and mind wandering using ESM, suggesting that the tendency to mind wander is a relatively stable characteristic. Furthermore, daily life mind wandering measured using ESM was found to significantly decrease with increasing levels of happiness. However, despite using the SART in this study the authors did not report any behavioural data in terms of SART performance which is typically indicative of level of attention during the task.

So far, experience sampling literature has focused on the relationship between mind wandering and background mood. For example, the majority of studies above have examined the relationship between mind wandering and mood during completion of a cognitive-experimental task. However, anhedonia should be considered in terms of both a deficit in general background mood but also the emotional response to specific stimuli (cf. Rottenberg, 2005). Therefore, future research would benefit from studying how mind wandering relates to positive emotional experience as individuals view rewarding stimuli.

### *4.1.4 The present study*

The published literature to date appears to provide a relatively strong evidence base for the link between mind wandering and positive affect with only occasional exceptions (Black, Semple, Pokhrel & Grenard, 2011; Desrosiers, Klemanski & Nolen-Hoeksema, 2013). However, there are a number of improvements to be made in order to strengthen this work and produce more reliable findings.

Firstly, a triangulation of measures of mind wandering would be extremely beneficial in producing a measure of mind wandering that is not tied to a particular methodology and is most reflective of an individual's mental state. The present study will therefore combine both an objective measure by means of the SART using behavioural indices such as variance in reaction times/number of errors along with self-report measures in both controlled laboratory and real-life settings to see how this more reliable measure relates to positive emotional experience.

Second, the majority of research to date has also only examined links between mind wandering and positive affect, without examining this link within the context of depression. For this reason the present study will include both simple measures of positive affect as well as specific measures of anhedonic symptoms. The study will also include a sample with a spread of depression symptoms allowing us to test the core mediation model – i.e. does mind wandering account for any observed relationship between depression and reduced positive affect?

Third, the present study also aims to improve on previous research in its measurement of positive emotional experience. To date, all previous research has studied deficits in background mood rather than deficits in emotional responding to positive stimuli. This study will therefore correlate the tendency to mind wander with positive emotional reactivity during a controlled laboratory mood induction task and through the use of Event Scheduling methodology. The positive mood induction task will include both autobiographical memory and video stimuli (previously used successful mood induction techniques, Joorman, Siemer & Gotlib, 2007; Martin, 1990) in order to compare how mind wandering relates to emotional experience during the processing of idiographic vs. nomothetic stimuli. Furthermore, it has been observed that emotions are multi-componential consisting of subjective, behavioural and physiological responses (Ekman, 1992). It is good practice to include measures of at least two of these response systems. As physiological measures are less susceptible to demand effects compared to self-report measures, the present study will include both physiological and self-report measures of emotional reactivity. Due to the relative ease of measurement and their sensitivity, measurements of heart rate (HR) and electrodermal activity (EDA) will be collected.

## 4.2 Study design

This study employed a cross-sectional design. The dependent variables (DVs) were self-reported positive and negative emotional reactivity to the mood induction laboratory tasks and during the event scheduling methodology as well as psychophysiological reactivity to the mood induction tasks. The independent variables were levels of depression and levels of mind wandering measured behaviourally on the SART and using self-report thought probes/questionnaire measures.

## 4.3 Hypotheses

It was predicted that mind wandering would mediate the relationship between depression severity and reduced positive affect. Specifically;

1. Participants with higher levels of depression symptoms will display higher levels of mind wandering during a SART and during positive event scheduling and will report greater trait levels of mind wandering.
2. Participants with higher levels of depression symptoms will show a significantly smaller increase in happiness and a significantly smaller decrease in composite negative emotion when recalling a positive memory, watching a positive video, and

completing everyday positive events. Participants with higher levels of depression symptoms will also display diminished EDA/HR when recalling a positive memory and watching a positive video (see section 2.3 for psychophysiology rationale).

3. Participants that display higher levels of mind wandering will display a significantly smaller increase in happiness and a significantly smaller decrease in composite negative emotion when recalling a positive memory, watching a positive video, and completing everyday positive events. Participants with higher levels of mind wandering will also display diminished EDA/HR when recalling a positive memory and watching a positive video.
4. Higher levels of mind wandering will mediate the relationship between increased depression severity and a smaller increase in happiness/smaller decrease in composite negative emotion when recalling a positive memory, watching a positive video, and completing everyday positive events. Higher levels of mind wandering will also mediate the relationship between increased depression severity and diminished EDA/HR when recalling a positive memory and watching a positive video.

## 4.4 Methods

### *4.4.1 Participants*

Participants were undergraduate students from the University of Exeter, recruited using poster advertisements. This poster advertisement sought to recruit participants who had "*recently been suffering from a depressed mood and/or a loss of interest or pleasure in life activities*" to allow for a good range of depression symptoms in the sample (see Appendix 2). This resulted in a sample of 70 (61 females), aged 17-46 years ($M$ = 19.8, $SD$ = 4.00). Forty eight participants (69%) were of White British ethnic origin. All participants gave written, informed consent and the study was approved by the psychology department ethics committee (see Appendix 3). As remuneration, participants received either course credits (needed to pass a research methods module for first year psychology undergraduates) or non-psychology students received an honorarium of £10 for taking part.

### 4.4.2 Questionnaire Measures

#### 4.4.2.1 Measure of depression

*The Beck Depression Inventory – Second Edition* (BDI-II; Beck, Steer & Brown, 1996) was used as a self-report measure of depression severity. The BDI-II comprises 21 items that ask participants to indicate how they have been feeling during the past two weeks, including today. For each item, four statements describe increasingly severe presentation of a symptom of depression. These statements are on a scale of 0 (symptom not present) to 3 (most severe presentation of the symptom). Symptoms measured include both somatic and affective components of depression, such as sadness, worthlessness, change in appetite and change in sleeping pattern. Items 4 (loss of pleasure) and 12 (loss of interest) characterise anhedonic symptoms. Participants are asked to choose the statement that best describes how they have been feeling; picking the statement with the highest number if several statements apply equally well. Scores range from 0-63. The following cut-off score guidelines have previously been put forward for the BDI-II: 0-13 = minimal depression, 14-19 = mild depression, 20-28 = moderate depression and 29 – 63 = severe depression. In this sample the BDI-II had excellent reliability (Cronbach's $\alpha = .91$).

There was a satisfactory spread in depression severity across the sample, with 65.7% of participants with minimal depression (0-13), 12.9% with mild depression (14-19), 17.1% with moderate depression (20-28) and 4.3% with severe depression (29-63) according to suggested BDI-II cut-offs. The mean BDI-II in this sample was 12.60 ($SD = 9.1$) which is slightly higher than that found in previous student samples (cf. Arnau, Meagher, Norris & Bramson, 2001). BDI-II scores were normally distributed and so parametric tests were used when analysing this variable unless otherwise stated.

#### 4.4.2.2 Composite measure of anhedonia

The *Snaith Hamilton Pleasure Scale* (SHAPS; Snaith et al., 1995) and *Mood Anxiety Symptom Questionnaire-Short Form* (MASQ-S; Watson & Clark, 1991) anhedonic depression subscale were used to create a composite measure of state anhedonia. A composite measure was used to reduce the chance of obtaining false positive results (type 1 error) when running multiple analyses. The MASQ-S was as described in study 1a. The SHAPS is a 14 item scale measuring the ability to experience pleasure over the past week, e.g. "I would be able to enjoy my favourite meal" by using the scale, "Definitely Agree", "Agree", "Disagree" and "Definitely Disagree." A raw SHAPS score (ranging from 14-56) was used in the calculation of composite anhedonia. Both scales had excellent reliability in this sample (SHAPS $\alpha = .91$, MASQ anhedonia $\alpha = .91$). To create a composite measure of anhedonia scores on these two measures were Z-scored and an average was taken.

#### *4.4.2.3 Measures of mind wandering*

The 'acting with awareness' subscale of the *Five Facet Mindfulness Questionnaire* (FFMQ-AA; Baer, Smith, Hopkins, Krietemeyer & Toney, 2006) was used to measure trait levels of mind-wandering as in previous studies (cf. Seli, Carriere & Smilek, 2015). The FFMQ-AA was as described in the previous chapter. In this sample the FFMQ-AA had excellent reliability (Cronbach's $\alpha = .90$).

The 'thinking content' component of the *Dundee Stress State Questionnaire* (DSSQ; Matthews et al., 1999) was administered as a retrospective state measure of levels and the content of mind wandering that took place during the cognitive-experimental measure of mind wandering - the SART (see section 4.4.3 for details of this task). Participants are asked to indicate how often they had a series of 16 different thoughts during the task, rated on a scale from one ("never") to five ("very often"). This questionnaire captures two components of subjective thought experience: including Task Unrelated Thought (Dundee-TUT, e.g. "I thought about personal worries") and Task Related Interference (Dundee-TRI, e.g. "I thought about how I should work more carefully."). Scores on both subscales range from 8-40. Cronbach's alphas for these two scales were relatively low (TRI $\alpha = .67$, TUT $\alpha = .60$), however this is unsurprising as items on these scales measure a broad range of cognitions (e.g. "I thought about something that happened in the distant past" is in the same TUT subscale as "I thought about something that might happen in the future").

### *4.4.3 Task Measures*

#### *4.4.3.1 Sustained Attention to Response Task*

A modified Sustained Attention to Response Task (SART; Stawarczyk et al., 2011) was used as both a behavioural and self-report measure of mind wandering. Originally developed to measure deficits in attention in individuals with a traumatic brain injury (Robertson, Manly, Andrade, Baddeley & Yiend, 1997), the SART has since been used to index mind wandering (e.g., Smallwood & Schooler, 2006; Stawarczyk et al., 2011). The SART is a simple Go/No Go paradigm where participants are told to respond to a frequent non-target by pressing the space bar (Go; digits 1-2, 4-9; 89% of trials) whilst withholding a response to a non-frequent target (No Go; digit 3; 11% of trials). This task paradigm exploits the idea that mind wandering is more likely to occur during simple and repetitive tasks (e.g., Cheyne, Carriere & Smilek, 2006). In order to do well on the task participants must maintain enough attention in order to press the button on the frequent Go trials but not press the button on a non-frequent No Go trial. Performance on the SART can be indexed in a number of ways, each of which has been proposed as a behavioural measure of mind wandering (e.g., Whyte, Grieb-Neff, Gantz & Polansky, 2006; Cheyne, Solman, Carriere & Smilek, 2009). These measures of mind wandering include errors of commission (responding when a target is presented), errors of omission (not responding when a non-target is presented) and reaction time variability (with an increased variability demonstrating greater inattention to the task). Following Stawarczyk et al (2011), thought probes were periodically embedded into the task to index participants' subjective awareness of mind wandering.

The SART was implemented using Windows Visual Basic software (Microsoft Corporation, 2010). Participants were seated 70cm from the computer screen. Before beginning the main SART participants completed a practice session observed by the experimenter of 10 numbers including two targets and two thought probes. Stimuli were presented in the centre of the screen (48 pt. font on a 19 inch monitor) for 500ms each. The interstimulus interval between stimuli (where participants were able to respond to targets) was 2000ms. Trials were presented in six higher order blocks of 90 trials (540 trials in total with the task lasting approximately 25 minutes). Within each block there were five sub-blocks of differing lengths (25, 35, 45, 55 or 65 seconds) with either 10, 14, 18, 22 and 26 stimuli respectively (See Figure 4.1). Sub-blocks were presented in a randomised order.

Within each individual sub-block the probability of targets and non-targets is pre-randomized with the following constraints: (1) minimum of one and maximum of three targets in each sub-block, (2) when two or three targets in a sub-block these are separated by at least one non-target, (3) the first stimulus in a sub-block is a non-target (acting as a buffer and not included in analysis), (4) the last five stimuli in each sub-block (preceding the thought probe) are non-targets. For complete block structure of task see Appendix 4.

Deviating from the method adopted by Stawarczyk et al., (2011), a self-paced thought probe was presented at the end of each sub-block (30 thoughts probes in total), with participants asked to rate honestly where their attention was focused just prior to seeing the probe on a likert scale of one ("Completely on task") to seven ("Completely off task"). This simpler scale was used to avoid participant confusion and potentially creating an aversive task prior to the emotional reactivity lab task. See Figure 4.2 for an example of a sub-block on the task. Upon completion of the SART participants completed the thought content component of the DSSQ (as in Smallwood, Riby, Heim & Davies, 2006).

| | | | | | |
|---|---|---|---|---|---|
| **1** | 55s | 45s | 65s | 35s | 25s |
| **2** | 65s | 35s | 55s | 25s | 45s |
| **3** | 65s | 55s | 45s | 25s | 35s |
| **4** | 45s | 35s | 65s | 55s | 25s |
| **5** | 35s | 55s | 25s | 65s | 45s |
| **6** | 35s | 65s | 25s | 45s | 55s |

*Figure 4.1.* The six higher order blocks used in the SART. Each higher order block contains a sub-block of each length. In total there are 30 blocks of stimuli.

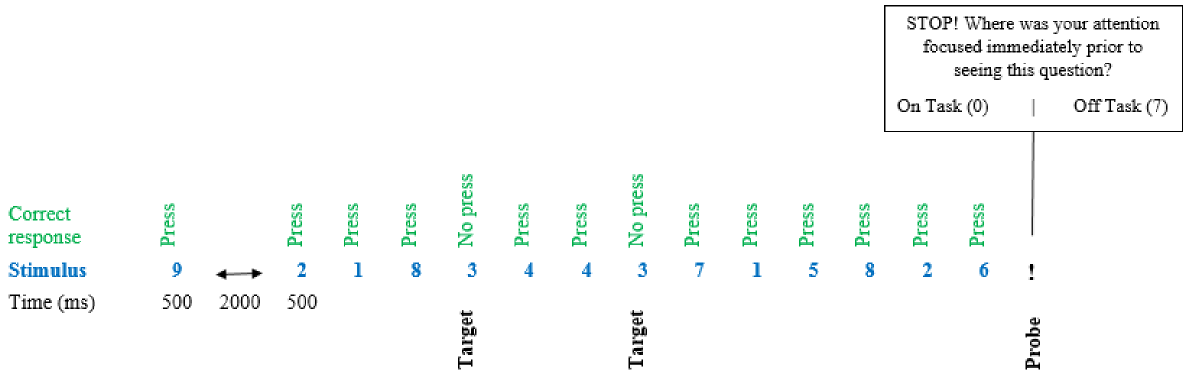



*Figure 4.2.* An example sub-block on the SART lasting 35s and containing 14 numbers, including two targets.

#### *4.4.3.2 Emotional reactivity laboratory task*

An emotional reactivity task was designed to measure reactivity to positive stimuli in a controlled laboratory environment. This task consisted of watching a short video clip and recalling a past autobiographical memory; approaches that have been used as successful mood induction procedures in the past (e.g., Martin, 1990, Joorman & Siemer, 2004). The reason for inclusion of both video and memory stimuli in the mood induction task allows for a comparison between idiographic (self-relevant) and nomothetic (general) stimuli. Prior to the positive video and positive memory stimuli, participants completed a counting task (counting how many times a particular digit occurred in a number grid for 30s; see Appendix 5) intended as a neutral baseline from which to assess affect change when completing the emotional stimuli. Participants rated their affective experience during each counting task and the video and memory stimuli on scales of happiness, sadness, anger, fear and disgust using visual analogue scales ranging from 0 (not at all) to 100 (extremely). For simplification, a composite negative emotion rating is used in the analysis, collapsing across all four negative emotion ratings. The positive video clip used was the ‘Welcome Back’ T-Mobile television advert produced in 2010. The clip lasts 3:01 minutes and depicts travellers arriving in to Heathrow airport. Pilot data on 29 participants found this video clip reliably increased levels of happiness (see Appendix 6 for summary of pilot results). For the positive memory recall, participants were asked to nominate a memory which they deemed ‘particularly happy’. The participant was asked to generate a cue word for this memory (e.g. “birthday”) which would be displayed at the appropriate time on a computer screen to prompt the participant to recall this memory. Participants were asked to recall the positive memory for one minute. During the memory recall period, participants described each memory by speaking aloud. Participants were asked to speak memories out loud rather than typing so as to minimise disturbance to the EDA recording measured through their fingertips. Participants also completed negative and neutral stimuli during the emotional reactivity task, however this data will not be analysed further as it is not of core interest to this thesis.

#### *4.4.3.3 Event scheduling*

An event scheduling method was used to assess participant’s emotional reactivity to positive events in the real world. An Android application was developed so that time stamped data could be collected regarding affect and levels of mind wandering as participants completed real life positive events.

Participants completed one experimenter chosen activity at the end of the testing session (going for a walk; lasting 15 minutes) and three participant chosen activities during the following day (each lasting 25 minutes). After the mood induction task, participants were asked to think of three positive activities that they were likely to find enjoyable that they could complete the following day. A wide range of activities were chosen including having an enjoyable dinner, socialising with friends, going for a run and reading. This element of choice was included in the design in order to reflect what happens in Behavioural Activation treatment for depression (Lewinsohn & Graf, 1973).

Participants were asked to give a time that they could complete these activities which was then programmed into a smartphone (HTC Desire C). The application worked by alarming 15 minutes prior to each programmed start time to give the participant time to prepare for the upcoming activity. The application included a postpone function of 20 minutes to provide participants with some flexibility. This postpone button could only be pressed twice to avoid clashes with activities scheduled later in the day.

Participants rated their mood emotional experience via the smartphone app before and immediately after the event. Affect was measured using 100 point visual analogue scales of happiness and sadness from 0 (not at all) to 100 (extremely). Affect was measured on only two scales (rather than creating a composite negative measure) to minimise participant burden during the positive events. Participants were also asked to rate their level of mind wandering once before, once during (using a randomly timed thought probe) and once after each event. At each time point participants were asked, "*To what degree over the past 5 minutes did you think about something other than what you are currently doing?*" which was rated on a visual analogue scale from 0 ("I was concentrated fully on what I was doing") to 100 ("my mind has wandered frequently to thoughts other than what I am currently doing"). A continuous measure of mind wandering from 0 to 100 was used to more sensitively assess the frequency of mind wandering during the positive events.

### ***4.4.4 Psychophysiology***

Psychophysiology setup and recording was as specified in Chapter 2. Heart rate (HR; measured in beats per minute; BPM) and electrodermal activity (EDA; measured in microsiemens, μS) measures were taken during the emotional reactivity laboratory task to provide an objective measure of emotional response. HR acceleration has previously been used as a simple measure of valence (Cacioppo, Tassinary & Berntson, 2007) and it is therefore expected that HR should increase to both video and memory stimuli. Similarly, EDA is a measure of arousal (see Blascovich, Vanman, Mendes & Dickerson, 2011) and so it is also expected to increase during the positive video and memory stimuli. These measures were chosen as they are safe and relatively easy to record and are known to be sensitive to changes in emotional experience. Due to equipment failure, valid HR and EDA data were not available for seven participants. Furthermore, two participants displayed extreme outliers in HR data (3 SDs from the mean) and so were excluded prior to the analysis. Therefore, the remaining sample size for valid psychophysiology data was N=61.

### *4.4.5 **Procedure***

Participants attended a two hour appointment which took place in a quiet testing room at the University of Exeter. Participants gave written, informed consent before completing the BDI-II, MASQ and SHAPS online using Limesurvey (Carsten Schmitz, 2012). Responses to these questionnaires were carefully monitored and the risk protocol/distress management procedure was carried out if necessary (as detailed in Chapter 2). Next, participants completed the modified SART, followed by the thinking content component of the DSSQ. Participants were then asked to sit quietly for three minutes in order to act as a recovery period before starting the mood induction task. Psychophysiology electrodes were then attached, a three minute baseline recording was taken, and participants completed the emotional reactivity task. After this, the event scheduling task was planned and participants completed a short training session on how to use the smartphone. Participants were given a short written guide on how to use the smartphone (see Appendix 7). Participants then completed the first positive activity (the walk). The three participant chosen activities were all completed the day following the appointment. Participants were sent remaining questionnaire measures (e.g. FFMQ-AA) via Limesurvey to complete in their own time at home. Other questionnaire measures were taken that are not described here or analysed further. After the participant had completed the three activities in their own time the following day they were asked to come back to the lab to drop off the smartphone and were then verbally debriefed. The procedure for this study is summarised in Figure 4.3.

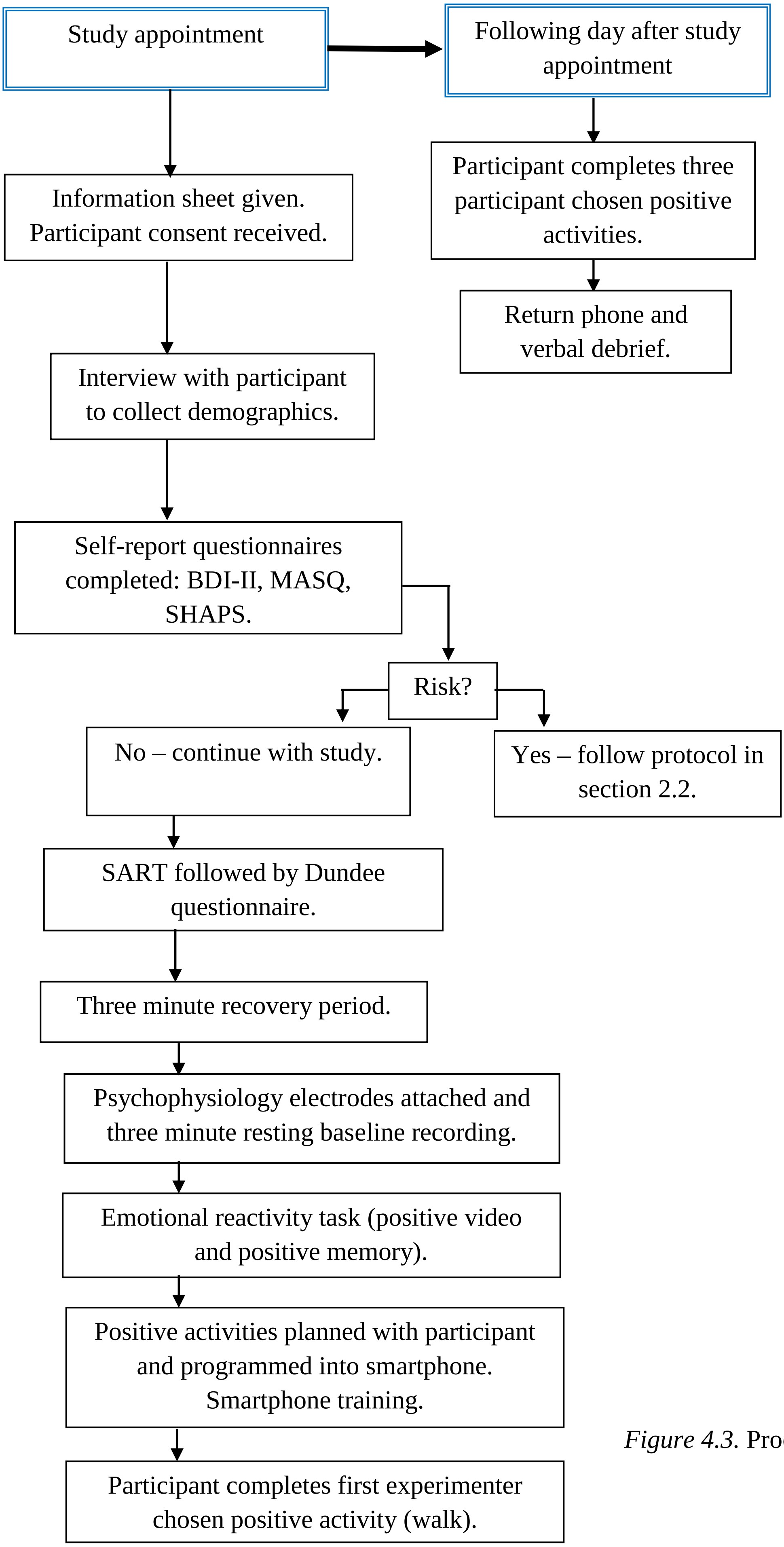



*Figure 4.3.* Procedure for study 2.

### *4.4.6 Data analysis strategy*

To assess emotional change during the emotional reactivity laboratory tasks, residual change scores for happiness and composite negative emotion were used across analyses, as they hold baseline emotional reactivity constant (see Allison, 1990). For this reason residual change scores have previously been referred to as "base-free" measures of change (Tucker et al., 1966) and are viewed as superior to simple difference scores as they take individual differences in baseline emotion into account. Residual change scores were calculated using linear regression in SPSS (Analyse – Regression – Linear), entering the baseline variable as the IV and the post-stimulus variable as the DV and then clicking save unstandardized residuals. To index HR and EDA response, residual change scores were also created using mean activity during the 30s second washout task prior to the positive stimuli and the mean activity during the positive video and positive memory.

The positive event data exhibited a nested structure (4 consecutive events nested within 70 participants) and therefore to test H3 specifically, linear mixed models were used. Linear mixed models provide the opportunity to examine relationships between mind wandering and emotional reactivity during the positive events both within- (level 1) and between- (level 2) participants, without violating assumptions of independence (Snijders & Bosker, 1999). The multilevel model was fitted to the data using restricted maximum likelihood estimation using SPSS Mixed (IBM; version 21). Two mixed models were created for residual happiness and residual sadness change during the positive events respectively. Mind wandering measured using a randomly placed thought probe during each event was entered as fixed effect and was mean centered to aid interpretation. To assess for model fit, the Bayesian Information Criteria (BIC) was used and the model explaining most variance in the dependent variable was retained for analysis. In terms of both residual happiness and sadness change this model contained no random intercept or random slope and only a fixed effect of mind wandering with age and gender entered as covariates.

The procedure described by Baron and Kenny (1986) was followed to test H4 and the proposed mediation model (see Figure 4.4). First, correlations between depression and levels of mind wandering will be presented (path a), followed by correlations between mind wandering and emotional reactivity (path b) and correlations between depression and emotional reactivity (path c). Sobel indirect tests were used to test for significance (path c′).

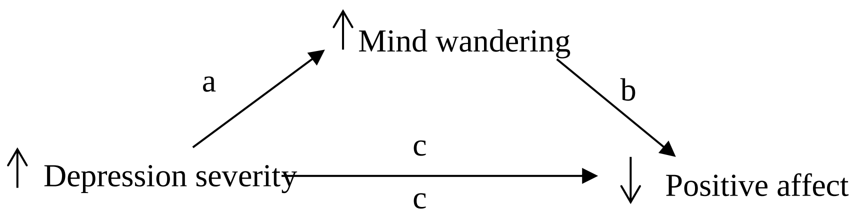



*Figure 4.4.* A diagram depicting the hypothesised mediation model.

## 4.5 Results

Alpha was set to .05. Prior to analyses, data were inspected for missing values, outliers and violations of the normality assumption. Where no violations were found, parametric statistics were conducted. Any violations, data transformations and outliers are described in the text.

### *4.5.1 SART analysis*

Prior to analyses, SART data was examined for participant completion errors which led to the exclusion of one participant's data who displayed an extreme outlier (3 SDs from the mean) in number of omission errors, resulting in a sample size during the SART of N=69. As per previous research using the SART (e.g., Chan, 2005), all reaction time (RT) data was examined for outliers (RT = < 30ms or > 600ms) and any outliers in a participants dataset were removed prior to computing the standard deviation of RT, a commonly used behavioural index of mind wandering. Mean RT across the SART was 344.62ms (SD = 40.01ms) and participants made on average 19.16 omission errors (out of a possible 480 non-targets; 4.0%) and 24.23 commission errors (out of a possible 60 targets; 40.4%). A mean score was created across the 30 thought probes, with participants rating an average of 3.56, indicating that mind wandering did occur during the SART.

For simplicity of analysis and to avoid multiple comparisons a composite measure of mind wandering during the SART was computed. It was decided a priori that to be a truly reflective measure of mind wandering it should contain both behavioural and self-report indices and intercorrelations between these indices should be $r \geq .30$. Table 4.1 presents intercorrelations between all behavioural measures of mind wandering; RT variability (standard deviation in RT), RT_CV (standard deviation in RT/mean RT), total errors (sum of total commission and omission errors) and self-report measures of mind wandering, TP average (average across 30 thought probes) and Dundee TUT (total task-unrelated thought on the retrospective Dundee thought content questionnaire).

Table 4.1. *Intercorrelations between behavioural and self-report measures of mind wandering on the SART (N = 69)*

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1 RT variability | - | | | | |
| 2 RT_CV | .73*** | - | | | |
| 3 Total errors (omission + commission) | .77*** | .59*** | - | | |
| 4 TP average | .35** | .13 | .30* | - | |
| 5 Dundee TUT | .06 | .05 | .09 | .38** | - |

*Note* - * $p < .05$, ** $p < .01$, *** $p < .001$. Behavioural indices include RT variability (the standard deviation in reaction times), RT_CV (the standard deviation in reaction times/mean reaction time) and Total errors (summation of omission and commission errors). Self-report indices include TP average (mean thought probe score) and Dundee TUT (total task-unrelated thoughts on the Dundee thought-content questionnaire).

As displayed in Table 4.1, there were strong correlations between all behavioural measures of mind wandering on the SART, Ps< .001. TP average also correlated well with behavioural measures, Ps< .02, with the exception of RT_CV, $p = .28$. Less well correlated were scores on the retrospective Dundee TUT, which only significantly correlated with TP average ($r = .39$, $p = .001$). Therefore a composite measure of mind wandering during the SART was created using RT variability, RT_CV, Total errors and TP average. To create this composite measure, these variables were Z-scored and an average was taken.

#### ***4.5.1.1 Correlating mind wandering with depression***

To test H1 (mediation path a), that individuals with higher levels of depressive symptoms will display greater levels of mind wandering, correlations were run between the BDI-II and newly created composite mind wandering variable. Prior to analyses, the data were investigated for potential covariates (age and gender). Results revealed a significant correlation between age and BDI-II, ($r_s = .26$, $p = .03$) with older participants reporting higher depression scores. Genders were also found to significantly differ on BDI-II score, $F(1, 68) = 4.55$, $p = .04$, with male participants reporting higher levels of depression. Results of these analyses indicate that both age and gender should be controlled for in all future analyses. As predicted, results revealed individuals with greater depression exhibited more composite mind wandering on the SART, controlling for age and gender ($r_p$ = .28, $p$ = .02). In addition, individuals with greater depression reported greater trait mind wandering measured using the FFMQ acting with awareness subscale ($r_p$ = -.43, $p$ < .001).

### *4.5.2 Emotional reactivity laboratory task*

Due to technical problems with the emotional reactivity task, five participants' data needed to be excluded, leaving a sample size of N = 65.

#### *4.5.2.1 Manipulation check*

Initial analyses were conducted to assess if the positive video and positive memory tasks were successful positive mood inductions. The change in emotional reactivity for these tasks is displayed in Table 4.2.

Table 4.2. *Self-report ratings and physiological indices for before and after the positive video and positive memory during the emotional reactivity lab task (N = 65)*

| | Mean (SD) | | | |
|---|---|---|---|---|
| | Video | | Memory | |
| | Before | After | Before | After |
| Happiness | 41.83 (21.23) | 83.51 (15.83) *** | 46.71 (22.50) | 78.37 (15.32) *** |
| Composite negative | 36.63 (47.93) | 24.35 (40.50) + | 35.55 (48.97) | 18.20 (20.58) ** |
| HR | 75.85 (10.17) | 74.12 (10.81) * | 77.62 (11.83) | 87.47 (11.35) *** |
| EDA | 5.18 (2.14) | 5.26 (2.28) | 5.02 (2.24) | 6.12 (2.59) *** |

*Note* – Mean values are displayed with standard deviations in parentheses. HR = heart rate in beats per minute (BPM); EDA = Electrodermal activity in microsiemens (μS). HR and EDA data is presented for 61 participants. Composite negative = the summation of sadness, fear, anger and disgust ratings. Asterisks are used to indicate if change from before to after the stimulus was significant, analysed using paired samples t-tests. + $p$ < .10, * $p$ < .05, ** $p$ < .01, *** $p$ < .001.

First, to establish if the positive video used in the emotional reactivity lab task was a successful positive mood induction (i.e. by increasing self-reported happiness and decreasing composite negative emotion), paired samples t-tests were conducted to compare mean happiness and composite negative ratings before and after the video. Results revealed a significant increase in happiness ratings, $t(64) = -15.90$, $p <.001$ but only a trend significant decrease in composite negative ratings, $t(64) = 1.90$, $p =.06$. Therefore, the positive video used in the emotional reactivity task had the intended effects on happiness ratings but did not significantly reduce levels of composite negative emotion.

HR and EDA data were also analysed in terms of change from before and after the positive video. Opposite to expected, results revealed a significant decrease in heart rate from before to after the positive video, $t(60) = 2.43$, $p =.02$. Also unexpectedly, EDA did not significantly change, $t(60) = -1.04$, $p <.21$. Therefore, the positive video did not have the intended effects on physiological indices of emotional reactivity.

The above analyses were replicated in order to establish if the positive memory was a successful mood induction. Results revealed a significant increase in happiness ratings, $t(64) = -12.68$, $p <.001$ and also a significant decrease in composite negative ratings, $t(64) = 3.61$, $p =.001$. Therefore, the positive memory worked as expected on self-reported emotional reactivity.

HR and EDA data were also analysed in terms of change from before and after the positive memory. As expected, results revealed a significant increase in heart rate from before to after the positive memory, $t(59) = -10.11$, $p <.001$. In addition, EDA significantly increased during the positive memory, $t(59) = -8.51$, $p <.001$. Therefore, the positive memory also had the intended effects on the physiological indices of emotional reactivity.

#### *4.5.2.2 Positive video analysis*

To analyse the relationships between depression severity, mind wandering and emotional reactivity to the positive video, a series of partial correlations were conducted on residual change scores, controlling for age and gender. Results of these partial correlations are presented in Table 4.3.

Table 4.3. *Correlations between depression severity, composite and trait mind wandering with residualised emotional reactivity measures to the positive video*

| | BDI-II | Video happiness reactivity | Video composite negative reactivity | Video HR change | Video EDA change |
|---|---|---|---|---|---|
| BDI-II | - | .01 | .17 | .002 | .10 |
| Composite mind wandering on SART | .29* | .06 | .13 | -.16 | .02 |
| FFMQ-AA | -.40** | -.12 | -.06 | .06 | -.11 |

*Note* - * $p < .05$, ** $p < .01$. Analyses are controlling for age and gender.

As displayed in Table 4.3, unexpectedly results revealed no significant relationship between depression severity and both self-reported happiness and negative emotional reactivity to the positive video, Ps> .20. Furthermore, depression severity did not correlate with either residual HR or EDA change to the positive video, Ps> .44. Therefore, results from the positive video analysis revealed no support for H2 (mediation path c).

To test H3 (mediation path b), the tendency to mind wander was measured two ways; the first a measure of composite mind wandering taken from the SART and the second a trait measure of mind wandering using the FFMQ-AA. Surprisingly, neither self-reported happiness nor negative emotional reactivity to the positive video correlated with the composite measure of mind wandering, Ps> .33 or trait mind wandering, Ps> .39. Additionally, neither measure of mind wandering correlated with the physiological indices of emotional reactivity, Ps> .22. Therefore, results from the positive video analysis also reveal no support for H3.

H4 stated that levels of mind wandering would mediate the relationship between increased depression severity and smaller increase in self-reported happiness/smaller decrease in composite negative emotion to the positive video. Despite support for H1 (mediation path a), that depression correlates with greater levels of mind wandering, results from the video analysis revealed no support for H2 or H3 (mediation paths b and c). Therefore, all preconditions for a mediation analysis were not met (Baron & Kenny, 1986) and so a Sobel test for indirect effects was not conducted.

#### *4.5.2.3 Positive memory analysis*

To analyse the relationships between depression severity, mind wandering and emotional reactivity to the positive memory, the above partial correlations were replicated once again controlling for age and gender. Results of these partial correlations are presented in Table 4.4.

Table 4.4. *Correlations between depression severity, composite and trait mind wandering with residualised emotional reactivity measures to the positive memory*

| | BDI-II | Memory happiness reactivity | Memory composite negative reactivity | Memory HR change | Memory EDA change |
|---|---|---|---|---|---|
| BDI-II | - | .01 | .17 | .08 | .08 |
| Composite mind wandering on SART | .29* | -.13 | .39** | -.18 | -.22 |
| FFMQ-AA | -.40** | .05 | -.11 | .24+ | .03 |

*Note* - + $p < .10$, * $p < .05$, ** $p < .01$. Analyses are controlling for age and gender.

As displayed in Table 4.4 and similar to the positive video, results revealed no significant relationship between depression severity and both self-reported happiness and negative emotional reactivity to the positive memory, Ps> .20.  Furthermore, depression severity did not correlate with either HR or EDA change to the positive memory, Ps> .55. Therefore, again, results from the positive memory analysis revealed no support for H2 (mediation path c).

To test H3 (mediation path b), partial correlations were conducted between the composite measure of mind wandering, trait measure of mind wandering (FFMQ-AA) and self-reported emotional reactivity to the positive memory. Results revealed only partial support for H3, as composite mind wandering significantly correlated with increased negative emotional change, $p = .002$, however did not correlate with happiness change to the positive memory, $p = 32$. Therefore, an increased level of mind wandering correlated with greater negative emotion change to the positive memory. Trait mind wandering did not significantly correlate with either self-report emotional reactivity measure to the positive memory, Ps< .39. Additionally, composite mind wandering did not significantly correlate with the physiological indices of emotional reactivity, Ps> .11. However, trait mind wandering was found to trend correlate with residual change in HR to the positive memory in an expected direction, $p$ = .07 as reduced trait mind wandering was trend correlated with a greater increase in HR to the positive memory. Trait mind wandering was unrelated to residual EDA change, $p$ = .81.

Results thus far reveal support for H1 (mediation path a), only partial support for H2 (mediation path b) and no support for H3 (mediation path c). Therefore, as with the positive video analysis, Sobel tests were not conducted as not all mediation preconditions were satisfied.

### 4.5.3 Positive events

#### 4.5.3.1 Manipulation check

Next, a manipulation check was conducted to assess if the positive real world events were also successful positive mood inductions. The change in emotional reactivity for the positive events is displayed in Table 4.5.

Table 4.5. *Self-report emotional ratings for before and after the walk and participant chosen real world positive events (1-3)*

| | Mean (SD) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Walk | | Event 1 | | Event 2 | | Event 3 | |
| | Before | After | Before | After | Before | After | Before | After |
| Happiness | 62.16 | 69.63** | 67.43 | 73.53* | 64.06 | 72.48*** | 67.35 | 74.51* |
| Sadness | 16.10 | 16.24 | 15.74 | 10.06** | 18.94 | 14.31* | 17.35 | 14.31 |

*Note* – Asterisks are used to indicate if change from before to after the stimulus was significant, analysed using paired samples t-tests. + $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$. Due to missing data and time stamp errors, complete data for the walk activity was present for 62 participants, 53 participants for event one, 52 participants for event two and 54 participants for event three.

To test if the first walk was a successful positive mood induction (i.e. by increasing self-reported happiness and decreasing sadness), paired samples t-tests were conducted to compare mean happiness and sadness ratings before and after the walk. Results revealed a significant increase in happiness ratings, $t(61) = -3.09$, $p = .003$, but no significant decrease in sadness ratings, $t(61) = -.06$, $p = .96$. Therefore, the walking activity had the intended effects on happiness ratings but did not significantly reduce levels of sadness.

Similar analyses were conducted for the participant chosen events which revealed significant increases in happiness for each event, Ps < .03, and significant decreases in sadness for each event, Ps < .01, with the exception of positive event 3where there was a non-significant decrease in sadness, $t(53) = 1.35$, $p = .18$. The positive events were therefore largely effective positive mood induction exercises.

#### *4.5.3.2 Positive event analysis*

Across all participants a total of 280 positive events were completed, with four activities completed per participant. Prior to analysis, event data was carefully inspected for missing data and time stamp errors. As per previously published research (cf. Delespaul, 1995), a time stamp error was defined as a period of time greater than 15 minutes between a question being displayed and answer provided. This is to ensure only reliable and in the moment data is analysed. Time stamp errors were apparent in 29 events and missing data in a further 29 events, resulting in successful completion of 222 events in total (79.29% completion rate).

To measure emotional reactivity to the positive events, residual change scores were created using happiness and sadness ratings taken before the event took place and then immediately after the event (where participants were asked, “how happy/sad did you feel on average when you were completing this activity?”). Absolute mind wandering during the events (MWd) was assessed via a randomly placed thought probe.

To analyse H1 and H3, partial correlations as completed previously were replicated controlling for age and gender. Prior to conducting these partial correlations, averaged variables (i.e. average MWd, average residual happiness change, and average residual sadness change) were created using the data from successfully completed events. To ensure averaged variables were representative, only participants with three or more successfully completed events were included in the analysis, leaving a sample size of N=55.

Results revealed no significant relationship between depression severity and average MWd ($r_p$ = -10, $p$ = .45), therefore providing no support for H1. Furthermore, in a similar way to both laboratory mood inductions, results revealed no significant relationship between depression severity and averaged residual happiness change to the positive events ($r_p$ = -.06, $p$ = .70). However, there was a significant correlation between depression severity and averaged residual sadness change to the positive events ($r_p$ = .30, $p$ = .03). In other words, higher levels of depression correlated with greater residual sadness change to the positive events, partially supporting H2.

As described, H3 (examining if mind wandering during the events related to happiness and sadness reactivity) was tested using linear mixed models to take into account within-participant clustering (for full details of model construction see section 4.4.6). The first model entered residual happiness change as the dependent variable with mean centered MWd entered as a predictor and age and gender entered as covariates. Through examination of the BIC, the model with the best fit (and therefore predicting most variance in residual happiness change) was retained which had no random intercept for participant, no random slope and only a fixed effect for MWd. In support of H3, results revealed levels of mind wandering to be significantly inversely related to residual happiness change ($\beta$ = -.08, $SE$ = .04, $p$ = .03). In other words, greater mind wandering during the positive events was correlated with less change in happiness. The second model predicting residual sadness change was as described above with no random intercept or random slope. In partial support of H3, there was a trend positive relationship between levels of mind wandering and residual sadness change ($\beta$ = .06, $SE$ = .04, $p$ = .08).

In summary, results from the positive event analysis revealed no support for H1 (mediation path a), only partial support for H2 (mediation path b) and only partial support for H3 (mediation path c). Therefore, once again Sobel tests were not conducted as not all mediation preconditions were satisfied.[1]

## 4.6 Discussion

Study 2 of this thesis aimed to further examine the cross-sectional relationships between mind wandering and positive affect disturbances in depression using a triangulation of

[1] All analyses in study 2 were repeated using simple difference change scores and the same pattern of findings emerged.

different measures. Specifically, the purpose of this study was to test the hypothesis that mind wandering will mediate the relationship between depression severity and reduced positive affect using an undergraduate student sample with varying levels of depression symptom severity (n = 70).

In support of H1, greater depression severity correlated with more mind wandering on the SART. Furthermore, there was a significant negative correlation between scores on the BDI-II and the FFMQ-AA, indicating that depressed individuals exhibit more trait mind wandering. However, inconsistent with H1 there was no relationship between depression and levels of mind wandering reported during the naturalistic positive events.

Unexpectedly, this study provided very little support for the relationship between depression and reduced happiness reactivity/increased negative reactivity to positive stimuli (H2). BDI-II scores failed to correlate with self-report and psychophysiological measures of emotional reactivity to the positive video and positive memory laboratory tasks. Further to this, BDI-II scores were unrelated to residual happiness change but did significantly correlate with greater residual sadness change during the positive events.

In examining H3, this study provided inconsistent support. There were no significant relationships between levels of mind wandering (composite mind wandering and FFMQ-AA) with self-reported and psychophysiological reactivity to the positive video. In terms of the positive memory task, greater composite mind wandering correlated with a greater increase in self-reported negative emotion, however all other relationships were non-significant. There was more support for H3 in the analysis of the event scheduling data. Greater mind wandering during the positive events correlated with lower residual happiness change, but only correlated with residual sadness change at a trend level.

Unfortunately, due to a lack of significant relationships (e.g. between depression scores and emotional reactivity to the laboratory tasks and positive events (mediation path c) and between mind wandering and most emotional reactivity measures during the laboratory tasks (mediation path b) not all preconditions for mediation were satisfied (Baron & Kenny, 1986), resulting in no support for H4.

The finding that greater depression severity correlated with greater mind wandering on the SART is consistent with previous research (Deng, Li & Tang, 2014, Farrin, Hull, Unwin, Wykes & David, 2003). However, depression did not correlate with levels of mind wandering during the completion of the naturalistic positive events. This unexpected finding could be due to the diverse variety of positive events chosen by participants. As previously mentioned, allowing participants to choose their own positive events (in order to reflect clinical treatments for depression such as Behavioural Activation) resulted in participants often engaging in activities that were cognitively demanding and which potentially did not allow their minds to wander in the short measurement time of 20 minutes. However, the finding that depression did not significantly correlate with mind wandering during the experimenter chosen walk ($r_p = .10$, $p = .45$), does not support this interpretation. Despite this, it would be more useful for future research to ask participants to complete the same positive event to allow observation of how mind wandering correlates to positive emotional experience without the complexity of differences in type of activity.

The finding that mind wandering failed to correlate with emotional reactivity during the laboratory tasks is surprising given the literature base linking mind wandering with reduced positive affect (e.g. McVay, Kane & Kwapil, 2009; Killingsworth & Gilbert, 2010; Brown & Ryan, 2003). This inconsistency could be due to the fact previous research has so far only looked at how mind wandering correlates with background mood and has yet to look at correlations with emotional reactivity to positive stimuli. This study used both nomothetic (positive video clip) and idiographic (positive autobiographical memory) stimuli to observe if mind wandering relates differently to emotional reactivity to these different types of stimuli. Results revealed very little difference as mind wandering failed to correlate with happiness reactivity to both the positive video and positive memory. However, greater mind wandering correlated with greater negative reactivity to the positive memory but did not relate to negative reactivity to the positive video. This finding suggests that mind wandering is more detrimental during the processing of personally relevant positive material.

However, in support of H3, elevated mind wandering was found to correlate with reduced happiness reactivity during the naturalistic positive events which is consistent with previous research in the field (e.g. Brown & Ryan, 2003; Deng et al., 2012; Atanes et al., 2015; Killingsworth & Gilbert, 2010). This correlational finding is also in line with the results of studies 1a and 1b in the present thesis and extends these results to a more ecologically valid context.

This study has some limitations that need to be considered. Firstly, a state measure of mind wandering was not measured during the positive laboratory tasks. This design decision was based on an attempt to minimise disruption to these short positive tasks. However, as a result, correlations have been conducted between a composite measure of mind wandering on the SART with emotional reactivity during these tasks. This is not ideal as the tendency to mind wander during the SART and mind wandering during these tasks could have been quite different, potentially contributing to the null results obtained. Secondly, although the positive events significantly increased levels of happiness, the walking activity and positive event 3 did not significantly reduce levels of sadness as expected. A third imitation is the length of the study session (120 minutes). This study aimed to use a triangulation of measures (e.g. a self-report trait questionnaire, behavioural task, retrospective questionnaire measure of mind wandering) in order to obtain more reliable results. However, this resulted in participants completing a number of self-report questionnaires prior to the SART (approximately 25 minutes in length), the mood induction task and then the first positive event, potentially causing participant fatigue. It is therefore possible that participants may not have completed all procedures to the best of their ability and fatigue may have disrupted enjoyment of the first positive event which took place immediately after the study session. A fourth limitation was the proposed mediation model. Although non-significant results rendered it difficult to test this model, temporal precedence criteria would have been a problem in this analysis as change in the mediator (i.e. mind wandering) did not occur prior to change in the outcome variable (i.e. happiness reactivity). A final limitation is the cross-sectional nature of this study. For example, during the positive events results revealed a significant correlation between greater mind wandering and lower happiness reactivity. However, similarly to studies 1a and 1b of the present thesis, it not possible to infer causation from these results.

In summary, this study provides some tentative support for the notion that mind wandering underlies positive affect disturbances, however there was no support for the proposed mediation model. As discussed, a limitation of cross-sectional research is the inability to infer causation. Therefore, a logical next step is to causally manipulate levels of mind wandering to observe its effect on emotional experience. This will enable conclusions to be drawn regarding whether mind wandering causes reduced positive affect.

# Chapter 5: Study 3 – The effect on emotional experience of a laboratory manipulation of mind wandering

## 5.1 Introduction

While there is evidence that mind wandering is correlated to reduced positive affect generally, and to some extent anhedonia in the context of depression (see studies 1a, 1b, 2 and Killingsworth & Gilbert, 2010; Raphiphatthana, Jose & Kielpikowski, 2016), what is currently lacking is causal evidence demonstrating that if mind wandering is manipulated that this will alter positive emotional experience. As far as we are aware, only two studies (Smallwood et al., 2009; Stawarczyk et al., 2013) have so far used causal designs and these studies have focused on negative affect and whether negative affect drives mind wandering rather than vice versa. This chapter will review the evidence for causal links between mind wandering and negative affect prior to reviewing methods for manipulating levels of mind wandering.

### *5.1.1 Causal links between mind wandering and negative affect*

One of the first studies to establish a causal relationship between mind wandering and affect was run by Smallwood et al., (2009). This study aimed to examine the effect of mood states on the tendency for mind wandering to occur. Participants either completed a positive, neutral or negative mood induction by watching short video clips prior to completing a variant of the Sustained Attention to Response Task (SART; Robertson et al., 1997). The SART has previously been utilised as an indirect behavioural measure of mind wandering as participants are asked to respond to a frequent non-target by pressing a button, whilst maintaining enough attention on task to withhold from making a response to a non-frequent target. Errors made on task (e.g. pressing a button when a target is presented) and variation in reaction time have been found to be associated with higher levels of mind wandering (Smallwood, Beech, Schooler, & Handy, 2008). After the SART task participants also completed the thought content component of the Dundee Stress State Questionnaire (DSSQ; Matthews, Joyner, Gililand, Campbell, & Faulconner, 1999) where they were asked to retrospectively rate how much their mind had wandered away from the task. The results of this study indicated that inducing a negative mood state led participants to make significantly more errors on the SART and participants reported greater amounts of task-unrelated thoughts and task-related thoughts compared to participants in a positive mood state. However, the use of a retrospective self-report measure in this study increases the likelihood that participants used their performance on the SART task to judge the amount of time they had spent mind wandering. Future research would benefit from using more immediate measures of mind wandering during the task to avoid this reporting bias. Nevertheless, this study was the first to extend on previously published correlational research linking mind wandering with a negative mood state. The results therefore illustrate a causal role of negative mood in decreasing attentional commitment to an ongoing task and increasing levels of mind wandering. Of crucial concern to this thesis however is investigating the reverse causal relationship, i.e. how does mind wandering alter affective state?

Following on from Smallwood et al., (2009), a later study aimed to replicate these findings by observing how a change in affective state related to subsequent frequency of mind wandering (Stawarczyk et al., 2013). Participants were randomly allocated to either anticipate a future negative event (a stressful speech about an unpleasant topic during which they would be videotaped) or an emotionally-neutral future event (a simple problem-solving task). Participants were told they would complete this event at the end of the study. Following this anticipation period, participants completed the SART during which self-reported mind wandering was measured using thought probes (following the procedure in Stawarczyk, Majerus, Maj, Van der Linden, & D'Argembeau, 2011). Participants also completed a measure of state affect, the Positive and Negative Affect Schedule (PANAS; Watson, Clark & Tellegen, 1988) at three time points during the study; at baseline, immediately after the anticipation period and immediately after the SART. As predicted, a greater increase in negative affect following the anticipation period correlated with an increase in mind wandering during the SART. However, a causal relationship was not supported as the total frequency of mind wandering did not differ between the two groups as expected. Of further interest was the finding that increased mind wandering during the SART led to greater increase in negative affect, therefore suggesting a role of mind wandering in maintaining a negative emotional state. This study is limited by providing only correlational support for the link between greater mind wandering and increased negative affect. An alternative approach to studying the causal nature of this relationship is to manipulate levels of mind wandering, however this is a comparatively novel procedure and there is not yet a well-established paradigm to do this.

### *5.1.2 Manipulating mind wandering*

One study has previously manipulated levels of mind wandering in a laboratory setting with success (Murphy, Macpherson, Jeyabalasingham, Manly & Dunn, 2013). With an understanding that mind wandering is more likely to occur during over familiar tasks (Manly et al., 1999; McVay & Kane, 2009), Murphy and colleagues created an adaptation of the SART. Participants with varying levels of depression (measured using the BDI-II; Beck, Steer & Brown, 1996) completed two versions of the SART. The versions of the task were identical except for the probability of targets appearing on screen. A 'high-probability SART' with increased targets was created with an expectation that mind wandering would occur less frequently than during a regular SART (as the 'high probability SART' was marginally more engaging to complete). This manipulation was successful as errors on task were elevated during the regular SART in comparison to the high probability version. In addition, there was a modulating effect of depression as the effect of the manipulation was more pronounced in individuals who were more depressed. This research study is valuable as establishing a mind wandering manipulation paradigm will allow for a clearer understanding of the relationship between mind wandering and different psychological phenomena. However, this study did not look at the affective consequences of the mind wandering manipulation. Therefore a clear next step is to measure emotional reactivity before and after a mind wandering manipulation.

Another potential method of experimentally manipulating mind wandering is through the use of meditation. A core skill developed in Mindfulness Based Cognitive Therapy (MBCT) is that of sustained attention and it has already been established that increased mindfulness is causally related to lower levels of mind wandering. For instance, Mrazek et al., (2012) aimed to see if a short laboratory mindfulness exercise is sufficient in reducing levels of mind wandering. Participants were allocated to complete either an eight minute mindfulness breathing exercise, passive relaxation or reading. Results revealed that participants who had completed a mindful breathing exercise showed significantly reduced mind wandering on a subsequent SART. This led the authors to highlight the opposing nature of the constructs of mindfulness and mind wandering. Given the established connection between mindfulness and increased positive affect (e.g., Easterlin & Cardena, 1998, Garland et al., 2010; Geschwind et al., 2011) it seems plausible that mind wandering may decrease levels of positive affect. However, once again this study did not examine the emotional impact of mind wandering, highlighting a crucial next step.

### *5.1.3 The present study*

The present study therefore aimed to manipulate levels of mind wandering in a controlled laboratory environment in order to investigate how differing levels of mind wandering impact on positive emotional experience. An established method of reducing levels of mind wandering is through the use of mindfulness meditation; however there is not yet a similarly effective paradigm to experimentally *increase* levels of mind wandering. Therefore, the present study designed and employed a novel manipulation design with three conditions. The first condition will attempt to experimentally decrease levels of mind wandering (MW-), the second condition will attempt to experimentally increase levels of mind wandering (MW+) and these two conditions will be compared to a control condition where mind wandering will not be manipulated.

In this study emotional reactivity will be measured pre and post the mind wandering manipulation (a mixed within-between subjects design). Advantages of this study design include being able to control for individual differences in positive emotional experience. Furthermore, this design allows for an additional correlational analysis between spontaneous levels of mind wandering (occurring naturally) and emotional reactivity during the first mood induction. The use of autobiographic memory recall has previously been used as a successful positive mood induction technique (e.g., Joorman, Siemer & Gotlib, 2007; Joorman & Siemer, 2004). This technique was chosen as a memory recall exercise involves more self-focused rather than externally-focused attention (as opposed to a positive video) and so it is conceivable that a memory mood induction will promote mind wandering. Furthermore, a positive autobiographical memory technique was used in study 2 and had the intended effects on self-report and psychophysiological indices of emotional reactivity. It is also arguable that self-relevant mood inductions are generally more potent than nomothetic ones. As previously explored in this thesis, emotions are multi-componential consisting of subjective, behavioural and physiological responses (Ekman, 1992). It is typically good practice to include measures of at least two of these response systems. Physiological measures are much less susceptible to demand effects compared to self-report measures and so the present study will include psychophysiology and self-report measures in order to provide a more objective measure of emotional reactivity. As in study 2 of this thesis, the psychophysiological measurements of heart rate and electrodermal activity (EDA) were collected.[2]

## 5.2 Study design

The study employed a mixed within and between-subjects design. Mind wandering was manipulated between-subjects with participants randomly allocated to one of three conditions (MW+, MW- and Control). The dependent variable was the within-subjects change in emotional reactivity from pre to post the mind wandering manipulation. Emotional reactivity to a positive memory recall exercise was measured using both self-reported happiness and negative emotion ratings and heart rate and electrodermal activity (EDA) physiological markers. Change in emotional reactivity to memory one (pre-manipulation) was compared to change in emotional reactivity to memory two (post-manipulation). The overall design of this study is depicted in Figure 5.1.

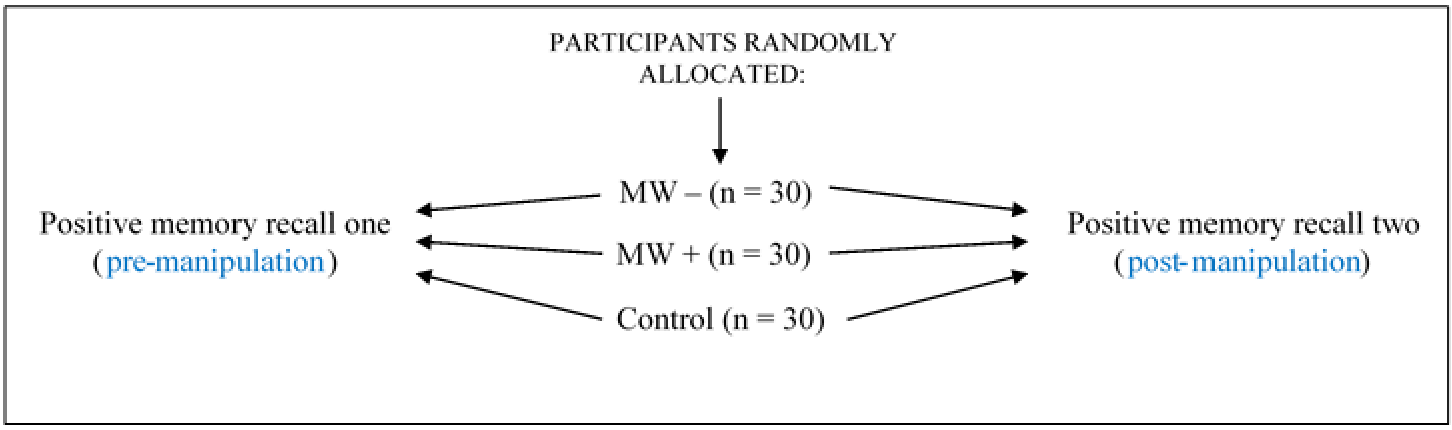



*Figure 5.1.* A diagram depicting the mixed within-between design of study 3.

[2] Limitations of these psychophysiological measures were discussed in section 2.3 which highlighted the caution needed when framing hypotheses surrounding psychophysiological change due to the low specificity of these measures.

## 5.3 Hypotheses

1. Participants allocated to the MW+ condition will report an increase in mind wandering from memory one to memory two compared to participants in the MW- condition who will show a decrease in mind wandering from memory one to memory two (both relative to participants in the control condition).
2. Participants that report a greater frequency of spontaneous mind wandering will report a lower increase in happiness ratings/greater increase in composite negative ratings and will display diminished EDA/heart rate to memory one. Greater levels of trait mind wandering will have similar effects on emotional reactivity to memory one.
3. Participants allocated to the MW+ condition will report a reduced increase in self-reported happiness from memory one to memory two compared to participants in the MW- condition who will report a greater increase in self-reported in happiness from memory one to memory two (both relative to participants in the control condition).
4. Participants allocated to the MW+ condition will report a greater increase in self-reported negative emotion from memory one to memory two compared to participants in the MW- condition who will report a lower increase in negative emotion from memory one to memory two (both relative to participants in the control condition).
5. Participants allocated to the MW+ condition will display diminished EDA /heart rate from memory one to memory two compared to participants in the MW- condition who will display increased EDA/heart rate (both relative to participants in the control condition).

## 5.4 Methods

### *5.4.1 __Participants__*

Participants were undergraduate students from the University of Exeter, recruited through convenience sampling via emails and poster advertisements. This resulted in a sample of 90 (68 females), aged 18-47 years (M = 20.85, SD = 4.23). Sixty three participants (70%) were of White British ethnic origin. All participants gave written, informed consent and the study was approved by the psychology department ethics committee (see Appendix 8). As remuneration, participants were placed into a prize draw to win one of two £20 Amazon vouchers or received one course credit for a psychology research methods module.

### *5.4.2 Measures*

#### *5.4.2.1 Measure of depression*

*The Beck Depression Inventory – Second Edition* (BDI-II; Beck, Steer & Brown, 1996) was as described in studies 1b and 2. The BDI-II was used as a measure of depressive severity during the past two weeks. In this sample the BDI-II had excellent reliability (Cronbach's α = .90).

#### *5.4.2.2 Composite measure of anhedonia*

The *Snaith Hamilton Pleasure Scale* (SHAPS; Snaith et al., 1995) and *Mood Anxiety Symptom Questionnaire-Short Form* (MASQ-S; Watson & Clark, 1991) anhedonic depression subscale were used as described in study 2. Both scales were used as state measures of anhedonic symptoms and had excellent reliability in this sample (SHAPS α = .91, MASQ anhedonia α = .92). To create a composite measure of anhedonia scores on these two measures were Z-scored and an average was taken.

#### *5.4.2.3 Measure of mind wandering*

The 'acting with awareness' facet of the *Five Facet Mindfulness Questionnaire* (FFMQ-AA; Baer et al., 2006) was as described in studies 1a, 1b and 2. This subscale was used as a measure of trait mind wandering in everyday life as in previous research (cf. Seli, Carriere & Smilek, 2015; Murphy, Macpherson, Jeyabalasingham, Manly & Dunn, 2013). In this sample the acting with awareness facet had good reliability (Cronbach's α = .88).

#### *5.4.2.4 Positive memory and mind wandering manipulation task*

The main computer task was programmed using Microsoft Visual Basic software (Microsoft Corporation, 2010). The computer task was presented to the participant using a Samsung Syncmaster 943N LCD monitor with 19 inch display.

Autobiographical memory recall

The computer task consisted of two positive mood inductions, one before and one after a manipulation of mind wandering. All participants recalled two personally relevant positive memories for two minutes. This length of time was chosen to be long enough to induce positive mood but not too long to become boring or burdensome to participants. Participants were asked to think of, "*two of the happiest times of your life*" and were asked to provide a cue word for both memories that could then be entered into the task. Whilst recalling each positive memory participants used the ‘write-out loud’ procedure. Instructions were to, *‘write down your stream of consciousness, letting us know whatever is going through your mind. This might include, but is not limited to, images, ideas, memories, feelings, fantasies, plans, sensations, observations, daydreams, objects that catch your attention, and efforts to solve a problem. There are no restrictions, qualifications, conventions, or expectations’* (cf. Wegner, Erber & Zanakos, 1993). This procedure differs from that used in study 2 where participants were asked to speak memories out loud rather than write them in order to avoid disruption to the EDA signal. The reason for this change in procedure was as a result of feedback received by participants that speaking out loud about personal memories had made them feel embarrassed when in a study environment. For ethical reasons it was decided that a participants would write down their memories and efforts were made to minimize disruption to the EDA recording (e.g. by placing the pen and paper next to participants and reminding them to avoid large movements). The use of the write-out loud procedure is beneficial when using an autobiographical mood induction technique as written scripts can later be analysed as a check that participants completed the task appropriately. For the present study, all written scripts were inspected to check the memories participants chose to recall were broadly positive in nature.

Prior to the recall of each memory there was a 30 second rest period to serve as a baseline measure of emotion. Participants rated their emotion experience on average during each baseline rest period and memory recall period on scales of happiness, sadness, anger, fear and disgust using visual analogue scales ranging from 0 (not at all) to 100 (extremely). For simplification, a composite negative emotion rating will be used in the analysis, collapsing across all four negative emotion ratings.

Mind wandering manipulation exercise

In between each memory recall participants completed the mind wandering manipulation exercise for approximately eight minutes. Participants randomly allocated to the MW- and MW+ conditions were asked to listen to an audio meditation exercise and follow the spoken instructions carefully. Both meditation exercises began by asking participants to relax and become aware of their breathing. As per traditional meditation exercises, the speaker noted that, “you will find that the mind wanders away from the breath.” In the MW- condition, this statement was followed by the instruction to, “register where the mind has wandered to, and then gently bring your attention back to the breath.” Similar instructions continued throughout the meditation exercise with the aim of reducing levels of mind wandering. In the MW+ condition, participants were given the instruction to, “register where the mind has wandered to, and follow your train of thought there.” The aim of this manipulation was to increase levels of mind wandering (for full meditation transcripts see Appendix 9). Meditation transcripts were piloted on eight participants prior to the study (including feedback from a trained mindfulness instructor). Participants in the control condition were asked to read newspaper articles, a technique that has been used in similar studies (Mrazek et al., 2012).

After each memory recall and the manipulation exercise, participants were asked to rate their frequency of mind wandering on continuous visual analogue scale from 0 (Not at all) to 100 (Extremely). The full computer task is depicted in Figure 5.2.

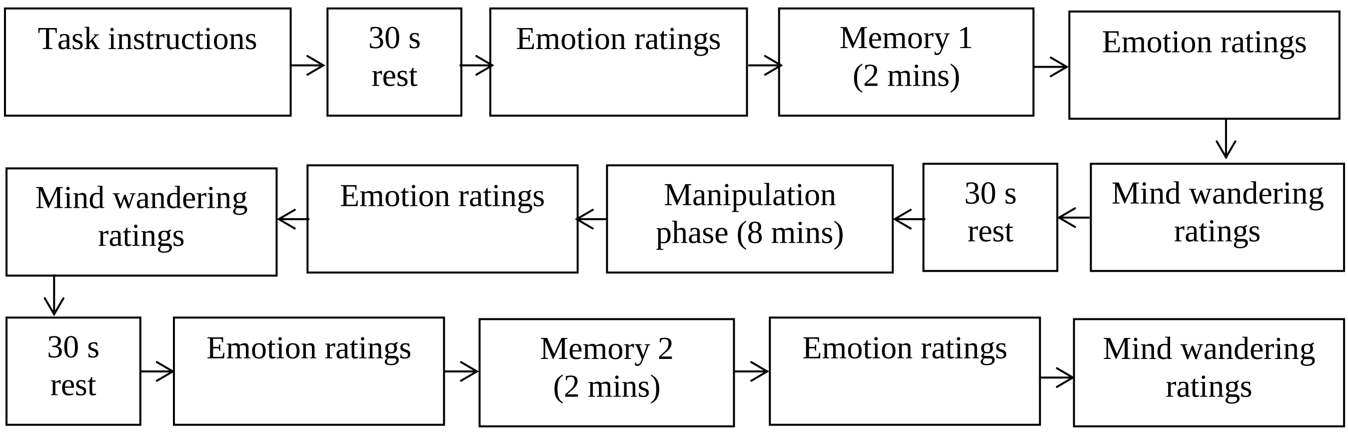



*Figure 5.2.* A flow diagram depicting the mind wandering manipulation and emotional reactivity computer task.

##### *5.4.2.5 Psychophysiology*

Psychophysiology setup and recording was as specified in Chapter 2. Heart rate (HR; measured in beats per minute; BPM) and electrodermal activity (EDA; measured in microsiemens, µS) measures were taken during the positive memory recall and mind wandering manipulation computer task to provide an objective measure of emotional response. HR has previously been used as a simple measure of valence (Cacioppo, Tassinary & Berntson, 2007) and it is therefore expected that HR should increase to a positive mood induction. Similarly, EDA is a measure of arousal (see Blascovich, Vanman, Mendes & Dickerson, 2011) and so it is also expected to increase during the positive memory recall task. These measures were chosen as they are safe and relatively easy to record and are known to be sensitive to changes in emotional experience. Due to movement artefacts in the ECG trace, valid HR data was only available for 57 participants. A further one participants HR data was excluded as they were an extreme outlier (leaving a final sample of 56; 19 in MW+, 17 in MW- and 20 in control). Due to equipment failure (broken EDA transducer; n=9) and experimenter error (incorrect EDA transducer attachment; n=8), valid EDA data was only available for 73 participants (23 in MW+, 24 in MW- and 26 in control).

### 5.4.3 ***Procedure***

Participants attended a one hour appointment in a quiet testing room at the University of Exeter psychology building. Participants read an information sheet and gave written, informed consent. A brief interview was carried out to collect demographic information from participants. Participants then completed the BDI-II, SHAPS, and MASQ-S online using Limesurvey (an online software system for collecting questionnaire data; Carsten Schmitz, 2012). Responses to these questionnaires were carefully monitored and the risk protocol/distress management procedure was carried if necessary (as detailed in Chapter 2). Psychophysiology electrodes were then attached and a resting baseline recording was taken for three minutes. Participants were then asked to think of two positive memories and to assign these memories a cue word (see Appendix 10). Participants then completed a one minute practice of the write-out loud procedure in order to become familiar with this technique. The nominated cue words were then entered into the task computer and participants completed the positive memory recall and mind wandering manipulation computer task. Finally participants completed the acting with awareness scale of the FFMQ along with other trait questionnaires that will not be analysed further. Participants were sent a written debrief via email.

## 5.5 Results

Alpha was set to .05. Prior to analyses, data was inspected for missing values, outliers and violations of the normality assumption. Where no violations were found, parametric statistics were conducted. Any violations and data transformations are described in the text. To assess emotional change to both memories, residual change scores for happiness and composite negative emotion were calculated for both memories separately, as they hold baseline emotional reactivity constant (see Allison, 1990). To index heart rate and EDA response, mean activity during the 30 second rest period prior to recalling each memory and mean activity during the two minute memory recall were used to create residual change scores for each positive memory.

### *5.5.1 Randomisation check*

First, analyses were conducted to ensure that participants in the three conditions were equivalent and did not significantly differ from one another on core variables. For normally distributed continuous variables (log transformed BDI-II, FFMQ-AA) a one-way ANOVA was conducted, with condition entered as the independent variable. Age was unable to be normalised using data transformations and therefore the non-parametric Kruskal-Wallis test was conducted for this variable. Categorical variables (Gender, Ethnicity) were analysed using the Chi-square test. Results of these analyses are displayed in Table 5.1.

Table 5.1.*Summary of key variables and outputs from statistical tests comparing these variables across conditions (N=90)*

| Variable | | Mean (SD) | | | Test statistic |
|---|---|---|---|---|---|
| | | MW+ (n=30) | MW- (n=30) | Control (n=30) | |
| Age | | 20.41 (4.31) | 20.23 (2.27) | 21.90 (5.43) | $H(2) = 4.82$, $p = .09$ |
| BDI-II | | 10.10 (8.70) | 10.13 (7.39) | 10.67 (8.13) | F<1 |
| FFMQ-AA | | 24.38 (5.59) | 25.27 (5.58) | 24.13 (4.88) | F<1 |
| Gender | Male | 6 | 8 | 8 | $X^2$<1 |
| | Female | 24 | 22 | 22 | |
| Ethnicity | White British | 18 | 19 | 26 | $\chi^2$ (2, N = 90) = 6.03, $p = .049$ |
| | Other | 12 | 11 | 4 | |

*Note*- BDI-II = Beck Depression Inventory second edition. FFMQ-AA = the acting with awareness subscale of the Five Facet Mindfulness Questionnaire. Standard deviations presented in parentheses.

As reported in Table 5.1, there was a significant group difference in Ethnicity, $p = .049$. Pairwise comparisons revealed there were significantly more participants of a White British origin in the control condition compared to both the MW+ condition, $\chi^2$ (1, N = 60) = 5.46, *p* = .04 and MW- condition, $\chi^2$ (1, N = 60) = 4.36, *p* = .04. Ethnicity did not differ between the MW+ and MW- conditions, $\chi^2$<1. Age was trend significantly different between conditions, *p* = .09. Participants in the control condition were significantly older than participants in the MW+ condition, *H*(1) = 4.18, *p* = .04 and trend significantly older that participants in the MW- condition, *H*(1) = 2.80, *p* = .095. As conditions significantly differed in terms of ethnic status all analyses were repeated when additionally entering ethnicity as a covariate to check that a similar pattern of findings emerged. There were no significant group differences in IQ, total BDI-II, trait levels of mind wandering and gender, Ps> .69.

### ***5.5.2 Manipulation checks***

#### *5.5.2.1 Mood Induction check*

To establish if the memory recall exercise used in this experiment was a successful positive mood induction (i.e. by increasing self-reported happiness and decreasing composite negative emotion), paired samples t-tests were conducted to compare mean happiness and composite negative ratings before and after memory one (collapsing across conditions). Results revealed a significant increase in happiness ratings from before (*M* = 59.76, *SD* = 16.63) to after (*M* = 76.00, *SD* = 17.25) memory one, *t*(89) = -9.70, *p* <.001, and also a significant decrease in composite negative emotion from before (*M* = 30.57, *SD* = 41.49) to after (*M* = 19.48, *SD* = 30.71) memory one, *t*(89) = 3.29, *p* = .001. HR and EDA data were also analysed in terms of change from before and after memory one (collapsing across conditions). As expected, results revealed a significant increase in heart rate from before (*M* = 79.55, *SD* = 9.29) to after (*M* = 83.12, *SD* = 11.15) memory one, *t*(55) = -4.10, *p* <.001. However unexpectedly, EDA did not significantly change from before (*M* = 6.47, *SD* = 2.48) to after (*M* = 6.39, *SD* = 2.54) memory one, *t*(72) = 1.27, *p* <.21. Therefore, the positive memory recall exercise worked as expected in terms of self-report emotion measures and HR response but not EDA response.

#### *5.5.2.2 Mind wandering manipulation check*

The next manipulation check was conducted to test H1 and see if the manipulation of levels of mind wandering was effective. Table 5.2 reports raw values of levels of mind wandering during memory one, the manipulation phase and memory two. Initially, a one-way ANOVA was conducted to compare levels of mind wandering during the manipulation phase across conditions. Surprisingly, results revealed no significant differences in levels of mind wandering during the manipulation phase between conditions, F(2, 89) = 1.57, $p$ = .22. To further test whether condition effectively influenced mind wandering from memory one to memory two, a mixed measures ANOVA was conducted with condition (MW+, MW-, Control) as the between-subjects factor and frequency of mind wandering during memory one and memory two as the within-subjects factor. Mind wandering frequency during memory two was not normally distributed and so both mind wandering variables were log transformed prior to analysis. Results revealed a significant main effect of time, F(1,87) = 45.80 $p$ = <.001, with mind wandering frequency decreasing from memory one to memory two. There was no significant main effect of condition, F(2,87) = 1.23, $p$ = .30, and no significant time by condition interaction, $F$<1, therefore demonstrating that the mind wandering manipulation did not successfully change mind wandering frequency between conditions.

Table 5.2. *Mind wandering frequency across conditions during memory one, manipulation phase and memory two.*

| Condition | Mean (SD) | | |
|---|---|---|---|
| | During memory 1 | During manipulation phase | During memory 2 |
| MW+ | 28.47 (25.91) | 66.67 (27.94) | 15.60 (24.08) |
| MW- | 34.40 (30.29) | 60.70 (27.51) | 19.50 (28.68) |
| Control | 24.50 (25.05) | 53.17 (33.09) | 12.73 (23.29) |

*Note*- Mind wandering frequency was measured on a scale of 0 (Not at all) – 100 (Extremely).

### *5.5.3 Spontaneous correlational analysis*

#### *5.5.3.1 Correlations with self-report emotional reactivity*

H2 predicted that spontaneous state mind wandering (as measured immediately after memory one) would correlate with reduced happiness and increased negative emotion. Partially supporting this, state mind wandering was significantly negatively correlated with happiness reactivity to the first positive memory ($r_s$ = -.28, $p$ = .01), however had no significant relationship with negative emotion reactivity ($r_s$ = .15, $p$ = .16). In other words, the more individuals mind wandered during the memory recall, the less their happiness experience increased. H2 also predicted that participants with higher levels of trait mind wandering (as indexed using the FFMQ-AA) would show reduced happiness and increased negative emotion to memory one. Residual change scores to memory one were skewed and so Spearman's correlations were conducted. In partial support for H2, there was a significant negative correlation between greater scores on the FFMQ-AA (i.e. less trait mind wandering) and greater negative emotion change to memory one ($r_s$ = -.38, $p$ = <.001) indicating that participants who tend to mind wander more during daily life showed increased negative emotion change to the first positive memory. However, trait levels of mind wandering did not significantly correlate with happiness reactivity to memory one ($r_s$ = -.11, $p$ = .31).

#### *5.5.3.2 Correlations with physiological reactivity*

To further test H2, heart rate and EDA were investigated in terms of residual change from before to after memory one. As HR and EDA residual change variables to memory one were skewed and could not be corrected by transformation, Spearman's correlations were conducted for all analyses. In terms of residual HR change, there was a non-significant relationship with levels of state mind wandering ($r_s$ = .04, $p$ = .78), but a trend relationship with the FFMQ-AA ($r_s$ = -.24, $p$ = .08). In other words, greater scores on the FFMQ-AA (lower trait mind wandering) trend correlated with a reduced increase in heart rate to memory one. This was contrary to that predicted as here greater trait levels of mind wandering trend correlated with greater heart rate change. In terms of residual EDA change, there was a non-significant relationship with levels of state mind wandering ($r_s$ = .17, $p$ = .15), but a slight trend relationship with the FFMQ-AA ($r_s$ = -.20, $p$ = .09). This suggests that lower trait mind wandering is associated with reduced increase in EDA response, which is opposite to that predicted.

### *5.5.4 Mind wandering manipulation analysis*

First, to establish that participant's emotional reactivity did not differ between conditions at baseline, a randomisation check was conducted. Due to the non-normality of the self-report and physiological residual change scores to memory one, the Kruskal Wallis test was used to contrast these variables across the three conditions. Results of this randomisation check are displayed in Table 5.3. There were no significant differences in either self-reported happiness or composite negative emotion residual change to memory one between conditions, Ps> .63.

Similarly, there were no significant differences in residual HR and EDA change to memory one between conditions, Ps> .39.

Table 5.3. *Self-report ratings and physiological indices for before and during memory one with outputs from Kruskal Wallis test comparing the change scores across three conditions (MW+, MW-, Control).*

| Variable | | Mean (SD) | | | Test Statistic |
|---|---|---|---|---|---|
| | | MW+ (n=30) | MW- (n=30) | Control (n=30) | |
| Happiness ratings | Before | 58.80 (16.41) | 62.13 (15.37) | 58.33 (18.27) | *H*(2) = .92, *p* = .63 |
| | During | 74.47 (16.90) | 76.87 (16.94) | 76.57 (18.36) | |
| Composite negative ratings | Before | 38.80 (54.16) | 24.57 (36.85) | 28.33 (29.65) | *H*(2) = .60, *p* = .74 |
| | During | 24.27 (40.05) | 15.60 (28.10) | 18.57 (21.46) | |
| HR | Before | 80.10 (8.71) | 81.51 (9.24) | 77.36 (9.88) | *H*(2) = 1.42, *p* = .49 |
| | During | 82.10 (8.79) | 84.75 (11.42) | 82.69 (13.15) | |
| EDA | Before | 6.51 (2.58) | 5.97 (2.13) | 6.90 (2.68) | *H*(2) = 1.87, *p* = .39 |
| | During | 6.56 (2.66) | 5.87 (2.20) | 6.72 (2.74) | |

*Note* – Mean values are displayed with standard deviations in parentheses. HR = heart rate; EDA = Electrodermal activity. For self-report and physiological indices the Kruskal-Wallis test compares residual change scores from before to during memory one. Incomplete data for physiological indices (see section 5.4.2.6 – valid HR data available for 56 participants, valid EDA data available for 73 participants).

#### *5.5.4.1 Effect of manipulation on self-report emotional reactivity*

To investigate the effect of the mind wandering manipulation (MW+, MW- and control) on emotional reactivity, an initial analysis was conducted to investigate any differences in self-reported emotion during the 9-minute manipulation phase. There was no 30 second rest period prior to the manipulation task and so a change score cannot be calculated. Instead, a Kruskal-Wallis test was conducted on absolute happiness and composite negative emotion during the manipulation. Mean happiness and composite negative emotion scores during the manipulation are shown in Figure 5.3. There was a significant difference between conditions in happiness experienced during the manipulation, $H(2) = 17.28$, $p = <.001$. Pairwise comparisons revealed that as expected participants in the MW- condition reported greater happiness compared to those in the control condition, $H(1) = 12.50$, $p = <.001$, however participants in the MW+ also reported greater happiness relative to the control condition, $H(1) = 13.13$, $p = <.001$. There was no significant difference in happiness during the manipulation phase between MW- and MW+ conditions, $H(1) = .13$, $p = .72$. Therefore, the manipulation did not have the intended immediate effects on happiness reactivity. There were no significant differences between conditions in composite negative emotion during the manipulation, $H(2) = .48$, $p = .79$.

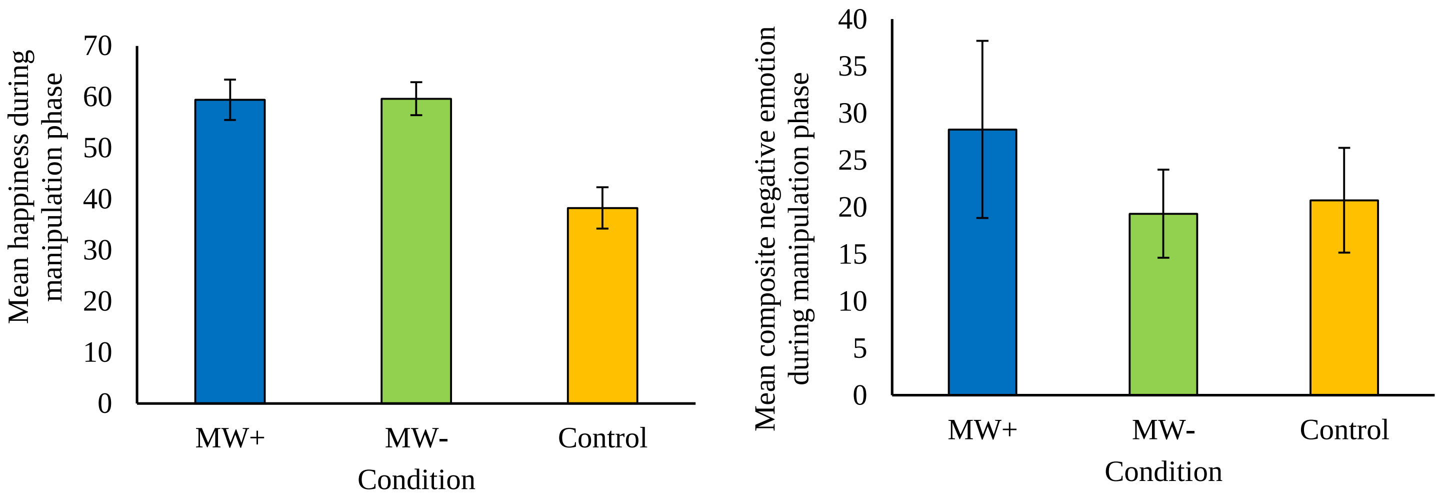



*Figure 5.3.* Graphs depicting mean scores of happiness and composite negative emotion during the manipulation phase between conditions. Errors bars are +/- 1 standard error of the mean.

To formally test H3 and H4, that the mind wandering manipulation would change emotional reactivity to memory two, residual change scores were calculated using happiness and composite negative emotion ratings to memory two. A 2x3 mixed measures ANOVA was conducted for happiness and composite negative emotions separately. Residual change scores were ranked prior to running the ANOVA due to the non-normal distribution of these variables (cf. Conover & Iman, 1982). Time (memory one, memory two) was the within-subjects factor and condition (MW+, MW- and control) was the between-subjects factor[3].

For happiness ratings there was no significant main effect of condition, $F(2, 87) = 1.59$, $p = .21$, and no significant time by condition interaction, $F<1$. The effect of the mind wandering manipulation on happiness ratings can be seen in Figure 5.4. Inconsistent with H3, this reveals there was no significant difference in happiness reactivity (from memory one to memory two) across the three conditions.

For composite negative ratings there was no significant main effect of condition, $F(2, 87) = 1.26$, $p = .29$, and no significant time by condition interaction, $F<1$. The effect of the mind wandering manipulation on composite negative ratings can be seen in Figure 5.5. Once again, inconsistent with H4, there was no significant difference in composite negative reactivity (from memory one to memory two) across the three conditions.

[3] Due to the use of residual change variables in the analysis, the main effect of time will not be reported. This is due to residual change variables having a mean of zero and therefore F equals zero and *p* equals one.

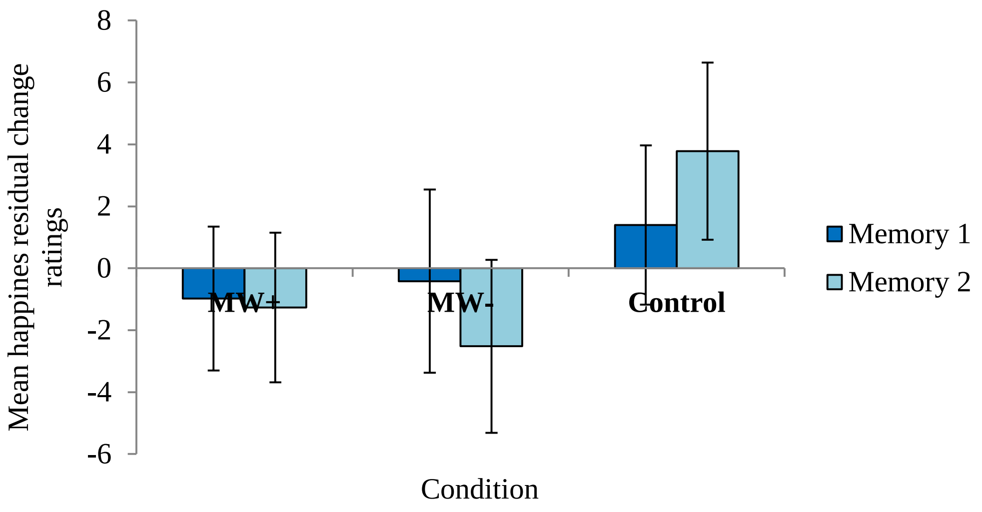



*Figure 5.4.* Graph of the interaction between condition and residual happiness change scores for memory one and memory two. Errors bars are +/- 1 standard error of the mean. Data presented in figure are non-ranked residual change scores.

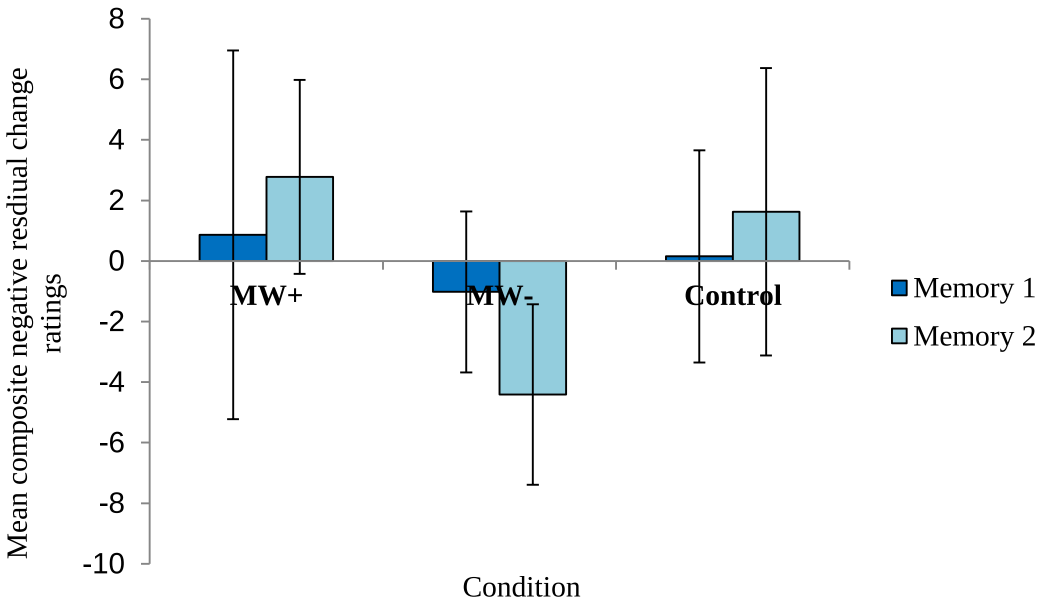



*Figure 5.5.* Graph of the interaction between condition and residual composite negative change scores for memory one and memory two. Errors bars are +/- 1 standard error of the mean. Data presented in figure are non-ranked residual change scores.

As reported in section 5.5.1 there was a significant difference in ethnicity between conditions with significantly more participants of a White British origin in the control condition ($p$=.049; as reported previously). Therefore, to check for a potential effect of ethnicity on these results, the analyses were repeated, entering ethnicity as a covariate. Overall, a broadly similar pattern of results emerged.

As the manipulation did not successfully work in this study, an additional method of investigating how mind wandering relates to self-reported emotion change is to explore *across* conditions (and therefore all participants) the correlations between change in mind wandering between memory one to memory two and change in happiness and composite negative reactivity. These change variables were not normally distributed and so non-parametric Spearman's correlations are reported. Results revealed a trend negative correlation between mind wandering change and residual happiness change, $r_s = -.19$, $p = .07$. This can be interpreted as the more mind wandering increased from memory one to memory two the less self-reported happiness increased. Mind wandering change and self-reported composite negative change were unrelated, $r_s = -.11$, $p = .31$.

Correlations between change in mind wandering from memory one a memory two and change in happiness and composite negative reactivity were also conducted *within* separate conditions. Within the MW+ condition (n=30), there was a significant inverse correlation between change in mind wandering frequency and residual happiness change from memory one to memory two, ($r_s = -.43$, $p = .02$). Therefore, the more mind wandering increased from memory one to memory two the less happiness increased, providing further correlational evidence for the link between mind wandering and reduced positive affect. There were no other significant correlations between mind wandering change and either happiness, rs < -.16, Ps> .41 or composite negative change, rs < -.09, Ps> .66 in the other conditions.

#### *5.5.4.2 Effect of manipulation on physiological reactivity*

To investigate the effect of the mind wandering manipulation (MW+, MW- and control) on physiological reactivity, again we first examined condition differences in absolute ratings during the 9-minute manipulation phase (using a Kruskal Wallis test). Mean HR and EDA during the manipulation phase are shown in Figure 5.6. Unexpectedly, results revealed no significant differences between conditions in terms of absolute HR during the manipulation phase, $H(2) = 1.70$, $p = .43$. There was however a trend significant difference between conditions in terms of absolute EDA, $H(2) = 5.75$, $p = .06$. Pairwise comparisons revealed that participants in the MW- condition displayed significantly lower EDA during the manipulation compared to participants in the control condition, $H(1) = 5.61$, $p = .02$. There were no other significant differences in absolute EDA between conditions, Ps> .11.

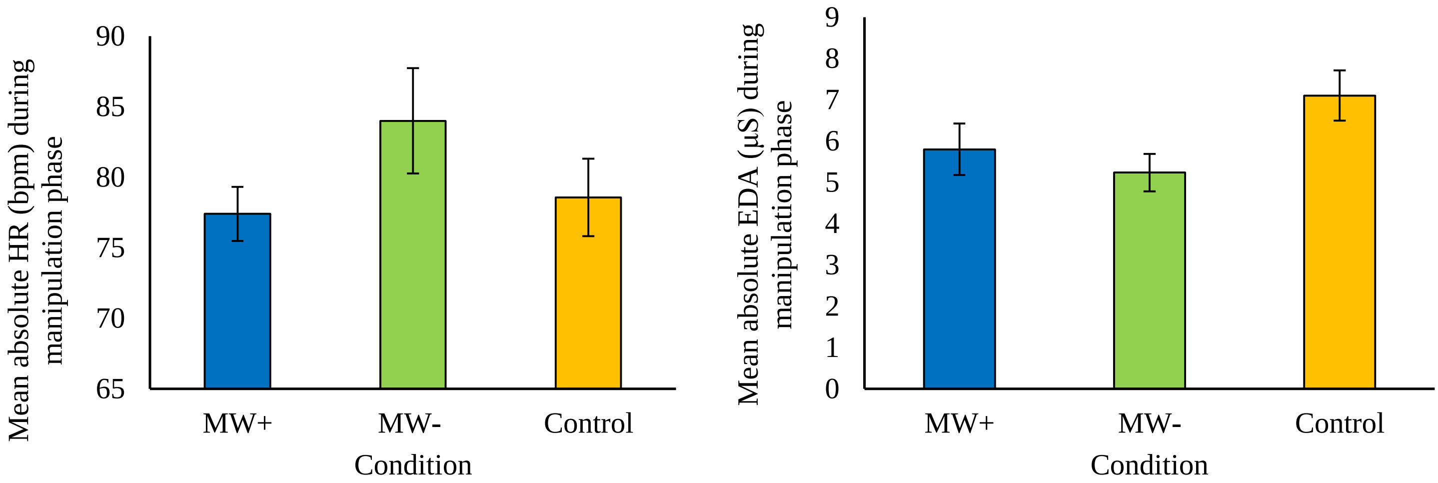



*Figure 5.6.* Graphs depicting mean absolute HR and EDA during the manipulation phase between conditions. Errors bars are +/- 1 standard error of the mean.

To formally test H5 that the mind wandering manipulation would change physiological reactivity to memory two, again a series of 2(time) x 3(condition) mixed measures ANOVA were conducted using rank transformed data.

The effect of the mind wandering manipulation on residual HR change can be seen in Figure 5.7. Results revealed no significant main effect of condition, $F<1$, and no significant time by condition interaction, $F<1$. Failing to support H5, this reveals there was no significant difference in residual HR change (from memory one to memory two) across the three conditions.

The effect of the mind wandering manipulation on residual EDA change can be seen in Figure 5.8. Results revealed no significant main effect of condition, $F<1$, and no significant time by condition interaction, $F<1$. Therefore, once again there was no support for H5 as EDA did not significantly differ from memory one to memory two across the three conditions.

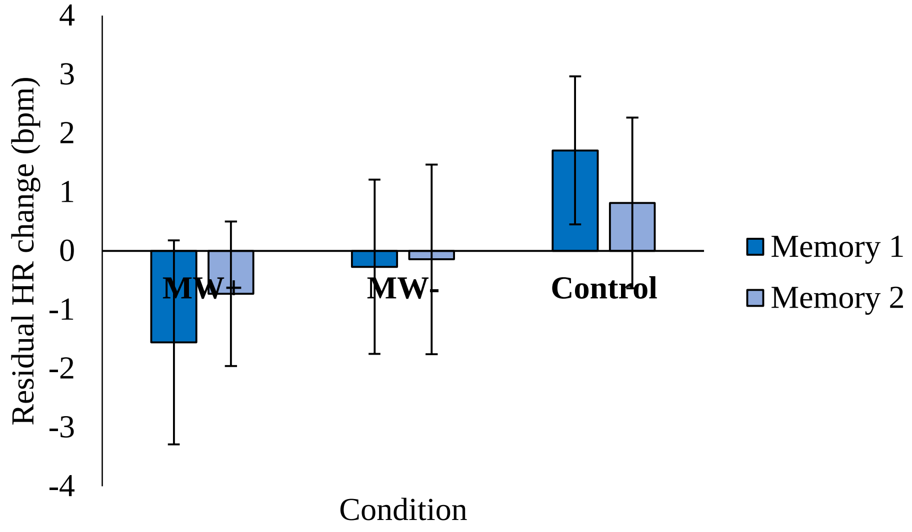



*Figure 5.7.* Graph of the interaction between condition and residual HR change for memory one and memory two. Errors bars are +/- 1 standard error of the mean.

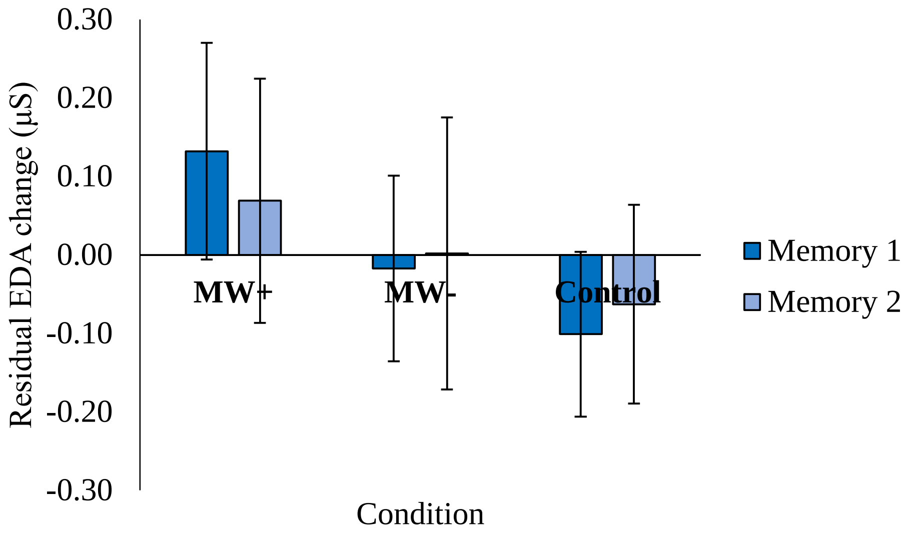



*Figure 5.8.* Graph of the interaction between condition and residual EDA change for memory one and memory two. Errors bars are +/- 1 standard error of the mean.

As with self-reported emotional reactivity variables, correlations were conducted *across* conditions (all participants) between change in mind wandering and change in residual change psychophysiology variables. Spearman's correlations revealed no significant relationships between mind wandering change from memory one to memory two and change in residual HR change, ($r_s$ = .15, $p$ = .19) or residual EDA change ($r_s$ = .10, $p$ = .36).

Correlations between change in mind wandering from memory one a memory two and change in HR and EDA were also conducted *within* separate conditions[4]. Overall, remaining analyses revealed no significant correlations within any of the three conditions between overall change in mind wandering and overall residual HR change, Ps> .15 or overall residual EDA change, Ps> .54.[5]

## 5.6 Discussion

Study 3 of this thesis aimed to investigate the causal effects of both increasing and decreasing mind wandering on affective experience when recalling a positive autobiographical memory in an undergraduate student sample (n = 90).

Results from this study revealed no support for H1 as the novel mind wandering manipulation employed was not successful. Frequency of mind wandering was not found to differ between the MW+, MW- and control conditions during the manipulation phase nor during the second positive memory recall exercise.

Providing partial support for H2, levels of spontaneous state mind wandering were found to correlate with self-reported happiness reactivity during memory one. In other words, higher levels of naturally occurring mind wandering was associated with a reduced increase in happiness. However, spontaneous mind wandering did not correlate with self-reported negative emotion as was predicted. Contrary to this and again in partial support of H2, higher trait levels of mind wandering (measured using the FFMQ-AA) did significantly correlate with greater negative emotion change to the first positive memory but did not significantly relate to happiness change. This result indicated that a greater tendency to mind wander during daily life is related to a greater increase in negative emotion when recalling a positive memory.

H2 also predicted that greater mind wandering (both state and trait) would relate to diminished EDA and decreased heart rate during memory one. Unexpectedly, neither change

[4] Valid ECG data was available for 19 participants in the MW+ condition, 17 participants in the MW- condition and 20 participants in the control condition. Valid EDA was data available for 23 participants in the MW+ condition, 24 participants in the MW- condition and 26 participants in the control condition. Reasons for exclusion of psychophysiology data are detailed in section 5.4.2.6. Due to the small sample sizes these analyses are likely to be underpowered.

[5] All analyses in study 3 were repeated using simple difference change scores and the same pattern of results emerged.

in heart rate or EDA correlated with levels of state mind wandering, however there were trend relationships between these physiological markers and trait mind wandering. Contradicting the original prediction, lower scores on the FFMQ-AA (greater trait mind wandering) were trend associated with increased heart rate change and with increased EDA change during memory one.

As the manipulation of mind wandering was not successful, interpretation of any subsequent significant findings is difficult to interpret. However, results revealed no support for H3 as there were no significant differences in self-reported happiness reactivity across the three experimental conditions. Furthermore, inconsistent with H4, there were no significant differences between conditions in composite negative emotion to the second memory compared to the first memory.

As the manipulation proved unsuccessful, supplementary analyses were conducted post hoc to examine correlations both across and within conditions between change in mind wandering and change in happiness/negative emotion reactivity. These analyses revealed a trend negative correlation between mind wandering change and residual happiness change across all participants in the three conditions. In other words, the more mind wandering increased from memory one to memory two, the less self-reported happiness increased. This therefore provides further correlational evidence for the link between increased mind wandering and reduced positive affect, albeit at a trend level. Across conditions, mind wandering change was found to be unrelated to negative emotion change. In terms of correlations within conditions, a similar inverse relationship between change in mind wandering and residual happiness change was apparent in the MW+ condition only and there were no other significant correlations between mind wandering change and happiness or negative emotion change in the other two conditions.

Finally, results of the present study provided no support for H5, as neither residual HR nor EDA change significantly differed across conditions from memory one to memory two. Further to this, there were no significant correlations between mind wandering change and change in physiological markers both across and within conditions.

The finding that a short mindfulness exercise in the MW- condition did not significantly reduce levels of mind wandering is surprisingly given previously published studies (Mrazek et al., 2012). This contradicting finding might be due to the use of self-report mind wandering measures in this study instead of behavioural indices on the SART. Research has found that mind wandering often takes place without our conscious awareness (Sayette, Reichle, & Schooler, 2009) and so the unsuccessful manipulation in this study might reflect a lack of meta-awareness and difficulty in recognizing mind wandering has occurred. Therefore, it is worth testing the validity of this manipulation using multiple measures of mind wandering that do not rely directly on self-caught recording. Furthermore, mind wandering is also more likely to occur as length of time on task increases (Smallwood, Obonsawin, and Reid, 2003; McVay & Kane, 2009). The two minute memory recall task used in the present study might not have been long enough for mind wandering to naturally occur. However, if the manipulation appeared to fail purely due to measurement difficulties, then this study found no empirical support for the causal hypothesis, as those in the MW+ condition did not report reduced happiness and increased negative emotion during memory two compared to participants in the MW- and control conditions.

A further explanation for why the manipulation of mind wandering failed to have the intended effects in this study could be simply that it was not effective enough. Several amendments could be made to improve the manipulation of mind wandering using meditation techniques. For example, the manipulation phase could be made longer, as eight minutes may have been insufficient to have lasting effects on levels of mind wandering. Secondly, the participants could have been given meditation exercises over the course of a couple of weeks prior to the study (as in Mrazek et al., 2013). MBCT has been found to reliably reduce mind wandering, however this intervention occurs over a period of eight weeks, highlighting the need for regular practice to develop sustained attention skills. A further problem with the manipulation used in this study could be that it occurred prior to participants completing the second positive memory recall. Perhaps a more effective procedure would involve the manipulation of mind wandering *as* participants actually complete a positive mood induction. However, a careful balance would be needed between creating an effective manipulation and minimising disruption to the positive mood task. One final consideration is the use of an undergraduate student sample in this study and it is of course possible that participants did not take the study seriously.

This study provided partial support for H2 as participants who reported elevated state mind wandering during memory one showed reduced residual change in happiness. This study therefore provides further correlational evidence for the link between increased mind wandering and decreased positive affect, supporting earlier work by Killingsworth & Gilbert (2010). Furthermore, this study supports prior questionnaire studies that have reported unique correlations between trait mind wandering and reduced anhedonic depression (Raphiphatthana, Jose & Kielpikowski, 2016; Zvolensky et al., 2006; studies 1a and 1b of this thesis). However, this study was unable to build upon previous literature by establishing a causal relationship.

Intriguingly, results of the psychophysiology analysis found that trait mind wandering trend correlated with emotional reactivity to memory one, however this was in the opposite direction to that predicted. It was originally predicted that those who mind wander more during daily life would show diminished physiological activity to the first positive mood induction. This prediction was based on the theory that greater HR change is linked to greater positive reactivity and greater EDA change is linked to increased arousal (Cacioppo , Tassinary & Berntson, 2007; Blascovich, Vanman, Mendes & Dickerson, 2011). Therefore, the results from the present study are unexpected as greater trait mind wandering was correlated with increased heart rate and EDA change. However, these findings possibly reflect the influence of mindfulness (including increased present moment awareness) on autonomic nervous system activity. It has previously been well established that meditators experience decreased heart rate (Wallace, 1970; Peng et al., 2004). Therefore individuals in the present study displaying increase trait present moment awareness are perhaps more likely to show decreased physiological change. Previous research has also found a link between increased EDA response and detection of mind wandering occurrence (O'Connell, Bellgrove, Dockree & Robertson, 2004). Results from the present study are consistent with this finding as individuals with greater FFMQ-AA (reduced trait mind wandering) might be more likely to detect mind wandering and bring their attention back to the ongoing task. However, these interpretations should be regarded tentatively as correlations were only at a trend level.

Additionally, as discussed in Chapter Two the use of heart rate analysis is a limitation of this study as changes are particularly difficult to interpret. An increase in heart rate can be as a result of an increase in activity of the sympathetic nervous system or a decrease in activity of the parasympathetic nervous system. An analysis of heart rate variability (HRV) in future studies would allow for a more accurate interpretation (see Appelhans & Luecken, 2006; Porges, 2007) as this enables separation of sympathetic and parasympathetic influences on the heart. However, due to movement artefacts in the ECG signal that could not be corrected, it was not possible to conduct HRV analyses in the present study.

In summary, the data presented in this chapter provides further correlational evidence for the link between mind wandering and reduced positive affect. However, due to an unsuccessful mind wandering manipulation, this study was largely unable to test the causal hypothesis that mind wandering drives reduced positive affect. A logical next step for subsequent chapters in this thesis is to improve on the mind wandering manipulation procedure used to again test if mind wandering is a causal mechanism underlying anhedonia. Suggestions for improvements have been discussed, including the use of a longer training procedure and manipulating mind wandering as participants complete the positive induction. Limitations of the use of autobiographical memory recall as a mood induction procedure have also been discussed with this task perhaps too short and cognitively demanding to allow for mind wandering to occur. Furthermore, this mood induction has limited ecological validity and so it would be interesting to look at the role of mind wandering in the context of a real world task. Finally, the present study only examined the potential impact of mind wandering on emotional reactivity. Subsequent chapters of this thesis would benefit from accounting for the dynamics of positive affect by measuring change in affect over several time points.

# Chapter 6: Study 4 – The effect on emotional experience of an ESM manipulation of mind wandering

## 6.1 Introduction

Study 3 of this thesis provided further correlational evidence for the link between mind wandering and positive affect disturbances. However, the core aim of study 3 was to test a causal link between mind wandering and positive affect disturbances. Due to an unsuccessful mind wandering manipulation this causal hypothesis could not be tested. Therefore, the aim of the present study 4 is to improve on the mind wandering manipulation used in study 3. An improved mind wandering manipulation will help to further examine the causal hypothesis that mind wandering drives positive affect disturbances.

### *6.1.1 The present study*

The present study aims to examine the affective consequences of differing levels of mind wandering. Specifically, the study will investigate how mind wandering drives emotional reactivity to naturalistic positive events through the use of event scheduling methodology (ESM). ESM allows for participants to complete more ecologically valid activities in their own natural environments, and is reflective of tasks individuals are asked to complete in therapies for depression (e.g., Behavioural Activation; Lewinsohn & Graf, 1973).

As in study 3, the present study has three experimental conditions. The first condition (MW-) will attempt to experimentally decrease levels of mind wandering, the second condition (MW+) will attempt to experimentally increase levels of mind wandering and these two conditions will be compared to a control condition where mind wandering will not be manipulated.

The mind wandering manipulation used in the present study will be improved in a number of ways. Firstly, the manipulation will be of a longer duration taking place daily over the course of seven days. During this period participants will be asked to complete a total of seven positive activities, each lasting 20 minutes. It is intended that regular practices each day in between uninstructed activities will result in a successful manipulation. The first positive activity will be termed ‘uninstructed’ where levels of mind wandering will not be manipulated. This first activity will allow for correlational analysis between spontaneous levels of mind wandering and emotional reactivity. Participants will then be asked to complete five ‘instructed’ positive activities during which their level of mind wandering will be manipulated. Participants will then complete a final ‘uninstructed’ activity on the seventh day. This study design allows us to examine impact on emotional reactivity during the manipulation (i.e. activities 2 to 6) and also its transfer to uninstructed activities (i.e. comparing activities 1 and 7). The benefits of studying transfer effects (i.e. how systematic practice changes emotional reactivity during the practice and then subsequently when not following the practice) will help to inform improvements to psychological therapies. For example, if mind wandering is found to be a mechanism causing disturbances in positive affect then techniques equivalent to those used in a MW- experimental condition could be used in the treatment of anhedonic clients. However, of most use are techniques that can be learnt and then transferred to multiple domains. The use of a specially developed smartphone application will enable participants’ data to be time stamped to check for compliance to the study.

A further improvement to the design in the present study is that mind wandering will be manipulated as participants complete the positive activities (as opposed to beforehand in study 3). Furthermore, all participants will be asked to engage in the same positive activity; a pleasant walk. This decision to not allow the participant to choose their own positive activities (which would be most reflective of clinical practice) stemmed from a key discussion point raised in study 2 (see section 4.6). The core aim of this thesis is to investigate the potential causal role of mind wandering in the inability to experience pleasure. To fully answer this question it is necessary to engage participants in activities where their minds have the ability to wander. As discussed in study 2, participants engaging in activities that demand high cognitive load are likely to not mind wander during the relatively short measurement time of 20 minutes. The additional benefit of participants completing the same activity is that it allows for true comparisons across conditions, with minimal confounds.

Mind wandering in the present study will be measured using thought probes before, immediately after, and five minutes after each pleasant walk. Probes will also include questions regarding momentary affect to account for the dynamic nature of emotions (Davidson, 1988). Further advancing the design of the present study, momentary affect during the pleasant walks will be measured using 14 different questions (as opposed to just happiness and composite negative emotions in studies 2 and 3) creating factors of positive affect (PA) and negative affect (NA) (following Geschwind et al., 2011). This broader range of mood ratings was included to more accurately measure changes in positive/negative emotions as participants complete the positive walks. Furthermore, a simple happiness rating might not be sensitive to changes in both high and low arousal positive affect (cf. Gilbert et al., 2008) and therefore it is better to have a range of items capturing this distinction.

## 6.2 Study design

This study used a mixed within and between-subjects design. Mind wandering was manipulated between-subjects with participants randomly allocated to one of three conditions (MW+, MW- and Control). The dependent variable was the within-subjects change in emotional reactivity from pre to post mind wandering manipulation. Change in emotional reactivity to the first uninstructed walk (pre-manipulation) was compared to change in emotional reactivity to second uninstructed walk (post-manipulation). In addition to this, emotional experience during the instructed walks was compared between conditions. The overall design of this study is depicted in Figure 6.1.

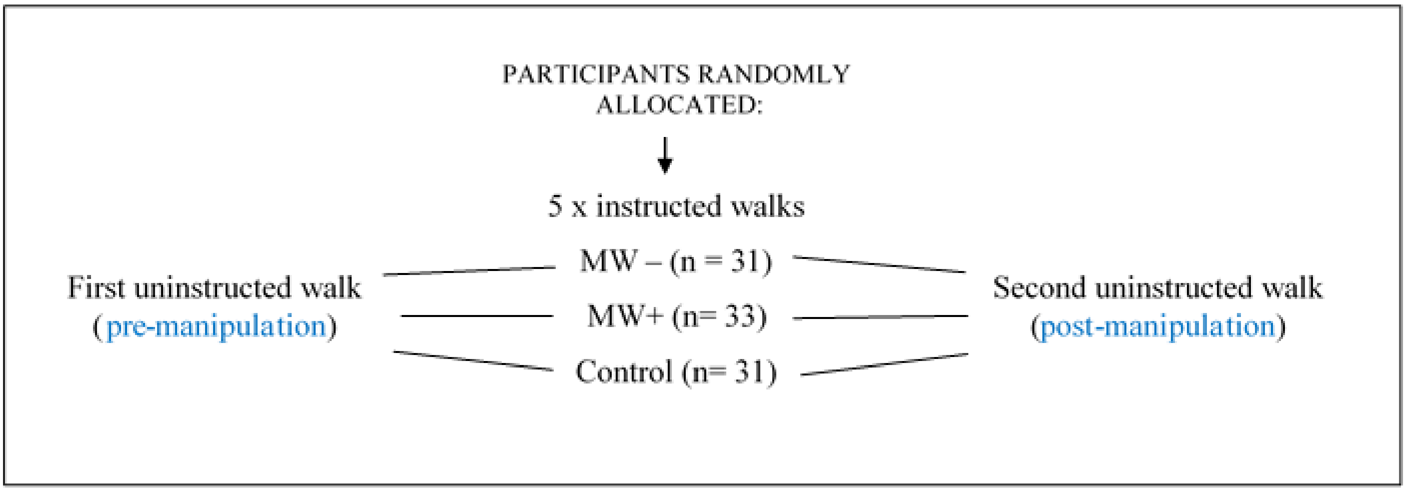



*Figure 6.1.* A diagram depicting the mixed- within design of study 4.

## 6.3 Hypotheses

1. Participants allocated to MW+ condition will report a greater increase in mind wandering from uninstructed walk 1 to uninstructed walk 2, relative to the control condition. In contrast, those allocated to MW- condition will report a greater decrease in mind wandering from uninstructed walk 1 to uninstructed walk 2, relative to the control condition.
2. Higher levels of mind wandering during uninstructed walk 1 will correlate with a less marked increase in PA and a less marked decrease in NA. In addition, higher trait levels of mind wandering (measured using the FFMQ-AA) will correlate with a less marked increase in PA and less marked decrease in NA during walk 1.
3. Participants allocated to the MW+ condition will report a greater decrease in levels of PA from uninstructed walk 1 to uninstructed walk 2, relative to the control condition. Participants allocated to the MW- condition will report a greater increase in levels of PA from uninstructed walk 1 to uninstructed walk 2, relative to the control condition.
4. Participants allocated to the MW+ condition will report greater increase in levels of NA from uninstructed walk 1 to uninstructed walk 2, relative to the control condition. Participants allocated to the MW- condition will report a greater decrease in levels of NA from uninstructed walk 1 to uninstructed walk 2, relative to the control condition.
5. During the *instructed* walks there will be condition differences in PA and NA, with MW+ participants reporting reduced PA change/ increased NA change relative to the control condition and MW- participants reporting increased PA change/decreased NA change relative to the control condition.

## 6.4 Methods

### ***6.4.1 Participants***

Participants were undergraduate students from the University of Exeter and members of the local community in Exeter, recruited through convenience sampling via emails and poster advertisements. This resulted in a sample of 95 (75 females), aged 17-60 years (M = 21.50, SD = 6.56). 52 participants (55%) were of White British ethnic origin. All participants gave written, informed consent and the study was approved by the psychology department ethics committee (see Appendix 11). As remuneration, participants received £10 or four course credits for a psychology research methods module.

### *6.4.2 Measures*

*The Beck Depression Inventory – Second Edition* (BDI-II; Beck, Steer & Brown, 1996) was as described in studies 1b, 2 and 3. The BDI-II was used as a randomisation check measure to ensure conditions did not differ in terms of depressive severity during the past two weeks. In this sample the BDI-II had excellent reliability (Cronbach's α = .93), however scores were positively skewed with limited spread. 73.8% of participants presented with minimal depression (0-13), 13.8% with mild depression (14-19), 6.3% with moderate depression (20-28) and 6.3% with severe depression (29-63). This study is therefore potentially limited by range restriction effects.

The 'acting with awareness' facet of the *Five Facet Mindfulness Questionnaire* (FFMQ-AA; Baer et al., 2006) was as described in all previous studies in this thesis. This subscale was used as a measure of trait mind wandering. In this sample the acting with awareness facet had good reliability (Cronbach's α = .81).

#### *6.4.2.1 Mind wandering manipulation event scheduling*

An event scheduling method was used to assess how a change in mind wandering affects participant's emotional reactivity to positive events in the real world. An Android application was developed so that time stamped data could be collected regarding emotional reactivity and levels of mind wandering as participants completed the pleasant walks.

In total, participants were asked to complete seven walks spaced across the period of a week. Participants completed two 'uninstructed' walks, one immediately following the first study appointment (walk one) and the other following the second study appointment scheduled seven days later (walk seven). Participants completed five walks in their own time (one walk per day) between the two appointments (walks two, three, four, five and six). These walks were termed 'instructed' and during these walks is where the mind wandering manipulation took place. Participants randomly allocated to the MW- and MW+ conditions were asked to listen to an audio exercise through headphones as they completed the instructed walks and follow the spoken instructions carefully. The audio exercises began by informing participants of the purpose of the current walk. In the MW- condition, participants were asked to complete the walk, '*with your full attention, focusing on your experience as it unfolds moment by moment.*' In contrast, participants in the MW+ condition were informed that, '*Our minds show a tendency to drift to thoughts and images that are away from the here and now.*

*Whilst you complete this walk you should allow yourself to go along with any thoughts or images that you might have and just allow your mind to wander.*' In order to minimise disruption to the walk, participants in the manipulation conditions were given audio prompts only every four minutes. An example prompt in the MW- condition was, '*remember that when your attention does wander, as it probably will, to bring it back to what is happening right now, in this moment'* whereas in the MW+ condition, '*remember that when your attention does wander, as it probably will, to let yourself freely follow it*' (for full audio transcripts see Appendix 12). Participants randomly allocated to the control condition were not asked to listen to an audio exercise and all walks were completed without instructions.

During the first lab appointment, participants were asked to give a time that they could complete the walks over the five days following the first study appointment which was then programmed into a smartphone (HTC Desire C or Huawei Ascend Y330). The application worked by alarming 15 minutes prior to each programmed start time to give the participant time to prepare for the upcoming walk. The application also included a postpone function of 30 minutes to provide participants with some flexibility. This postpone button could only be pressed twice to ensure participants completed all walks. To encourage pleasant walks, the experimenter expressed that, '*the aim of these walks is for you to have 20 minutes each day for some time-out by yourself, getting some fresh air and light exercise. We would like you to choose to walk somewhere pleasant such as by the river, in a park or on the university campus.'*

As in study 2, participants were asked to rate their affective experience via the smartphone app before (set point) and immediately after the walk (reactivity). PA and NA were measured on 14 rating scales (following Geschwind et al., 2011), with seven PA items (happy, satisfied, cheerful, enthusiastic, strong, curious, animated) and seven NA items (anxious, lonely, guilty, down, suspicious, disappointed, insecure). Each affect item was rated using 100 point visual analogue scales from 0 (not at all) to 100 (extremely). Participants were also asked to rate their level of mind wandering at set-point, reactivity and regulation for each walk. Participants were asked, "*To what degree over the past 5 minutes/during the walk did you think about something other than what you are currently doing?*" which was rated on a visual analogue scale from 0 ("I was concentrated fully on what I was doing") to 100 ("my mind has wandered frequently to thoughts other than what I am currently doing"). As in study 2, this continuous measure of mind wandering was used in order to sensitively assess the frequency of mind wandering.

### 6.4.3 ***Procedure***

Participants attended two appointments spaced seven days apart in a quiet testing room at the University of Exeter psychology building. The first appointment was one hour in duration and the second appointment was 45 minutes. At the start of the first appointment participants read an information sheet and gave written, informed consent. A brief interview was carried out to collect demographic information from participants. Participants then completed the BDI-II online using Limesurvey (Carsten Schmitz, 2012). As in previous studies, responses to these questionnaires were carefully monitored and the risk protocol/distress management procedure was carried out if necessary (see Chapter 2). Participants then planned the five walks they would complete in between study appointments and these times were programmed into the smartphone app. As a reminder, participants were given a timetable of walks to take home with them, including details about location and time of each walk. Participants then completed the first uninstructed walk, completing questions on the smartphone app. Participants were sent a set of questionnaires to complete in their own time at home, including the FFMQ-AA and other questionnaires that will not be analysed further. Participants returned seven days later for the second lab appointment and completed the second uninstructed walk. Finally, participants returned the smartphone to the laboratory and were verbally debriefed. A summary of the procedure used in this study is depicted in Figure 6.2.

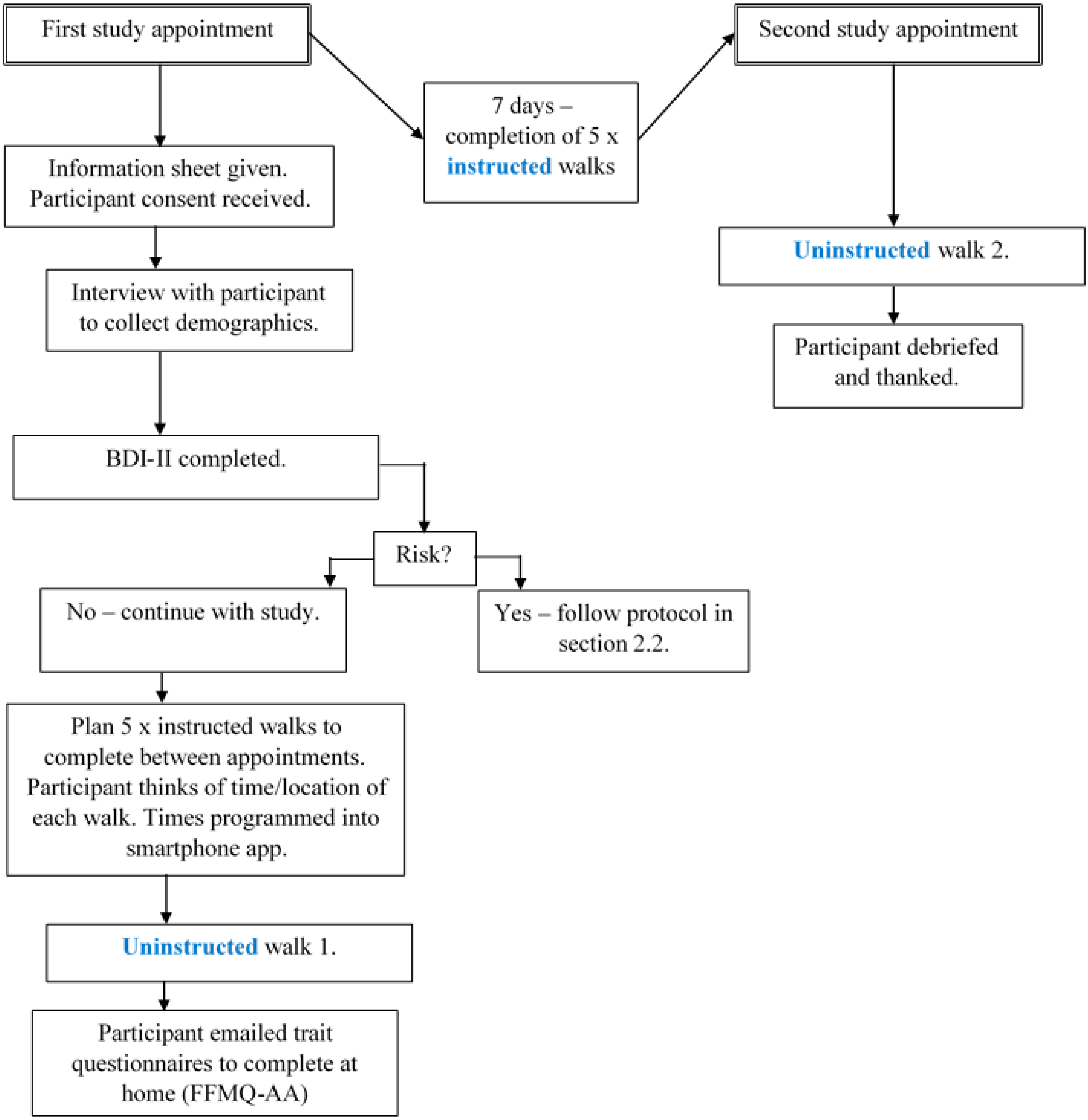



*Figure 6.2.* Procedure for study 4.

### 6.4.4 ***Data Analysis strategy***

Statistical analyses were carried out on the computer using SPSS version 21. The following tests were employed: one-way ANOVA, Kruskal-Wallis test, Chi-square test, paired t-tests, correlations and mixed measures ANOVA. Alpha was set to .05. Prior to all analyses, data was inspected for missing values, outliers and violations of the normality assumption. Where no violations were found, parametric statistics were conducted. Any violations and data transformations are described in the text. As previously in this thesis, emotional reactivity to the walks was measured using residual change scores for PA and NA, as they hold baseline emotional reactivity constant (see Allison, 1990). These residual changes scores in emotional reactivity were correlated with an absolute level of mind wandering measured immediately post-activity. This absolute measure of mind wandering was chosen instead of a residual change score as it was decided to be the most reflective measure of level of mind wandering during each activity. To ensure participants had an adequate dose of the manipulation, participants that failed to successfully complete at least three instructed walks were excluded from all analyses as two walks was considered not sufficient for creating a successful mind wandering manipulation. The remaining sample size was therefore N= 80 (27 participants in MW+, 27 participants in MW-, 26 participants in control).

## 6.5 Results

### *6.5.1* ***Randomisation check***

First, analyses were conducted to ensure that participants in the three conditions did not significantly differ from one another on core variables. The BDI-II displayed positive skew and so was log transformed prior to analysis. For normally distributed continuous variables (log transformed BDI-II, FFMQ-AA) a one-way ANOVA was conducted, with condition entered as the independent variable. Age was not normally distributed and was unable to be transformed and therefore the non-parametric Kruskal-Wallis test was conducted for this variable. Categorical variables (Gender, Ethnicity) were analysed using the Chi-square test. Results of these analyses are displayed in Table 6.1. There were no significant group differences on any core variables, Ps> .10.

*Table 6.1.* Means (and Standard Deviations) of key variables and outputs from statistical tests comparing these variables across conditions (N=80)

| Variable | | Mean (SD) | | | Test statistic |
|---|---|---|---|---|---|
| | | MW+ (n=27) | MW- (n=27) | Control (n=26) | |
| Age | | 22.22 (6.05) | 22.52 (9.46) | 20.19 (4.74) | *H*(2) = 4.61, *p* = .10 |
| BDI-II | | 9.56 (10.09) | 9.30 (5.43) | 10.89 (10.00) | F<1 |
| FFMQ-AA | | 25.83 (5.65) | 24.84 (4.41) | 24.04 (5.23) | F<1 |
| Gender | Male | 6 | 4 | 6 | $\chi^2$<1 |
| | Female | 21 | 23 | 20 | |
| Ethnicity | White British | 16 | 16 | 13 | $\chi^2$<1 |
| | Other | 11 | 11 | 13 | |

*Note*- BDI-II = Beck Depression Inventory second edition. FFMQ-AA = the acting with awareness subscale of the Five Facet Mindfulness Questionnaire.

### ***6.5.2 Manipulation checks***

#### ***6.5.2.1 Positive event check***

In order to establish if the pleasant walks used in this study were a successful positive mood induction (i.e. by increasing PA and decreasing NA), paired samples t-tests were conducted to compare averaged PA and NA before and after all seven walks (collapsing across all three conditions). Results revealed a significant increase in PA from before ($M$ = 43.85, $SD$ = 12.26) to after ($M$ = 48.62, $SD$ = 12.54) all walks, $t(79) = -5.47$, $p < .001$. There was also a significant reduction in NA from before ($M$ = 17.35, $SD$ = 12.30) and after ($M$ = 14.18, $SD$ = 11.52) all walks, $t(79) = 5.52$, $p < .001$. Therefore, results revealed that the pleasant walks had the intended effects on both levels of PA and levels of NA across participants.

#### ***6.5.2.2 Mind wandering manipulation check***

The next manipulation check was conducted to test H1 and see if the manipulation of levels of mind wandering was effective. Table 6.2 reports raw values of levels of mind wandering during the each of the seven walks.

*Table 6.2.* Mind wandering frequency across conditions **during the two uninstructed walks (walk 1 and 7)** and **during the five instructed walks (walks 2-6)**

| Condition | Mean (SD) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Uninstructed walk 1 | Instructed walk 2 | Instructed walk 3 | Instructed walk 4 | Instructed walk 5 | Instructed walk 6 | Uninstructed walk 7 |
| MW+ | 50.15 (22.96) | 69.93 (23.07) | 68.31 (21.24) | 57.32 (20.19) | 62.81 (25.18) | 63.13 (21.90) | 63.62 (22.92) |
| MW- | 57.48 (23.57) | 53.50 (20.85) | 42.15 (23.33) | 43.48 (19.67) | 38.73 (19.87) | 41.00 (23.93) | 45.96 (22.80) |
| Control | 45.85 (27.09) | 55.31 (29.91) | 40.96 (25.70) | 35.44 (27.67) | 43.67 (28.12) | 42.77 (31.84) | 41.72 (28.29) |

*Note*- Mind wandering frequency was measured on a scale of 0 (Not at all) – 100 (Extremely).

To test whether condition effectively influenced mind wandering frequency from the first uninstructed walk to the second uninstructed walk, a mixed measures ANOVA was conducted with condition (MW+, MW-, Control) as the between-subjects factor and frequency of mind wandering during the first uninstructed walk and second uninstructed walk as the within-subjects factor. Results revealed a non-significant main effect of time, $F<1$, and a trend main effect of condition, $F(2, 75) = 2.81$, $p = .07$, which were qualified by a significant time by condition interaction, $F(2,75) = 5.72$, $p = .01$. To resolve this interaction the difference in mind wandering frequency between activity 1 and activity 7 was computed and compared between conditions using a one-way ANOVA. Results revealed a greater decrease in mind wandering in the MW- condition relative to the MW+ condition, $p = .001$, greater increase in mind wandering in the MW+ condition relative to the control condition, $p = .03$, but no significant difference in mind wandering change between the MW- and control condition, $p = .33$. This therefore provides support for H1 and demonstrates that the mind wandering manipulation was largely successful.

To test if mind wandering levels differed during between conditions during the instructed walks only, a one-way ANOVA was also conducted. Results revealed a significant condition difference, $F(2, 79) = 9.67$, $p < .001$. Pairwise comparisons demonstrated that levels of mind wandering during the instructed walks were significantly higher in the MW+ condition compared to both the MW-, $p < .001$ and control condition, $p = .001$. Although, levels of mind wandering during the instructed walks were lowest in the MW- condition, levels were not statistically different to those in the control condition, $p = .85$.

### 6.5.3 ***Spontaneous correlational analysis***

H2 stated that higher levels of mind wandering during the first uninstructed walk will correlate with a less marked increase in PA and a less marked decrease in NA. Results found that increased mind wandering trend correlated with less marked PA, ($r$ = -.22, $p$ = .054) and significantly correlated with a less marked decrease in NA, ($r$ = .24, $p$ = .04), revealing partial support for H2. Contrary to that predicted by H2, increased trait mind wandering (lower FFMQ-AA scores) did not significant correlate with either PA change ($r$ = -.12, $p$ = .30) or NA change ($r$ = .14, $p$ = .22) to the first uninstructed walk.

### *6.5.4* ***Mind wandering manipulation analysis***

First, to establish that participant's emotional reactivity did not differ between conditions during uninstructed walk one, a randomisation check was conducted. Both residual change in PA and residual change in NA to walk one were normally distributed and so a one-way ANOVA was conducted. Results of this randomisation check are displayed in Table 6.3. There were no significant differences in either residual PA or residual NA change to the first uninstructed walk, Ps≥ .24, and so groups were comparable at baseline in terms of their emotional reactivity to the pleasant walks.

*Table 6.3.* PA and NA before and during **uninstructed walk one** with outputs from One-way ANOVA test comparing residual change scores across three conditions (MW+, MW-, Control).

| Variable | | Mean (SD) | | | Test Statistic |
|---|---|---|---|---|---|
| | | MW+ (n=27) | MW- (n=27) | Control (n=26) | |
| PA | Before | 53.01 (16.79) | 62.24 (13.10) | 54.79 (16.13) | $F(2, 79) = 1.45$, $p = .24$ |
| | During | 51.93 (16.19) | 58.71 (14.85) | 58.00 (15.31) | |
| NA | Before | 14.87 (14.00) | 12.92 (11.15) | 14.26 (14.34) | F<1 |
| | During | 11.84 (11.48) | 11.06 (8.62) | 12.14 (14.51) | |

*Note* – Mean values are displayed with standard deviations in parentheses. One-way ANOVA conducted on residual change scores. PA = an average of happy, satisfied, cheerful, enthusiastic, strong, curious, animated (0-100). NA = an average of anxious, lonely, guilty, down, suspicious, disappointed, insecure (0-100).

#### *6.5.4.1 Effect of manipulation on PA and NA emotional reactivity*

To test H3 and H4, that the mind wandering manipulation would change emotional reactivity, PA and NA residual change scores were also calculated for the second uninstructed walk. A 2x3 mixed measures ANOVA was conducted for residual PA and residual NA separately. Time (uninstructed walk one, uninstructed walk two) was the within-subjects factor and condition (MW+, MW- and control) was the between-subjects factor[6].

For residual PA change there was no significant main effect of condition, F<1, and no significant time by condition interaction, F<1. The effect of the mind wandering manipulation on residual PA change can be seen in Figure 6.3. Inconsistent with H3, this reveals there was no significant difference in PA reactivity (from uninstructed walk one to uninstructed walk two) across the three conditions.

For residual NA change there was no significant main effect of condition, F<1, and no significant time by condition interaction, $F(2, 75) = 1.28$, $p = .29$. The effect of the mind wandering manipulation on residual NA change can be seen in Figure 6.4. Once again, inconsistent with H4, there was no significant difference in NA reactivity (from uninstructed walk one to uninstructed walk two) across the three conditions.

[6] Due to the use of residual change variables in the analysis, the main effect of time will not be reported. This is due to residual change variables having a mean of zero and therefore F equals zero and *p* equals one in these analyses.

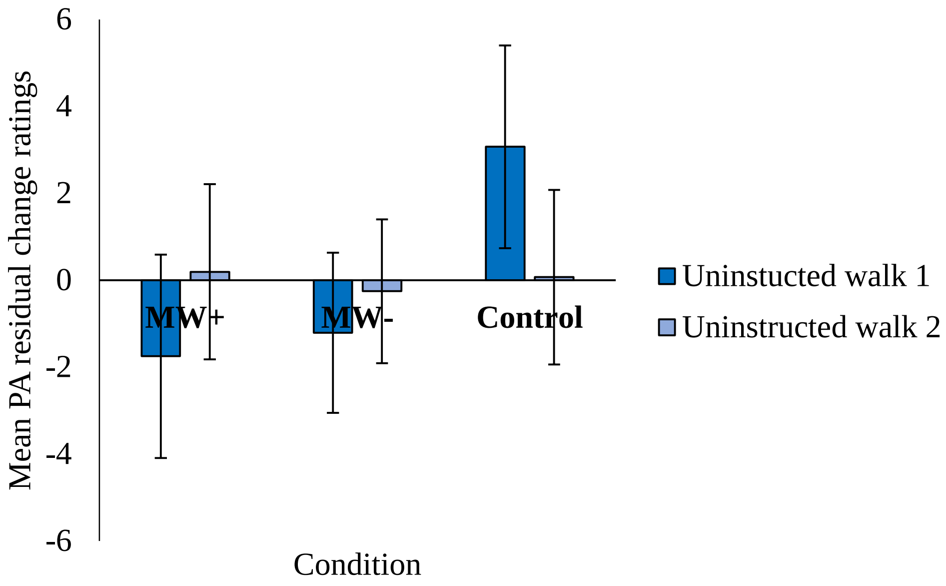



*Figure 6.3.* Graph of the interaction between condition and residual PA change scores for uninstructed walk one and uninstructed walk two. Errors bars are +/- 1 standard error of the mean.

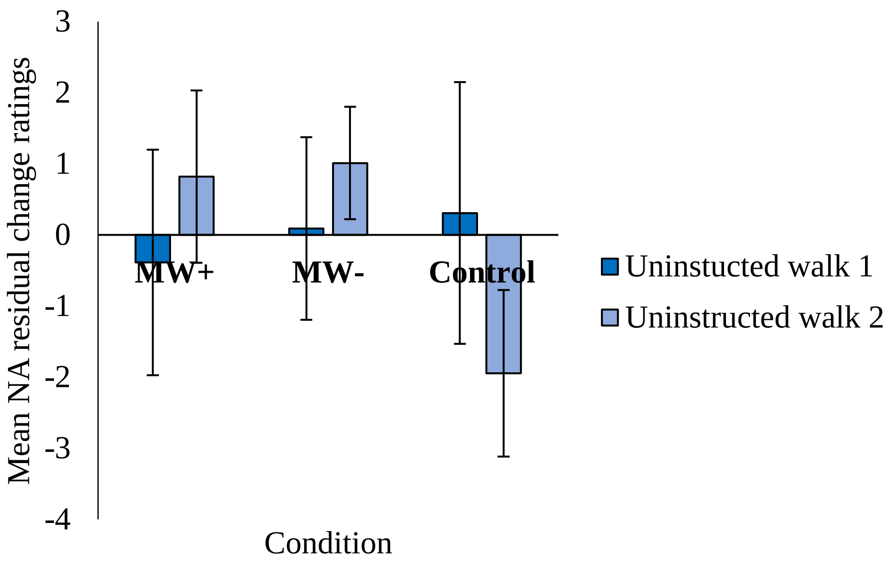



*Figure 6.4.* Graph of the interaction between condition and residual NA change scores for uninstructed walk one and uninstructed walk two. Errors bars are +/- 1 standard error of the mean.

#### *6.5.4.2 Between-condition differences in emotional reactivity during instructed walks*

To test H5, that there will be between condition differences in PA and NA change during the instructed activities (walks 2-6), average residual PA change and average NA change variables were computed. Averaged residual PA change during the instructed walks was normally distributed and so conditions were compared using a one-way ANOVA. The effect of condition on averaged residual PA change during the instructed walks is displayed in Figure 6.5. Results revealed no significant condition difference in residual PA change during the instructed walks, F<1, providing no support for H5. Averaged residual NA change during the instructed walks was also normally distributed and so conditions were once again compared using a one-way ANOVA. The effect of condition on averaged residual NA change during the instructed walks is displayed in Figure 6.6. Results revealed no significant condition difference in residual NA change during the instructed walks, F<1 also providing no support for H5.

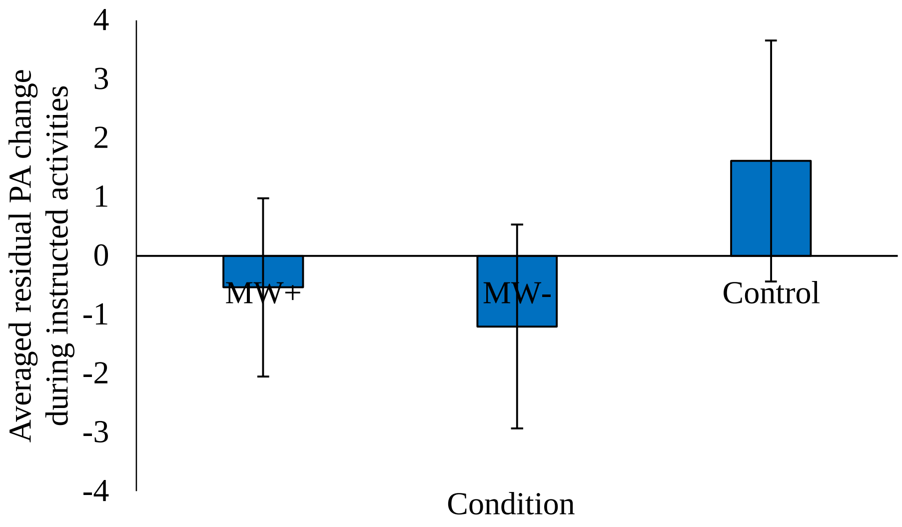



*Figure 6.5.* Graph of the effect of condition on average residual PA change during instructed activities (walks 2-6). Errors bars are +/- 1 standard error of the mean.

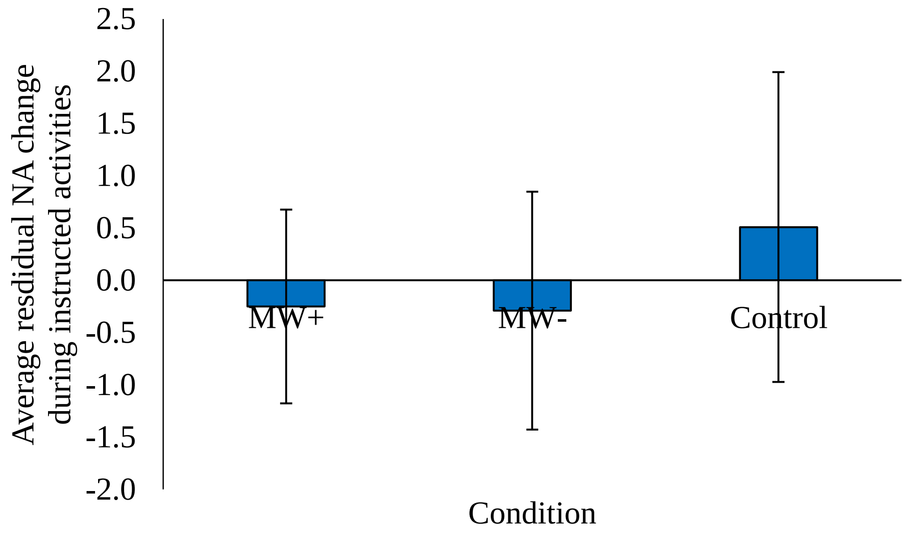



*Figure 6.6.* Graph of the effect of condition on average residual NA change during instructed activities (walks 2-6). Errors bars are +/- 1 standard error of the mean.

### *6.5.5 Supplementary analysis*

#### *6.5.5.1 Within-condition correlations*

As in study 3, an additional method of investigating whether mind wandering relates to PA and NA change is to conduct correlations *within* separate conditions. Selecting each condition separately, correlations were conducted between residual change in mind wandering from walk 1 to walk 7 and residual change in PA/NA from walk 1 to walk 7. Residual change in NA was not normally distributed and unable to be transformed and so Spearman's correlations were conducted for all analyses. Within the MW+ condition (n=27), there was a significant inverse correlation between change in mind wandering frequency and residual PA change ($r_s$ = -.43, $p$ = .03) and a significant positive correlation with residual NA change ($r_s$ = .43, $p$ = .03). Therefore, the more mind wandering increased from walk 1 to walk 7 the less PA increased and more NA increased, thus providing correlational support for the link between mind wandering and emotional disturbances. Within the MW- condition (n=27) there were no significant correlations between change in mind wandering and either PA change ($r_s$ = -.17, $p$ = .41) or NA change ($r_s$ = -.04, $p$ = .86). In the control condition (n=26), there was a significant inverse correlation between change in mind wandering and PA change

($r_s$ = -.43, $p$ = .03) but only a trend correlation with NA change ($r_s$ = .36, $p$ = .07). Thus again, greater increase in mind wandering was related to less change in PA and trend related to greater change in NA.[7]

## 6.6 Discussion

Study 4 of this thesis improved the mind wandering manipulation procedure used in study 3 to further test the causal relationship between mind wandering and positive affect disturbances. The aim of the study was to explore how differing levels of mind wandering influenced emotional experience during the completion of real-world positive events (n = 80).

Results of the manipulation check revealed a largely successful mind wandering manipulation in this study. There was a greater increase in mind wandering from the first to the second uninstructed walk in the MW+ condition relative to the control group, a decrease in mind wandering from the first to the second walk in the MW- condition relative to MW+ condition but no significantly difference in mind wandering change between MW- and control conditions. Analysis of mind wandering frequency during the instructed walks only corroborated this as mind wandering was significantly higher during these walks in the MW+ condition relative to MW- and control conditions, but not significantly lower in the MW- condition relative to the control condition. Sample sizes in this study were relatively small (n = 26 in the control group) and so it is possible that these analyses are underpowered. Participants in the MW- condition did show a greater decrease in mind wandering relative to control participants (although not a statistically significant difference). Consequently there is majority support for H1 and this study has therefore established a successful paradigm for manipulating levels of mind wandering which could be used in future research studies.

The first uninstructed walk also allows for correlations between spontaneous levels of mind wandering and emotional reactivity. In partial support of H2, greater mind wandering during this walk trend correlated with reduced residual PA change and significantly correlated with increased residual NA change. This therefore provides tentative correlational evidence for the link between mind wandering and emotional disturbances. However, trait mind wandering (using the FFMQ-AA) did not significantly correlate with either residual PA or residual NA change to the first uninstructed walk.

[7] All analyses in study 4 were repeated on simple difference change scores and the same pattern of results emerged.

This study provided no causal evidence for the role of mind wandering and emotional disturbances, thus providing no support for H3 or H4. Results revealed no significant differences in either PA reactivity or NA reactivity (from uninstructed walk one to uninstructed walk two) across the three experimental conditions. Further to this, there was no support for H5 as results revealed no condition differences in averaged residual PA or NA change during the instructed activities (walks 2-6). These null findings are consistent with results obtained in study 3.

However, within-condition correlations between change in mind wandering and change in PA/NA from walk 1-7 did reveal further correlational support. Analysis of participants in both MW+ and control conditions demonstrated a significant inverse correlation between change in mind wandering and change in PA. This shows that the more mind wandering increased from walk 1 to walk 7 in these conditions, the less PA increased. Furthermore, there was a significant positive correlation in the MW+ condition and trend positive correlation in the control condition between change in mind wandering and change in NA. This indicated that the more mind wandering increased from walk 1 to walk 7 in these conditions, the more NA increased. Unexpectedly, there were no significant correlations between change in mind wandering and change in PA/NA in the MW- condition. The use of MW- prompts in this study was not successful (as the MW- condition did not reduce levels of mind wandering relative to the control condition). In contrast, the MW+ manipulation was successful as the MW+ condition significantly increased levels of mind wandering relative to the control condition. This supports recent research by Banks, Welhaf & Srour (2015) who found that one week of meditation training was insufficient to reduce levels of mind wandering. In contrast, the results of this study go against that by Mrazek, Smallwood & Schooler (2012) who reported a reduction in mind wandering after meditation training. The unsuccessful MW- manipulation in this study is surprising given that participants were asked to complete regular activities each day and mind wandering during walk 7 was measured in a context similar to that of the training walks. This suggests the mind wandering manipulation could be further improved, perhaps with the addition of group meetings with a trained meditation instructor (as in Mrazek et al., 2013; Morrison et al., 2013) to more closely mimic procedures used in mindfulness based interventions. To our knowledge this is the first study to successfully experimentally increase levels of mind wandering in a naturalistic environment away from the laboratory.

Despite a partially successful mind wandering manipulation in the present study results revealed no condition differences in residual PA or NA reactivity to the activities. This null finding could be due to two reasons. Firstly, this could suggest that mind wandering is not causally related to emotional disturbances. If this were to be the case, it is likely that targeting mind wandering in anhedonic clients will make little difference to treatment outcomes. However, these null findings might simply be the result of methodological issues in the present study. Although longer, the manipulation used still might not have been long enough to change emotional experiences. For example, rather than relatively brief instruction over the period of seven days, perhaps longer term practice is required to have a larger impact on levels of mind wandering. A true test of this causal hypothesis would be to examine changes in mind wandering and positive affect after completion of a full evidence-based mindfulness intervention such as Mindfulness Based Cognitive Therapy (MBCT; Segal, Williams & Teasdale, 2002) for depression.

Regardless of a lack of support for H3 and H4, spontaneous correlations revealed trend correlational support for the link between increased mind wandering during uninstructed walk one and reduced residual PA reactivity. This correlational evidence (albeit fairly weak in the present study) is in line with previous studies (studies 1a, 1b, 2 and 3) and a growing body of literature showing that elevated levels of mind wandering are related to reduced positive affect (e.g., Killingsworth & Gilbert, 2010; Brown & Ryan, 2003; Atanes et al., 2015).

There are a few limitations to the present study which should be carefully considered. First, it could be debated that the following of the MW+ instructions is an ‘activity’ in itself and therefore a participant that follows these instructions is perhaps not mind wandering but is instead concentrated on their ongoing task. For example the definition of mind wandering is, “a shift in contents of thoughts away from an ongoing task” (Smallwood & Schooler, 2015) and therefore mind wandering in this experimental condition might not be classified as ‘true’ mind wandering. Second, although intending to minimise potential confounds by asking participants to complete the same positive activity, there were still some confounds that were not controlled. For example, variables such as the weather and location of the walk could have affected the overall enjoyment of each walk. Attempts were made by the researcher to reduce the impact of these confounding variables. The implementation of a postpone function allowed participants to delay the walk due to bad weather if needed. Furthermore, participants were advised to choose pleasant walks such as on the university campus, in a park or by the river. An extra consideration here is whether allowing participants to choose when to carry out the scheduled walk (as opposed to needing to forward plan with the experimenter) might have made these walks more enjoyable for participants. Allowing participants to choose and then to trigger the ratings themselves would make the activities more self-determined and therefore more reflective of real life. This is an important consideration for future event scheduling designs. In addition, this study asked participants to rate their emotional experience immediately before each walk (set point) and immediately after each walk (reactivity). As in Study 3, this design decision was made to measure PA and NA after completion of the walks in order to minimise disruption to the audio instructions and for participants to feel less monitored. However, future research might benefit from including in-activity ratings of PA and NA instead of retrospective ratings in order to more sensitively assess changes in emotional experience.  Another limitation was the use of a majority student sample. Students were recruited into the present study to allow for a large sample size and because it is known that students regularly experience mind wandering (Lindquist & McLean, 2011; Wilson & Korn, 2007). This sample is therefore not generalisable to anhedonic clients and future research would benefit from utilising a more representative sample. A final limitation is in the use of event scheduling methodology. A benefit of event scheduling methodology is that it permits researchers to study emotional reactivity to specific events in naturalistic settings. However, for psychological phenomena such as mind wandering, event scheduling might not be the ideal methodology. As reported, mind wandering happens regularly throughout our waking hours (Killingsworth & Gilbert, 2010), however despite this it might not occur during the short measurement periods used in event-contingent sampling. To illustrate, mind wandering might be more likely to occur during mundane tasks of daily living rather than when completing engaging positive mood inductions (either in the laboratory or when going on a nice walk). Thus, to fully encapsulate the occurrence of mind wandering a procedure known as Experience Sampling Methodology may be preferred (for a full comparison of Event Scheduling and Experience Sampling see section 2.5).

In summary, the present study provides no causal support for the link between mind wandering and positive emotional disturbances. Despite improving on the mind wandering manipulation in this study, mind wandering had little impact on emotional experiences. The use of an interactive and empirically tested training design in the form of a mindfulness based intervention is likely to produce reliable mind wandering change. It would also be beneficial to study the role of mind wandering on positive affect during everyday life (as opposed to during relatively artificial positive mood inductions) and on a more representative sample. This will be the focus of the final empirical study in this thesis.

# Chapter 7: Study 5 – Investigating if reductions in mind wandering mediate the effects of Mindfulness Based Cognitive Therapy on positive affect

## 7.1 Introduction

The two previous empirical chapters have found that two manipulations of mind wandering have no significant impact on positive affect experience in unselected samples. However, there are a number of issues with both of these studies that mean it is premature to accept the null hypothesis on the basis of this data.

First, in both studies relatively brief mind wandering manipulations were used which either did not work (study 3) or had a small impact on levels of mind wandering (study 4). Therefore, an interactive and empirically tested training design in the form of a formal mindfulness based intervention will increase chances of reliable mind wandering change. Second, the sample used in both previous studies were non-clinical student samples and so a sample with a broad range of depression symptoms will ensure the effect of mind wandering is being studied in a representative sample. Third, previous manipulation studies in this thesis have measured positive affect upon completion of relatively artificial paradigms. For example, in study 3 participants completed a short positive memory recall exercise and in study 4 participants were asked to complete a pleasant walk whilst following prompts on a smartphone application. It could be argued that neither of these paradigms are reflective of typical daily experiences. Fourth, due to the type of positive mood inductions used and use of an event scheduling design, positive affect has so far been measured during relatively narrow temporal windows and there is a limited opportunity for mind wandering to occur. Due to the internal, subtle nature of mind wandering (rendering it difficult to manipulate), research will benefit from studying how mind wandering relates to affect during everyday life and not just reactivity to positive scheduled events. Finally, the previous two manipulation studies measured positive affect and mind wandering in uni-dimensional ways. It would be beneficial to measure positive affect using a combination of standardised questionnaires as well as emotional reactivity to positive stimuli and affect experience during everyday life. In the same way, measures of mind wandering can be triangulated with the inclusion of self-report trait measures, behavioural measures (e.g. SART) and through thought probes using ESM.

Overall, the present study aims to provide a stronger causal test by looking at whether changes in mind wandering mediate any beneficial effects of MBCT on increasing positive affect in depression vulnerable individuals. The mediating role of mind wandering in this context has yet to be examined in research. The following review will consider the content of MBCT programmes and then evidence that they change mind wandering will be discussed.

### 7.1.1 ***The MBCT intervention***

Mindfulness Based Cognitive Therapy (MBCT; Segal, Williams & Teasdale, 2002) is a group-based clinical intervention designed to reduce relapse into depression using a combination of mindfulness meditation and cognitive behavioural techniques (for full details see section 1.4.1.1). MBCT is the psychological intervention of choice for depressive relapse prevention as recommended by the National Institute for Clinical Excellence (NICE; 2015). This clinical intervention is delivered in groups of 8-15 participants across eight sessions each lasting two hours. As well as a core attitudinal aspect (teaching clients to become non-judgemental, open and kind to themselves) a central component to MBCT is its attentional aspect. The first week of an MBCT course, titled, “waking up to the autopilot” introduces the idea of remaining in the ‘here and now’. Throughout the eight weeks therapists teach that when the mind wanders away (as if often does) to acknowledge and accept these thoughts and then to guide it back to an attentional focus such as breathing. As well as during formal mindfulness exercises, participants are encouraged to practice this approach in daily life - to engage with their present experiences and to try to redirect attention when it wanders to distracting thoughts or worries. Empirical research has evidenced a reduction in mind wandering after completion of mindfulness based interventions such as MBCT.

### 7.1.2 ***Manipulating mind wandering using MBCT***

Schooler et al., (2014, p.11) stated that mindfulness is “an antidote for mind wandering” and according to Mrazek, Smallwood and Schooler (2012) sustained attentiveness represents a fundamental element (if not complete characterisation) of mindfulness. Formal mindfulness based interventions have been found to reduce levels of mind wandering using a wide range of measures including self-report questionnaires such as the Five Factor Mindfulness Questionnaire (FFMQ; Baer et al., 2006) and Mindful Attention Awareness Scale (MAAS;

Brown & Ryan, 2003) but also using behavioural measures such as the Sustained Attention to Response Task (SART; Robertson et al., 1997).

The FFMQ is a 39 item measure of mindfulness which measures five distinct facets; observing, describing, nonjudging, nonreacting and acting with awareness (for a full description of this questionnaire see section 3.3.2.1). The acting with awareness subscale of the FFMQ (FFMQ-AA) includes items such as, “when I do things, my mind wanders off and I’m easily distracted” and has been used to index trait mind wandering (Seli, Carriere & Smilek, 2015; Murphy et al., 2013; all previous studies in this thesis). Previously published research has found significant increases in FFMQ-AA scores (a reduction in mind wandering) after completion of mindfulness based interventions. For example, Carmody and Baer (2008) reported an increase in FFMQ-AA scores pre to post an eight week Mindfulness Based Stress Reduction (MBSR; Kabat-Zinn, 2003) programme. In particular, the authors found that a greater number of hours spent practicing mindfulness from home was significantly associated with a larger increase in acting with awareness. In a study examining the factor structure of the FFMQ, Gu et al., (2016) reported changes in facets of mindfulness as a result of completion of MBCT. Data for this study were taken from two multi-centre randomised controlled trials; the Preventing depressive relapse in NHS settings through MBCT [PREVENT] trial (Kuyken et al., 2015) and the Staying Well After Depression [SWAD] trial (Williams et al., 2014). Pre-MBCT data from the PREVENT trial has also been analysed in study 1b of the current thesis. In a large sample size (N =238), Gu et al., (2016) reported significant increases in FFMQ-AA scores (reduced trait mind wandering) from pre to post MBCT. This study also supports that by Bohlmeijer et al., (2011) who reported changes in facets of mindfulness as a result of different intensities of mindfulness based intervention. The original aim of this study was to assess the psychometric properties of the Dutch version of the FFMQ in a sample of 376 adults who displayed symptoms of depression and anxiety. Participants completed a nine week mindfulness intervention from home of which included teaching on ‘contact with the present moment’ (Hayes et al., 2006). Further to this participants were asked to complete daily mindfulness exercises and on average participants completed 4 hours a week of practice. Participants formed one of three conditions; a nine week mindfulness intervention with minimal email support, a nine week mindfulness intervention with intensive email support and a waiting list control group. Results revealed significant increases in FFMQ-AA scores in both minimal and intensive mindfulness intervention groups with no significant change in the control group. The authors concluded that the acting with awareness facet (along with nonreacting and nonjudging) were highly sensitive to change with two mindfulness facets (observing and describing) only moderately sensitive. Therefore, published literature to date has provided robust evidence that mindfulness based interventions, including MBCT, can reduce the tendency to mind wander as measured using the self-reported FFMQ.

The use of other self-report questionnaires provides further support for a reduction in mind wandering after completion of formal mindfulness interventions. The MAAS is a 15 item measure of mindfulness which places an emphasis on the tendency to attend to present moment experiences in everyday activities. Items include, “It seems I am ‘running on automatic’ without much awareness of what I’m doing.” Indeed this measure of mindfulness has previously been criticised for being a purely attentional measure and leaving out non-judgemental attitudinal aspects of mindfulness (Walach et al., 2006). Higher scores on the MAAS therefore typically indicate greater present moment attention and reduced mind wandering. Schroevers and Brandsma (2010) found a significant increase in MAAS scores from pre to post an MBCT intervention adapted for stress reduction purposes. Participants attended eight weeks of 2.5 hour sessions and a six hour silence day that took place between week six and seven of the course. Participants were also asked to complete 45 minutes of home practice a day and to incorporate mindful awareness into their daily activities. The sample used in this study was uncharacteristic to that attending a typical MBCT course as from a total of 64 participants, only half reported a prior history of depression or anxiety. However, despite the relatively non-clinical nature of this sample participants did report lower MAAS scores (i.e. greater mind wandering) pre-intervention compared to the general population (Brown & Ryan, 2003) and scores increased to that similar to the general population post-intervention. In further support of this, Frewen et al., (2008) studied 43 student participants enrolled to participate in a mindfulness intervention similar to formats used in MBSR and MBCT but adapted for an undergraduate sample with depression and anxiety symptoms. This intervention consisted of eight weekly 2-2.5 hour sessions along with homework such as daily meditation. Consistent with the above research, MAAS scores were found to significantly increase from pre to post this adapted mindfulness based clinical intervention. More specifically, MAAS scores significantly increased from pre to mid-treatment (before session five), indicating a relatively fast change in levels of mind wandering. However, the authors reported a disparity in their findings as scores on the acting with awareness subscale of the Kentucky Inventory of Mindfulness Skills (KIMS; Walach et al., 2006) failed to change significantly. However, this result should be considered carefully due to the relatively small sample size and unrepresentativeness of a student population.

Overall, through the use of self-report questionnaires, MBCT and other mindfulness based interventions have been found to robustly reduce levels of mind wandering, highlighting the benefits of using such an intervention in manipulation designs. In addition to this, previous research has found reductions in mind wandering when using objective behavioural measures such as the SART.

A study by Jha et al., (2015) adapted a mindfulness based intervention for a military cohort and found post-intervention improvements on the SART. Their intervention called 'Mindfulness-Based Mind Fitness' was an eight hour course delivered over eight weeks. Forty participants were assigned to receive mindfulness training, 40 participants were assigned to a stress and resilience training course and 24 participants received no training. Participants assigned to the mindfulness course experienced significantly fewer lapses of attention on the SART. Performance on a different sustained attention task (the Dichotic Listening Task; Tiitinen et al., 1993) has also been compared between participants undertaking a three month intensive meditation course (n=17) and matched control participants (n=23) (Lutz et al., 2009). The dichotic listening task consists of listening to a tone presented in one ear and pressing a button upon presentation of an infrequent deviant tone and has previously been used as an index of attentional function (e.g., Hillyard et al., 1973; Polich & Criade, 2006). Participants in the intensive meditation arm of the study completed 10-12 hours of meditation a day and practices included Vipassana meditation (focused attention and open monitoring) and Metta meditation (loving-kindness). Lutz and colleagues reported that participants in the meditation condition show much less variability in response time on the listening task which is a marker of greater attentional stability. Conversely, research using behavioural measures of mind wandering has also found no significant differences in SART performance between mindfulness meditators and non-meditators (Josefsson & Broberg, 2011). However, this study can be critiqued for using a weaker study design as compared with a pre-post change design, this study is not able to take into account individual differences.

### 7.1.3 ***MBCT and positive affect***

It has been found that mindfulness based interventions lead to increases in positive affect (see section 1.4.3.1). For example, people who undergo MBCT have been found to experience increased momentary positive emotion and engage more often in positive activities when compared to waitlist control participants (Geschwind et al., 2011). Participants with residual symptoms of depression after at least one prior past episode, were randomly allocated to either eight weeks of MBCT (n = 63) or eight weeks of waitlist control (n = 66). Geschwind and colleagues found that MBCT was associated with more overall levels of positive affect (PA), more appraisals of everyday activities as pleasant and higher levels of reward experience (conceptualised as the effect of pleasant activities on momentary PA). This variable of reward experience is able to capture increases in PA when engaging in pleasant activities, relative to baseline levels. The observed increases in positive affect were also found to be associated with reductions in levels of depression symptoms and therefore this finding highlighted the potential of increased positive affect in the protection against future depression. A reanalysis of this trial by Batink et al., (2013) found that in participants with two or fewer previous depressive episodes the effect of MBCT on depressive symptoms was mediated by changes in total KIMS score and specifically the subscales of acceptance and acting with awareness. However, in participants with three or more depressive episodes, the effect of MBCT on depressive symptoms was mediated only by changes in levels of PA and NA. In fact as much as 80% of the effect of MBCT on depression was mediated by changes in PA. That the relationship between MBCT and depression was mediated by PA only in participants with three or more episodes could represent a link between anhedonia and depression chronicity. An even more recent reanalysis examined emotion-cognition interactions and found that MBCT stimulates an increase in levels of positive cognition relative to control participants (Garland, Geschwind, Peeters & Wichers, 2015). MBCT was found to strengthen a relationship between current levels of positive affect and future positive cognitions. In other words, prior experiences of positive affect (trigged by MBCT) were found to cause an ‘upward spiral’ of future positive affect and positive cognitions. Therefore, previous research has found a robust link between MBCT and increased levels of positive affect.

### 7.1.4 ***The present study***

The above review has highlighted research to show that mindfulness based clinical interventions improve attentional processes and reduce levels of mind wandering. This review has also introduced research highlighting improvements in positive affect after completion of these interventions. However, despite research showing MBCT reduces mind wandering and increases positive affect, no research to date has explicitly tested if changes in mind wandering mediate these changes in levels of positive affect. If mind wandering change as a result of MBCT is found to mediate changes in positive affect this will help to improve our understanding of drivers of anhedonia in depression. Thus, the final study in this thesis aims to address this gap in the literature.

Previous studies in this thesis (studies 3 and 4) have attempted to manipulate levels of mind wandering using short audio exercises in the laboratory or using a week-long training intervention. These manipulation designs can be criticised for being too short and reliant on a participant's dedication to the research study. Therefore in the present study an empirically tested mind wandering manipulation in the form of an MBCT intervention will be used and compared with control participants who will not receive any intervention. This MBCT intervention will be eight weeks in length and delivered by trained therapists. As per the MBCT protocol, participants in the intervention group will be asked to complete daily meditation exercises and to incorporate mindfulness into their everyday activities. This high intensity intervention therefore has the maximum chances of reducing levels of mind wandering.

As in studies 3 and 4, this study will utilise a pre-post research design in order to establish both cross-sectional relationships prior to the intervention and to conduct within/between participant change analyses. Building on previous research linking MBCT with increased positive affect, this study will use a triangulation of measures which assess changes in both background mood and emotional reactivity (Rottenberg, 2005). Therefore, participants will be asked to complete positive emotion mood induction tasks (e.g. watching a positive video and recalling a positive memory; methods used previously with success in this thesis) in order to assess how MBCT changes emotional reactivity to positive stimuli. This study will also replicate the design of Geschwind et al., (2011) to assess changes in momentary affect in everyday life using ESM with the addition of mind wandering thought probes. As well as changes in positive affect, negative affect will also be assessed to capture how MBCT changes negative emotional responding to positively valenced stimuli (found to be elevated in depressed populations; Dunn et al., 2004) and the experience of negative affect in everyday life. In order to maximise the robustness of the findings (cf. Schooler & Schreiber 2004), mind wandering will also be measured using a questionnaire of self-reported trait mind wandering (FFMQ-AA) and behavioural task measure (the SART).

## 7.2 Study design

Study 5 employed a mixed within and between-subjects design (see Figure 7.1). Mind wandering was manipulated between-subjects by whether or not participants attended an eight week MBCT programme. Participants formed one of two testing groups; recovered depressed MBCT and recovered depressed controls.[8] Allocation to testing groups was not randomized as this was a pragmatic study of routine MBCT practice in an NHS clinic. The key dependent variable was the within-subjects change in positive emotional experience from the first testing session (T1) to the second testing session (T2), which occurred pre to post the MBCT programme (or equivalent eight week period for control participants). Emotional experience was measured in terms of self-reported anhedonia questionnaires, reactivity to positive stimuli (positive video and positive memory recall) and in an ecologically valid manner using ESM. A further dependent variable was the within-subjects change in levels of mind wandering from T1 to T2 assessed using a triangulation of measures (the acting with awareness subscale of the FFMQ, SART and thought probes during ESM).[9]

[8] In addition to the two main testing groups, a third group of never depressed control participants were recruited at T1 only. This group was recruited to allow for a secondary analysis investigating if individuals who have recovered from depression show residual deficits in positive affect. Analysis of this subgroup will not be presented in the current thesis as recruitment is still ongoing and this question is secondary to the present thesis aims.

[9] Participants in both recovered depressed testing groups completed a one year follow up (T3). This testing session was included to investigate whether changes in positive emotional experience as a result of completing MBCT drive the treatment's protective effects and reduction in relapse rates. As data collection is still ongoing, data from T3 will not be presented in this thesis.

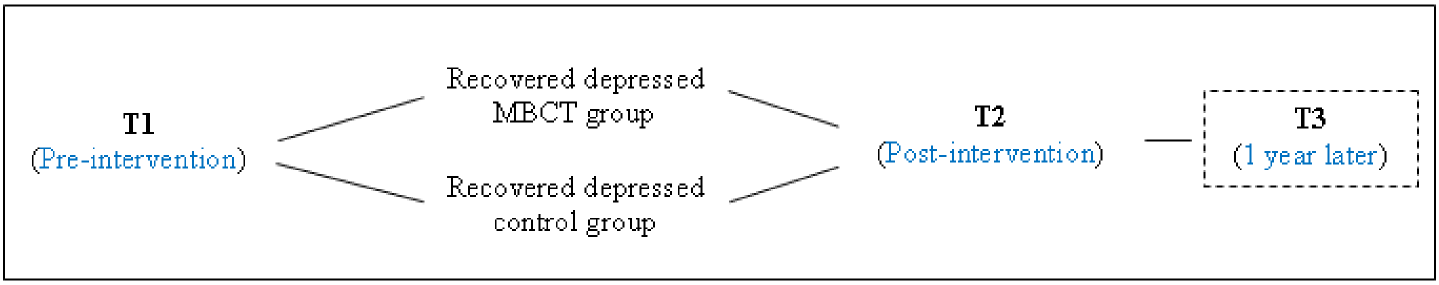



*Figure 7.1.* A diagram depicting the mixed within-between design of study 5. Dotted lines represent data that will not be presented in the current thesis.

## 7.3 Hypotheses

Listed below are the hypotheses that will be investigated in the present study. Data analysis will include T1 cross-sectional relationships and analysis of manipulation effects at T2.

### *7.3.1 Cross-sectional hypotheses*

1. Greater levels of depression (measured using the BDI-II) will correlate with increased levels of mind wandering at T1 (measured using the SART, FFMQ-AA and during ESM).
2. Greater levels of depression will correlate with less marked increase in happiness and less marked decrease in composite negative emotion to the positive video and positive memory recall tasks at T1. Greater levels of depression will also correlate with decreased PA and increased NA during ESM at T1.
3. Greater levels of mind wandering will correlate with less marked increase in happiness and less marked decrease in composite negative emotion to the positive video and positive memory recall tasks at T1. Greater levels of mind wandering will also correlate with decreased PA and increased NA during ESM at T1.
4. At T1, levels of mind wandering will mediate the relationship between depression and emotional reactivity to the positive video and positive memory recall tasks and between depression and levels of positive and negative affect measured using ESM.

### *7.3.2 Change hypotheses*

5. Participants in the MBCT condition will show a reduction in mind wandering (measured using the SART, FFMQ-AA and during ESM) from T1 to T2, while those in the control condition will show no change in levels of mind wandering from T1 to T2.

6. Participants in the MBCT condition will report a decrease in anhedonic symptoms from T1 to T2, while those in the control condition will show no change in levels of anhedonic symptoms from T1 to T2.
7. Participants in the MBCT condition will report an increase in happiness and a decrease in composite negative emotion to the positive video and positive memory recall tasks from T1 to T2, relative to the control condition. Participants in the MBCT condition will show an increase in levels of PA and decrease in levels of NA during ESM from T1 to T2, relative to the control condition. Participants in the MBCT condition will also show an increase in rating everyday events as enjoyable, relative to the control condition.
8. The change in mind wandering from T1 to T2 will mediate change in self-reported anhedonic symptoms, emotional reactivity to the positive video and positive memory tasks and change in levels of PA/NA/enjoyment ratings during ESM.

## 7.4 Methods

### *7.4.1 Participants*

Participants formed two main testing groups; 1) participants with a history of depression who were not currently depressed and entered the MBCT programme and 2) control participants with a history of depression who were not currently depressed, but who were not undergoing any active relapse prevention intervention.

The MBCT participants were recruited from those taking part in groups run at the Accessing Evidenced Based Psychological Therapies (AccEPT) clinic at the University of Exeter (see http://www.exeter.ac.uk/mooddisorders/acceptclinic/). Participants were recruited from MBCT groups running in Exeter and Barnstaple, North Devon, delivered by six therapists fully qualified in delivering MBCT. At T1, 52 MBCT participants were recruited (36 women, 69.2%) aged 22-75 years ($M$ = 52.1, $SD$ = 14.2). Forty four MBCT participants (84.6%) were of White British ethnic origin. 21 MBCT participants dropped out of the study from T1 to T2 (40% drop out rate) – 8 failed to fully complete the MBCT programme and 12 participants dropped out of the study due to reasons such as time commitments, wanting to focus on treatment and finding the study burdensome. Therefore at T2, 32 MBCT participants remained in the study (25 women, 78.1%) aged 25-72 years ($M$ = 53.8, $SD$ = 12.3) and 29 MBCT participants (90.6%) were of White British ethnic origin.

Control participants were recruited from the local community in Exeter through use of online and poster advertisements and using the Exeter 10,000 EXTEND database at the Exeter Clinical Research Facility. This is a database of community volunteers of adults with a permanent address within 25 miles of Exeter. At T1, 50 control participants were recruited (36 women, 72.0%) aged 18-73 years (*M*= 44.4, *SD* = 16.9). Forty one control participants (82%) were of White British ethnic origin. 18 control participants dropped out of the study from T1 to T2 (38% drop out rate) for reasons such as time commitments, finding the study burdensome or were unreachable via telephone or email. Therefore at T2, 32 control participants remained in the study (24 women, 75.0%) aged 21-73 years (*M* = 46.3, *SD* = 16.7) and 28 control participants (87.5%) were of White British ethnic origin. Not all participants completed all measures – details of the sample size for each measure is presented in Figure 7.2.

Exclusion criteria for both groups were: being currently depressed; less than 18 years old; presenting with comorbid diagnoses of current substance dependence, organic brain damage, current/past psychosis, current manic episodes; having previously attended an MBCT programme; and those receiving formal concurrent psychotherapy. Participants were not excluded if they were taking antidepressants as many participants who complete the MBCT programme (or who are in recovery from depression and not due to complete an MBCT programme) continue to take these medications. It was therefore decided prior to recruitment that it would not be practical to recruit individuals who were not taking medication and also it would not be ethical to ask individuals to stop taking their medication for the purposes of the current study. Full details of medication usage was recorded during the initial screening interview.

Participants received an honorarium of £5 per testing session (pre/post MBCT or equivalent eight week period). All participants completed a range of other measures and tasks that will not be reported further in this thesis. To ensure motivation to complete these other measures participants also had the opportunity to win £5 in shopping vouchers per testing session.

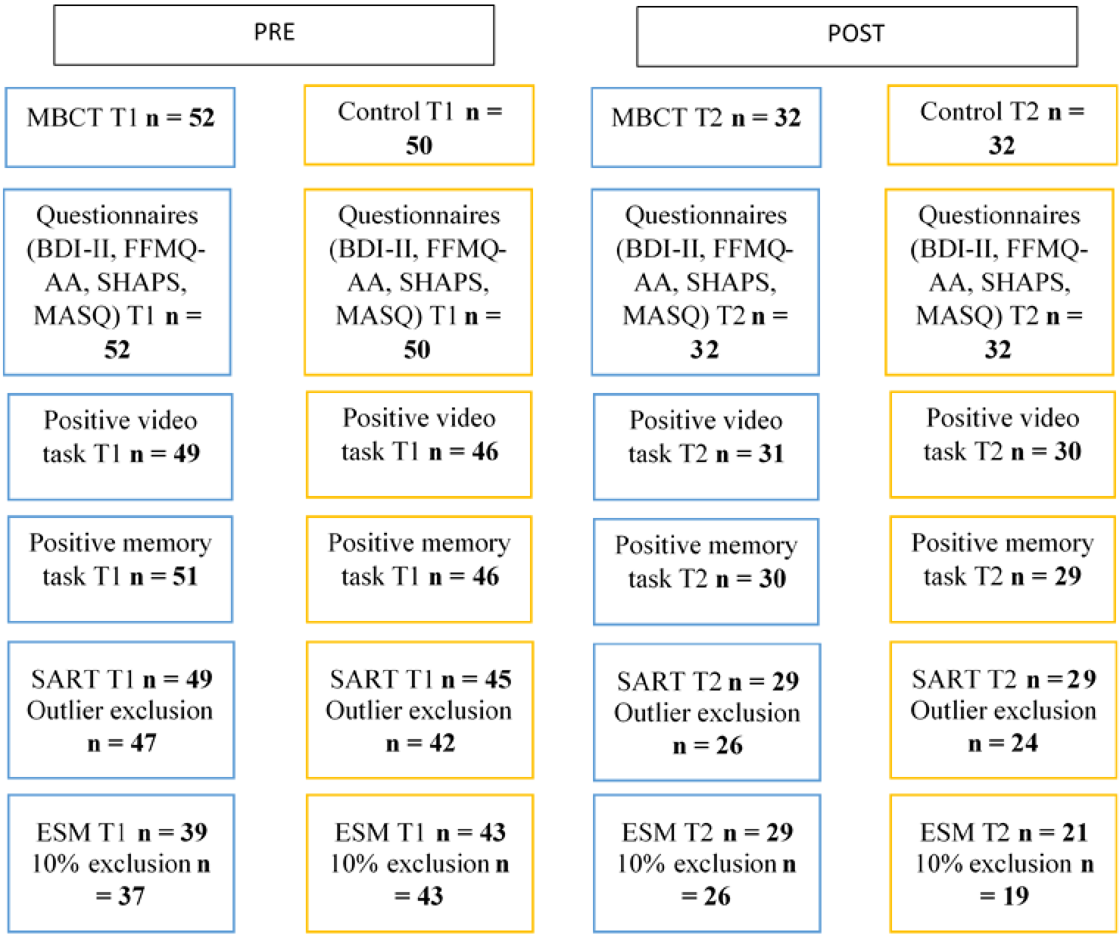



*Figure 7.2.* A review of the sample size in the MBCT and control testing groups for each measure used in the study.

### *7.4.2 Measures*

#### *7.4.2.1 Structured Clinical Interview for Diagnosis*

The Structured Clinical Interview for Diagnosis (SCID, clinical version, First et al., 1994) module A and psychosis screening tool were used to assess participants at T1. The SCID is an interview-based assessment that systematically goes through the DSM-IV criteria for mental disorders. In the present study, the SCID was conducted over the telephone by a trained researcher (the thesis author Grace Jell) and took approximately 30-60 minutes per participant. Participants were asked questions regarding current depression (over the past month), past depression, number of past depression episodes, current and past manic episodes and current and past psychosis. If risk was detected during the clinical interview then the full Mood Disorders Centre risk protocol was carried out (see Section 2.2 for further details). During this initial telephone assessment participants were also asked about demographic variables (age, ethnicity), employment status, medication use, meditation experience, neurological problems and alcohol and drug dependence. After the interview participants were informed if they were eligible to take part in the research study. Any outstanding queries regarding diagnosis were confirmed by trained clinical psychologists (Dr Barney Dunn and Dr Kim Wright).

#### *7.4.2.2 Questionnaire measures*

All questionnaire and task measures (sections 7.4.2.2 and 7.4.2.3) were delivered via a secure online platform developed by Cambridge Brain Sciences (CBS; see http://home.cbstrials.com/) meaning participants were able to complete these questionnaire and task measures in their own home.[10] Three participants (two MBCT, one control) opted to complete the online questionnaires and tasks at the University of Exeter due to internet connection issues and availability of a home computer.

The *Beck Depression Inventory – Second Edition* (BDI-II; Beck, Steer & Brown, 1996) was as described in studies 1b, 2, 3 and 4of the present thesis. The BDI-II was used to check testing groups were comparable at T1 in terms of levels of depression severity. Additionally, the BDI-II was used in cross-sectional analyses (to investigate how depression correlated with mind wandering and emotional experience at T1). In this sample the BDI-II had excellent reliability at T1 and T2 (T1 Cronbach's $\alpha$ = .90; T2 Cronbach's $\alpha$ = .90). Across groups at both time points, BDI-II scores were normally distributed. The spread of BDI-II scores for both testing groups is displayed in Table 7.1. There was a good spread of BDI-II scores in both groups and so the present study is not limited by range restriction effects.

[10] As participants completed the online platform from home the lead experimenters contact details were given to participants if they were in need of support (e.g. not understanding the task instructions or technical problems). The CBS online cognitive assessment platform has been used in other published studies (e.g., Owen et al., 2010; Hampshire, Highfield, Parkin & Owen, 2012). To minimise confounds, participants were asked to complete online tasks on their own and in a quiet, distraction-free environment.

*Table 7.1*. Spread of BDI-II scores in both testing groups at T1 and T2

| | MBCT | | Control | |
|---|---|---|---|---|
| | T1 (n = 52) | T2 (n = 32) | T1 (n = 50) | T2 (n = 32) |
| Minimal (0-13) | 19 (36.5%) | 27 (84.4%) | 23 (46.0%) | 18 (56.3%) |
| Mild (14-19) | 8 (15.4%) | 4 (12.5%) | 11 (22.0%) | 4 (12.5%) |
| Moderate (20-28) | 18 (34.6%) | 1 (3.1%) | 9 (18.0%) | 9 (28.1%) |
| Severe (29-63) | 7 (13.5%) | 0 (0.0%) | 7 (14.0%) | 1 (3.1%) |

The *Snaith Hamilton Pleasure Scale* (SHAPS; Snaith et al., 1995) and *Mood Anxiety Symptom Questionnaire- Short Form* (MASQ-S; Watson & Clark, 1991) anhedonic depression subscale were used to create a composite measure of state anhedonia as in studies 2 3 and 4 of this thesis. A composite measure was used for consistency with previous studies and to reduce the chance of type 1 error when running multiple analyses. This measure of anhedonia was used to assess the interaction between testing group and time in terms of change in anhedonic symptoms. As previously, this composite measure was obtained by Z-scoring both questionnaires and taking an average. In this sample, both scales had good to excellent reliability at T1 (SHAPS α = .89, MASQ anhedonia α = .95) and excellent reliability at T2 (SHAPS α = .90, MASQ anhedonia α = .95).

The ‘acting with awareness’ subscale of the *Five Facet Mindfulness Questionnaire* (FFMQ-AA; Baer et al., 2006) was used to measure trait levels of mind wandering as in all previous studies. Greater scores on the FFMQ-AA are indicative of lower trait mind wandering. The FFMQ-AA was used in cross-sectional analyses (to investigate how mind wandering correlated with depression and emotional experience at T1) and change analysis from T1 to T2 (to investigate any interaction between testing group and time in terms of levels of mind wandering). In this sample the FFMQ-AA had good reliability at both time points (T1 Cronbach’s α = .88; T2 Cronbach’s α = .88).

#### *7.4.2.3 Task measures*

Sustained Attention to Response Task (SART)

As an objective, behavioural measure of mind wandering participants completed an online version of the Sustained Attention to Response Task (SART; Robertson et al., 1997) at T1 and T2. The SART was implemented using a secure online platform developed by Cambridge Brain Sciences (CBS; see http://home.cbstrials.com/). Prior to beginning the SART, participants were instructed to sit approximately 40cm from the computer screen and were told to respond quickly and make as few errors as possible.

As in study 2 of the present thesis, the SART followed a Go/No Go paradigm whereby participants were told to respond with a manual button press upon presentation of frequent targets (digits 1-2, 4-9; 88.9%) and to withhold from pressing a button upon presentation of a non-frequent targets (digit 3; 11.1%). However, a slightly different version of the SART was programmed in the present study compared to the task used in study 2 (which adopted the specification outlined by Stawarczyk et al., 2011). The version in the present study closely followed the task specification laid out in Manly, Robertson, Galloway & Hawkins, (1999). This difference in SART specifications in the present study compared to previous chapters was for pragmatic reasons. Only this modified version of the SART was available on the online platform and we did not have resources to pay for it to be reprogrammed. Furthermore, in order to run this study using the online platform (and therefore allow for participants to complete the tasks from home), it was time saving to use a specification already programmed.

The SART in the present study began with 18 practice trials, consisting of two targets. The present SART was much shorter in length (5 minutes and 16 seconds) and consisted of 270 digits presented in the centre of the computer screen. There were 30 of each digit, which were presented randomly in five different font sizes (48, 72, 94, 100 and 120 point; corresponding to heights of 12-29mm). These different font sizes were used to reduce the possibility of participants making button presses based on the perceptual templates of the digits, instead of processing of the actual numerical values. Compared to the SART used in study 2, digits in the present SART were presented on screen for a shorter duration of 250ms (compared to 500ms in study 2) and with a quicker interstimulus interval of 900ms (compared to 2000ms in study 2). Furthermore, the interstimulus interval consisted of a 900ms duration mask, which was composed of an '*X'* presented in a 29mm ring. As in study 2, the target digits were presented in a pre-determined randomised manner. Deviating from the SART method in study 2, thought probes were not used and a retrospective measure of mind wandering after the task was not given (e.g. Dundee Stress State Questionnaire, Matthews et al., 1999). Reasons for these deviations are as above and due to pragmatic reasons with using the online platform.

Positive video emotional reactivity task

In order to index emotional reactivity to nomothetic stimuli at T1 and T2, participants were asked to complete a positive video mood induction task. This task was also implemented using the online CBS secure platform. This task consisted of watching a short positive video clip (an approach used previously as in Martin, 1990, and in study 2 of the present thesis). Two different positive video clips were used and clips were fully counterbalanced to ensure participants did not view the same video clip at T2. The positive video clips were chosen based on happiness ratings in a previous pilot of 29 participants (see Appendix 5 for summary of pilot results). The first positive video clip was the ‘Welcome Back’ T-Mobile television advert produced in 2010 and used in study 2. This clip lasted three minutes and one second. The second positive video clip was a comical scene taken from the film ‘Love Actually’ which lasted two minutes and 56 seconds. Prior to watching the positive video clip participants completed a short counting task (counting how many times a letter occurred in a grid for 30 seconds, see Appendix 10). This counting task was intended as a washout as participants previously viewed a neutral video (however this data will not be analysed further as it is not of core interest to this thesis). This washout task was followed by a 30 second relaxation period intended as a neutral baseline from which to assess emotional change when watching the positive video clip. Participants rated their emotional experience on average during the relaxation period and positive video on scales of happiness, sadness, anger, fear and disgust using visual analogue scales ranging from 0 (not at all) to 100 (extremely). As in previous studies in this thesis, a composite negative emotion rating was used (collapsing across all four negative emotions) for simplification and to avoid multiple comparisons. Participants also viewed a neutral video clip, however this data will not be analysed further as it is not of core interest to this thesis.

Positive memory emotional reactivity task

To further index emotional reactivity to idiographic stimuli at T1 and T2, participants also completed a positive autobiographical memory mood induction task (an approach used previously as in Joorman & Siemer, 2004, and in studies 2 and 3 of the present thesis). Participants were given instructions to think of one memory that was 'very happy' for them and were given the following as examples, "*a wedding day, birth of children, success at work or in education, spending time with people you like*." Participants were instructed that the memory they chose should be reasonably clear and vivid as they would be asked to describe this memory in detail. Furthermore, participants were advised for the memory to be as specific as possible (e.g. being able to identify a particular time and place when it happened). Prior to starting the task participants provided two or three cue words that would later be presented on the computer screen to prompt participants to start recalling the memory. Similar to the method used in studies 2 and 3, participants used the write-out loud procedure when recalling the positive memory in order to depict their 'stream of consciousness' (cf. Wegner, Erber &Zanakos, 1993). Specifically, participants were advised to, "*type whatever goes through your mind as you remember it*" and to try and keep writing for the full recall period of two minutes. Participants were told not to worry about grammar or spelling and were given several questions to aid their memory recall including, "*what was happening?",* "*who was there?"* and "*what emotions were you experiencing?"* Similar to the positive video task, participants completed a washout counting task for 30 seconds (as again participants were asked to recall a neutral memory – this data will not be analysed further) followed by a 30 second relaxation period prior to recalling the positive memory. Emotional experience on average during the relaxation period and positive memory were measured on the same rating scales as used in the positive video task.

#### ***7.4.2.1 Experience sampling***

Experience sampling methodology (ESM) was used to assess participant's levels of affect and mind wandering whilst in their own daily environment at T1 and T2. Upon recruitment into the study, participants were informed that they were able to opt out of this part of the study if they felt it would be invasive.

As opposed to event-contingent sampling (participants complete questions when a pre-designated event occurs) used in studies two and four of the current thesis, the present study utilised signal-contingent sampling whereby participants were prompted by a random signal to answer questions. This method was chosen to assess how levels of mind wandering and affect change in participants as they go about their daily life pre/post MBCT relative to the control group. Closely following the procedure used in Geschwind et al., (2011), participants completed ESM for six consecutive days at T1 and again at T2. Using a specially developed smartphone application, participants were beeped 10 times each day at unpredictable moments between 7:30am and 10:30pm, resulting in a maximum of 60 beeps. Each of the ten beeps per day were set to occur in blocks of 90 minutes, e.g. from 7:30am-9am, 9am-10:30am, 10:30am-12pm and so on. At each beep participants were asked to rate how they were feeling using 14 mood rating scales (as in Geschwind et al., 2011), with seven items measuring positive affect (PA; happy, satisfied, cheerful, enthusiastic, strong, curious, animated) and seven items measuring negative affect (NA; anxious, lonely, guilty, down, suspicious, disappointed, insecure). To replicate Geschwind et al., (2011) each affect rating was measured using a 7 point likert scale from 0 (not at all) to 7 (very). This means of measure momentary affect is similar to the design used in study 4 and expands on study 2 which measured only happiness and sadness during the event scheduling procedure. This broader range of affect ratings was included to more accurately assess changes in positive and negative emotion in everyday life. At each beep participants were also asked to rate their levels of mind wandering as follows, "*To what degree during the 5 minutes before you heard the alarm had you been thinking about something other than what you were currently doing?"* As in previous studies in this thesis, participants answered this question using a visual analogue scale from 0 ("I was concentrated fully on what I was doing") to 100 ("My mind wandered frequently to thoughts other than what I was currently doing"). Participants were instructed to answer the questions immediately after the beep, thus minimizing memory distortion. Participants rated other questions at each beep which will not be analysed further (see Appendix 11 for full set of questions).

### *7.4.3 Procedure*

All procedures were approved by the NRES (Health Research Authority) Committee South West – Exeter (see Appendix 12). Prior to starting the study all participants gave written, informed consent. As participants had previously suffered from depression, permission was sought at the consent stage to contact their GP to let them know they were taking part in this research study. A summary of the procedure used in this study is depicted in Figure 7.3. [11]

#### *7.4.3.1 T1 testing session*

To assess a participant was eligible to take part in the study participants underwent a screening process using the Structured Clinical Interview for DSM-IV (SCID; First et al., 1994). The SCID was delivered by a trained researcher (thesis author Grace Jell) over the telephone and took approximately 30-60 minutes. Eligible participants were then invited to take part in the T1 testing session which would take place during the week prior to the MBCT intervention (or as soon as possible in the control group). Participants were emailed a URL link to a secure online platform containing the questionnaire and task measures. In this email participants were instructed to complete the online battery on their own, in a distraction-free environment. Participants were advised to complete this online battery any time during the week prior to their first MBCT class. Participants that failed to complete the online battery prior to their second MBCT class were excluded from the study. As part of the online battery participants completed the BDI-II, FFMQ-AA, MASQ and SHAPS questionnaires and the SART, video and memory recall tasks. During the same week prior to the intervention participants completed six days of ESM. For completion of ESM, participants were lent a smartphone (HTC Desire C or Huawei Ascend Y330) so that participants who did not own a phone could take part. Participants met with the experimenter (thesis author Grace Jell) for a detailed explanation of the experience sampling method. For participants that could not attend a training session with the experimenter, all participants were provided with a guide on how to use the smartphone application (see Appendix 13). Participants were asked to return

[11] Both testing groups will complete a T3 testing session conducted 12 months after the completion of T2. This third assessment consists of a SCID interview to assess for the presence of current depression and depression over the past 12 months. Questions are also asked about any changes in medication over the past 12 months and any other psychological treatments. Participants are also sent a battery of online self-report measures (BDI-II, SHAPS, and MASQ) to assess for levels of depression and anhedonic symptoms. The purpose of T3 is to investigate if any improvements in positive emotional experience can account for reduced relapse rates one year following MBCT.

the smartphone when attending their first MBCT class (or control participants returned the phone to the university at day that suited them/posted the phone/phone was collected).

#### *7.4.3.2 T2 testing session*

The T2 testing session took place in the two weeks immediately following the MBCT programme (and 8-10 weeks after T1 for the control participants). The T2 testing session was identical to the T1 testing session with the exception that demographic information was not collected. Participants were emailed a different URL link to complete the same questionnaire and task measures as described above. To minimise repeat and practice effects between the two testing sessions, parallel forms of the video and memory recall tasks were developed (i.e. participants were asked to recall a different memory and viewed different videos). Half of the participants viewed tasks set A at T1 and tasks set B at T2; the other half of the participants viewed tasks set B at T1 and tasks set A at T2 (i.e. full counterbalancing). Participants also completed 6 days of ESM.

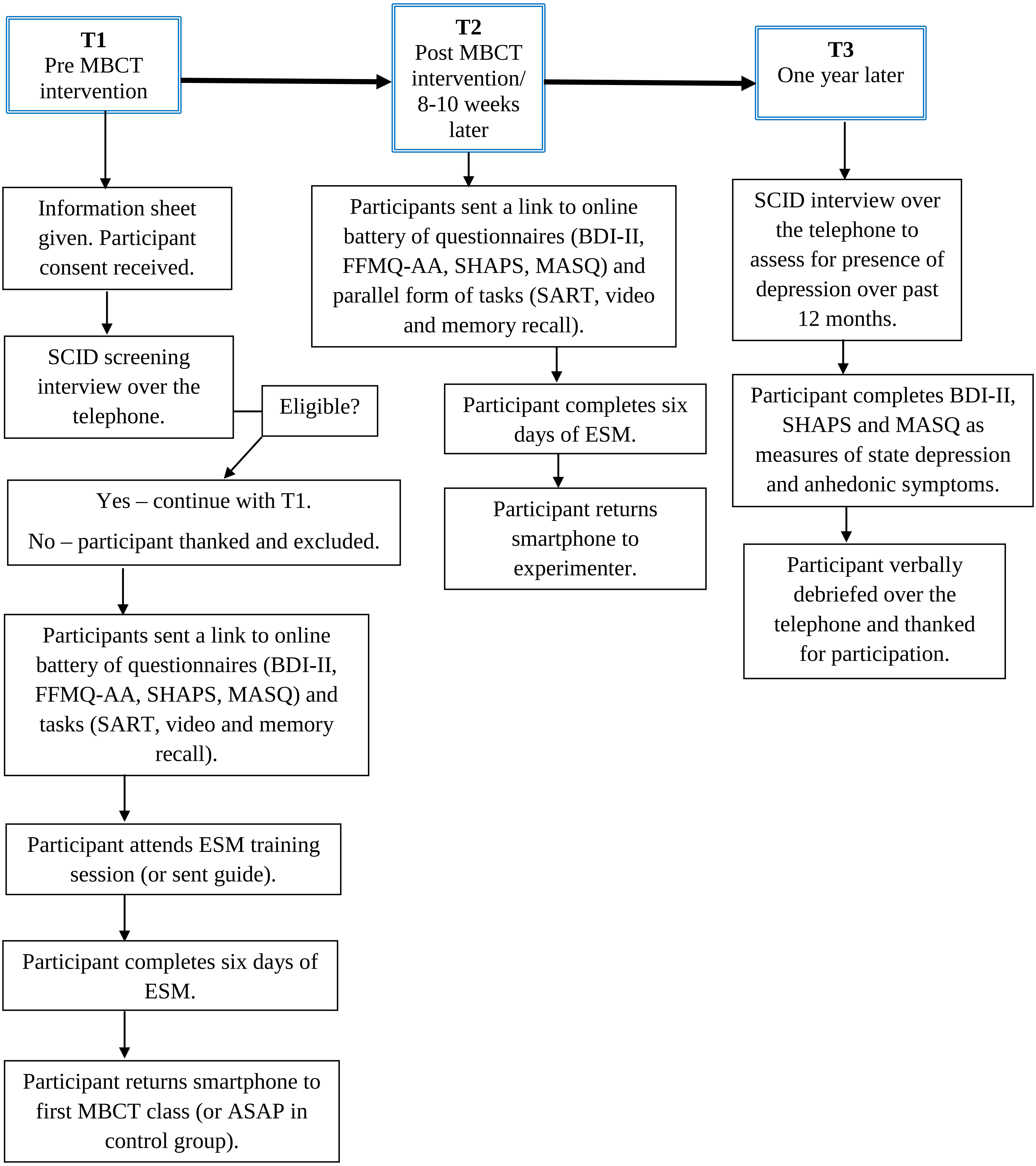



*Figure 7.3.* Procedure for study 5.

### *7.4.4 Data Analysis strategy*

Statistical analyses were carried out on the computer using SPSS version 21. Alpha was set to .05. Prior to all analyses, data was inspected for missing values, outliers and violations of the normality assumption. Where no violations were found, parametric statistics were conducted. Any violations/outliers are described in the text. As used in previous studies in this thesis, residual change scores were calculated to assess emotional reactivity to the positive video and positive memory recall tasks. Residual change scores were used as they hold baseline emotional reactivity constant (Allison, 1990).

Altogether the following tests were employed in this chapter: one-way ANOVA, Chi-square test, paired t-tests, correlations and mixed measures ANOVA. Mediation analyses were conducted according to procedures outlined by Baron and Kenny (1986) and used the Sobel Test (Preacher & Leonardelli, 2001).

In order to test H3 (that greater levels of mind wandering during ESM will correlate with decreased PA and increased NA), H5 (that participants in the MBCT group will show a reduction in mind wandering during ESM relative to the control group) and H7 (that participants in the MBCT condition will show an increase in PA/decrease in NA during ESM relative to the control condition) - linear mixed models were used. This decision to use linear mixed models was based on the hierarchical structure of the data with multiple observations (level 1) clustered within participants (level 2). Multilevel modelling provides an opportunity to look at relationships both within and between participants, without violating assumptions of independence (Snijders & Bosker, 1999). Multilevel linear regression analyses were carried out using the SPSS Mixed procedure. Models were constructed through examination of the Bayesian Information Criteria (BIC) and models with the lowest BIC (and therefore explaining most variance) were retained for analysis.

For H3, two separate models were constructed with levels of PA and levels of NA as the dependent variables respectively and mind wandering as the predictor variable. To aid interpretation, the predictor variable (levels of mind wandering) was mean centered prior to analysis. For levels of PA the model explaining most variance included both a random intercept and random slope with the following equation:

$$(\text{Positive affect})_{ij} = \beta_{0i} + \Sigma\beta_q\chi_{qij} + \Sigma\beta_r\chi_{ri} + e_{ij}$$

(Positive affect)$_{ij}$ denoted level of positive affect for participant *i* at beep *j*. The intercept in the model is denoted as $\beta_{0i}$ and the error term as $e_{ij}$. $\chi_{qij}$ denoted the beep level variable of mind wandering ($\chi_q$) with its corresponding coefficient $\beta_q$. $\chi_{ri}$ denoted a participant level variable ($\chi_r$) with its corresponding coefficient $\beta_r$. The intercept ($\beta_{0i}$) was specified as randomly varying at the participant level, thus modelling the assumption that ratings tend to be more similar if taken from the same participant. The beep level variable of mind wandering was also randomly varying at the participant level allowing for the relationship between mind wandering and positive affect to be different between participants. The coefficients $\beta_q$ and $\beta_r$ are equivalent to unstandardized regression coefficients in standard multiple regression.

For levels of NA the model explaining most variance also included both a random intercept and random slope with the following equation:

$$\text{(Negative affect)}_{ij} = \beta_{0i} + \Sigma\beta_q\chi_{qij} + \Sigma\beta_r\chi_{ri} + e_{ij}$$

For H5, one model was constructed with level of mind wandering during ESM as the dependent variable and testing group (MBCT, control) and time (T1, T2) were added as fixed effects. Of key importance in these models was the significance of the categorical (testing group) by categorical (time) interaction, assessed using a reduction in -2 log likelihood. In order to assess change in model fit the model was fitted with maximum likelihood estimation. Included in this model was a random intercept for participant and a random slope for time.

For H7, three separate models were constructed with levels of PA, levels of NA and enjoyment ratings as the dependent variables, again with testing group (MBCT, control) and time (T1, T2) were added as fixed effects. PA and NA models were constructed in the same way as for H5, with a random intercept for participants and a random slope for time. The enjoyment ratings model was not improved by inclusion of a random slope and so included only a random intercept for participant.

## 7.5 Results

### *7.5.1 Group comparisons at baseline*

First, analyses were conducted to check whether testing groups were comparable at T1. All participants with valid T1 data were included in this analysis. Variables compared were age, gender, ethnicity, current antidepressant use, number of previous depressive episodes, employment status, prior meditation experience and current depression levels (BDI-II). Both continuous variables of age and BDI-II score were normally distributed and so a one-way ANOVA was conducted to compare groups. Remaining categorical variables were analysed using the Chi-square test. Results of these analyses are displayed in Table 7.2.

Table 7.2. *Means (and Standard Deviations) of key variables and outputs from statistical tests comparing these variables between groups at T1*

| Variable | | Mean (SD) | | Test statistic |
|---|---|---|---|---|
| | | MBCT | Control | |
| Age | | 52.11 (14.19) | 44.43 (16.95) | $F(1, 91) = 5.55$, $p = .02$ |
| BDI-II | | 18.13 (10.10) | 15.86 (10.17) | $F(1, 101) = 1.28$, $p = .26$ |
| Number of depression episodes | 3 or under | 20 | 28 | $X^2$ (2, N = 92) = 2.57, p = .28 |
| | Over 3 | 14 | 11 | |
| | Indistinct | 11 | 7 | |
| Gender | Male | 10 | 10 | $X^2 < 1$ |
| | Female | 36 | 36 | |
| Ethnicity | White British | 44 | 41 | $X^2$ (1, N = 92) = 1.39, p = .24 |
| | Other | 2 | 5 | |
| Employment status | Currently working | 25 | 27 | $X^2 < 1$ |
| | Not working | 21 | 19 | |
| Antidepressant use | Yes | 31 | 19 | $X^2$ (1, N = 92) = 6.31, p = .01 |
| | No | 15 | 27 | |
| Prior meditation experience | None | 17 | 23 | $X^2$ (3, N = 92) = 4.16, p = .25 |
| | A little | 13 | 15 | |
| | A lot | 12 | 7 | |
| | Expert | 4 | 1 | |

*Note* – Randomisation check conducted on all participants with valid T1 data. T1 BDI-II data available for 52 participants in MBCT group and 50 participants in control group. Demographic data (age, gender, ethnicity, employment status, prior episodes antidepressant use, meditation experience) available for 46 participants in MBCT group and 46 participants in control group.

Results revealed a group difference in age with participants in the MBCT group (*M* = 52.11, *SD* = 14.19) being significantly older than participants in the control condition (*M* = 44.43, *SD* = 16.95). Furthermore, there was a higher proportion of participants in the MBCT on antidepressant medication (N = 31) compared to participants in the control condition (N = 19). Therefore, the variables of age and antidepressant use will be controlled for in future change analyses. Groups did not significantly differ on any other variables, Ps> .24.

### *7.5.2 Manipulation checks*

Analyses were conducted to assess if the positive video and positive memory liking tasks were successful positive mood inductions at T1. Data for the positive video task was acquired for 49 participants in the MBCT group and 46 participants in the control group. Valid data for the positive memory task was acquired for 51 participants in the MBCT group and 46 participants in the control group. The change in emotional reactivity for these tasks is displayed in Table 7.3.

Table 7.3. *Happiness and composite negative emotional ratings before and after the positive video and positive memory liking tasks*

| | Mean (SD) | | | |
|---|---|---|---|---|
| | Video | | Memory | |
| | Before | After | Before | After |
| Happiness | 33.80 (23.88) | 67.32 (24.95) | 29.50 (23.48) | 74.60 (25.70) |
| Composite negative | 26.23 (36.74) | 26.24 (36.88) | 36.59 (48.93) | 24.29 (33.00) |

*Note* – Mean values are displayed with standard deviations in parentheses. T1 video data available for 49 MBCT participants and 46 control participants. T1 memory data available for 51 MBCT participants and 46 control participants. Composite negative = the summation of sadness, fear, anger and disgust ratings. Emotion ratings scored from 0 (Not at all) – 100 (Extremely).

In order to establish if the positive video liking task was a successful positive mood induction, paired samples t-tests were conducted to compare mean happiness and composite negative ratings before and after the video. Results revealed a significant increase in happiness ratings, $t(94) = -13.14$, $p < .001$ and therefore the positive video liking task was successful. However, there was no significant change in composite negative emotion in response to the positive video, $t(94) = -.003$, $p = .998$.

The above analyses were repeated in order to establish if the positive memory liking task was a successful mood induction. Results revealed a significant increase in happiness ratings, $t(96) = -14.84$, $p < .001$, indicating that the memory recall task was also a successful positive mood induction. Furthermore, there was a significant decrease in composite negative ratings to the positive memory task, $t(96) = 2.25$, $p = .03$.

### *7.5.3 __Validity of tasks__*

The original sample size collected for the SART at T1 was 49 participants in the MBCT group and 45 participants in the control group. The original sample size collected for the SART at T2 was 29 participants in the MBCT group and 29 participants in the control group. However after examining the data, 5 participants were excluded from the SART analysis as they displayed extreme outliers in number of omission errors (+/- 3 SDs from the mean). The remaining sample size was 47 participants in the MBCT group, 42 participants in the control group at T1 (total N = 89) and 26 participants in the MBCT group, 24 participants in the control group at T2 (total N = 50). As per previous research (e.g., Chan, 2005) and study 2 of this thesis, all reaction time (RT) data was examined for outliers (RT = < 30ms or > 600ms) and any outliers in an individual participants dataset were removed prior to calculating the standard deviation of RT. The mean RT across participants at T1 was 360.64ms and participants made on average 14.48 omission errors (out of a possible 240 non-targets; 6% error rate) and 13.16 commission errors (out of a possible 30 targets; 44% error rate). This high proportion of commission errors indicates that mind wandering did occur during the SART at T1. However, this number of commission errors is significantly higher than that reported in previously published literature, as participants who report making more slips of action on a self-report questionnaire made 4% errors of commission on a similar SART and those that rated themselves as making fewer everyday mistakes made only 2% errors of commission (Manly, Robertson, Galloway & Hawkins, 1999).

Once again, to simplify analysis and to avoid multiple comparisons, a composite measure of mind wandering during the SART was computed at T1 and T2. As in study 2, intercorrelations of all indices of mind wandering were examined and results are presented in Table 7.4. All indices were highly correlated at T1 and indices were also highly correlated at T2, Ps < .001, and therefore a composite measure of mind wandering during the SART was created using all indices; RT variability, RT_CV and total errors. To create these composite variables, indices were Z-scored and an average was taken.

Table 7.4. *Intercorrelations between indices of mind wandering on the SART at T1 (N = 89) and T2 (N =50)*

| | T1 | | | | | T2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 1 RT variability | - | | | | | - | | | | |
| 2 RT_CV | .90*** | - | | | | .87*** | - | | | |
| 3 Commission errors | .28** | .46*** | - | | | .53*** | .76*** | - | | |
| 4 Omission errors | .44*** | .49*** | .39*** | - | | .56*** | .55*** | .51*** | - | |
| 5 Total errors (omission + commission) | .44*** | .60*** | .79*** | .80*** | - | .51*** | .69*** | .85*** | .79*** | - |

*Note* - ** $p < .01$, *** $p < .001$. Indices of mind wandering include RT variability (the standard deviation in reaction times), RT_CV (the standard deviation in reaction times/mean reaction time) and Total errors (summation of omission and commission errors). T1 = testing session one; T2 = testing session two.

### ***7.5.4 Cross-sectional correlations at T1***

Cross-sectional correlations were conducted on all participants who completed T1. Prior to analyses, the data were investigated for potential covariates (age, gender and ethnicity). Levels of depression were found to be unrelated to all tested covariates, Ps> .27, and so these variables were not controlled for in subsequent analyses.

H1 states that at T1, individuals with higher levels of depressive symptoms will report greater levels of mind wandering. Both BDI-II score and composite mind wandering on the SART were normally distributed and so a Pearson’s correlation was conducted. Unexpectedly, there was no relationship between depression and performance on the SART, ($r$ = .001, $p$ = .99). This provides no support for H1 as depression did not correlate with a behavioural measure of mind wandering. However, a Pearson's correlation was conducted between the BDI-II and scores on the FFMQ-AA (trait mind wandering) and results revealed a significant correlation, ($r$ = -.47, $p$ < .001). This indicates that higher levels of depression are related to less acting with awareness/more trait mind wandering. H1 was further tested using ESM data, however although in the expected direction, the relationship between BDI-II and averaged mind wandering during ESM at T1 was non-significant, ($r$ = .11, $p$ = .33). Therefore, there is little support for H1 in this study as depression only correlated with trait mind wandering and was not found to significantly correlate with mind wandering on the SART or during ESM.

H2 states that individuals with higher levels of depressive symptoms will report less marked increase in happiness and less marked decrease in composite negative emotion to the positive video and positive memory recall tasks. Residual change in happiness to the video at T1 was normally distributed, however residual change in composite negative emotion was nonparametric and unable to be transformed and so for consistency a Spearman's correlation was conducted for both change scores. Scores on the BDI-II did not correlate with residual change in happiness ($r_s$ = -.01, $p$ = .96) and residual change in composite negative emotion ($r_s$ = .05, $p$ = .66) to the positive video, providing no support for H2. In a similar way, residual composite negative change score to the positive memory was skewed and so Spearman's correlations were conducted for the memory analysis. Once again, unexpectedly, the BDI-II was unrelated to residual change in happiness ($r_s$ = .06, $p$ = .58) and residual change in composite negative emotion ($r_s$ = .16, $p$ = .11). H2 also states that greater levels of depression will correlate with decreased PA and increased NA during ESM at T1. Both average PA and NA variables were normally distributed and so Pearson's correlations were conducted between the BDI-II and averaged emotion ratings during ESM at T1. In full support of H2, individuals with higher levels of depression reported reduced momentary positive affect ($r$ = -.59, $p$ <.001) and greater momentary negative affect ($r$ = .60, $p$ <.001) at T1.

H3 states that greater levels of mind wandering (on the SART and self-report trait mind wandering on the FFMQ-AA) will correlate with less marked increase in happiness and less marked decrease in composite emotion to the positive video and positive memory recall tasks. Analysis of the positive video task revealed no support for H3. Composite mind wandering on the SART was unrelated to residual happiness change (*r* = .001, *p* = .99), however significantly correlated with residual composite negative change in an unexpected direction ($r_s$ = -.25, *p* = .02). Greater mind wandering on the SART was correlated with a greater decrease in negative emotion. Scores on the FFMQ-AA were also unrelated to residual happiness change (*r* = -.09, *p* = .42) and residual composite negative change ($r_s$ = -.02, *p* = .88) to the positive video.

Analysis of the positive memory task revealed only partial support for H3. Composite mind wandering on the SART was unrelated to both residual happiness change ($r_s$ = -.07, *p* = .52) and residual change in composite negative emotion ($r_s$ = .12, *p* = .28). However, although scores on the FFMQ-AA were unrelated to residual happiness change (r = -.08, *p* = .43) they did significantly correlate with change in composite negative emotion ($r_s$ = -.18, *p* = .08) at the level of a non-significant trend. In other words, less trait mind wandering trend correlated to a more marked decrease in composite negative emotion to the positive memory.

H3 also states that greater levels of mind wandering will correlate with decreased PA and increased NA during ESM at T1. As detailed in section 7.4.4, this hypothesis was tested using linear mixed models. In full support of H3, there was a significant inverse relationship between levels of mind wandering measured with ESM thought probes and positive affect (F = 19.57, β = -.004, *SE* = .001, *p* < .001). Results also revealed a significant positive relationship between levels of mind wandering measure with ESM thought probes and negative affect (F = 55.92, β = .007, *SE* = .001, *p* < .001). Therefore as predicted, greater levels of mind wandering in daily life correlated with lower levels of positive affect and higher levels of negative affect within participants.

In summary, cross-sectional analysis of the positive video task, positive memory task and ESM revealed partial support for H1 as there was a significant negative correlation between depressive symptoms and the FFMQ-AA, however no significant relationships between depression and mind wandering on the SART or depression and mind wandering measured using ESM. There was partial support for H2, as although depression did not correlate with emotional reactivity to the positive video and positive memory liking tasks, there were strong correlations between the BDI-II and levels of momentary positive and negative affect during ESM at T1. Finally there was once again only partial support for H3. Greater trait mind wandering was found to be trend related to a less marked decrease in negative emotion to the positive memory. Furthermore, linear mixed models revealed significant relationships between greater mind wandering measured using ESM and lower positive affect and higher negative affect. Overall, the preconditions for a mediation analysis are not met due to a lack of significant relationships between the IV (depression) and mediator variable (levels of mind wandering) and between the IV and outcome variable (emotional reactivity) (see Baron & Kenny, 1986). Therefore, a Sobel test for indirect effects was not conducted.

### *7.5.5 Change analyses*

#### *7.5.5.1 Change in mind wandering analysis*

H5 predicted that participants in the MBCT condition will show a reduction in mind wandering from T1 to T2, while those in the control condition will show no change in levels of mind wandering. Mind wandering was measured behaviourally using the SART, a self-report trait measure (the FFMQ-AA) and using ESM thought probes. Levels of mind wandering on all measures at T1 and T2 are presented in Table 7.5.

Group comparison checks were initially conducted to see if groups differed in terms of levels of mind wandering at T1. All mind wandering variables at T1 were normally distributed and so a one-way ANOVA was used. Results revealed no significant difference in groups on performance on the SART at T1, $F<1$, or in average level of mind wandering during ESM, $F(1, 79) = 1.86$, $p = .18$. However, there was a significant group difference at T1 in FFMQ-AA scores, $F(1, 99) = 8.05$, $p = .01$. Participants in the control group reported significantly higher FFMQ-AA (less trait mind wandering) than MBCT participants at T1.

*Table 7.5.* Levels of mind wandering (composite measure on the SART, FFMQ-AA, average during ESM) at T1 and T2 in both conditions

| | Mean (SD) | | | | | |
|---|---|---|---|---|---|---|
| | Composite mind wandering on SART | | FFMQ-AA | | Mind wandering during ESM | |
| | T1 | T2 | T1 | T2 | T1 | T2 |
| MBCT | -.15 (.57) | -.04 (.60) | 21.23 (5.10) | 25.52 (3.53) | 29.62 (17.86) | 15.40 (11.56) |
| Control | -.21 (.59) | -.08 (.78) | 23.53 (5.37) | 23.40 (6.01) | 25.71 (12.75) | 27.63 (22.39) |

*Note* – Data presented for participants with both valid T1 and T2 data. SART data valid for 26 participants in MBCT group and 23 participants in control group. FFMQ-AA data valid for 31 participants in MBCT group and 30 participants in control group. ESM data valid for 22 participants in MBCT group and 17 participants in control group. FFMQ-AA scores range from 8 to 40, with greater scores depicting lower trait mind wandering. Mind wandering during ESM measured on a scale of 0 (“I was concentrated fully on what I was doing”) to 100 (“My mind wandered frequently to thoughts other than what I was currently doing”).

To assess change in composite mind wandering on the SART a mixed measures ANOVA was conducted with group as the between-subjects factor (MBCT, control), time as the within-subjects factor (T1, T2) and age and antidepressant usage added as covariates (as groups significantly differed on these variables at baseline; see section 7.5.1). A key test of H5 is the significance of the interaction term in this ANOVA. Unexpectedly there was no significant main effect of time, F<1, no significant main effect of group, F<1 and no significant time by group interaction, F<1.

In contrast, when comparing scores on the FFMQ-AA, there was no significant main effect of group, F<1, no significant main effect of time, F<1, but a significant time by condition interaction, F(1, 56) = 18.29, $p$ = <.001. This interaction was resolved by creating a change score in FFMQ-AA from T1 to T2 and comparing this score between groups with a one-way ANOVA. Results revealed a significant effect of group, F(1, 60) = 19.39, $p$ = <.001, with the MBCT group reporting a mean increase of 4.29 in FFMQ-AA scores from T1 to T2 (less mind wandering) and the control group showing a mean decrease of .13.[12] Results are depicted in Figure 7.4.

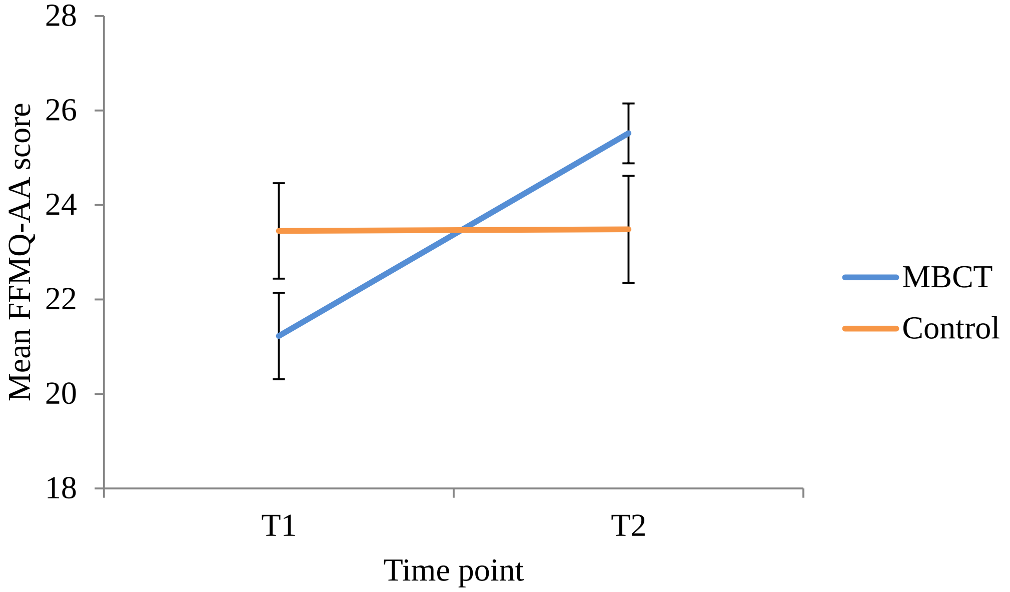



*Figure 7.4.* Graph of the interaction between group and scores on the FFMQ-AA for T1 and T2. Analyses are controlling for age and antidepressant use. Errors bars are +/- 1 standard error of the mean.

Linear mixed models were used to assess change in mind wandering during ESM (for details of modelling process see section 7.4.4). Support for H5 is through a significant categorical (testing group; MBCT vs. Control) by categorical (testing session; T1, T2) interaction. Results revealed a significant interaction, $\chi^2$ (1) = 44.87, p = < .001. The MBCT group was associated with a decrease in mind wandering from 32.33 (out of 100) to 15.02 and the control group was associated with a smaller decrease from 28.39 to 26.14. See Table 7.6 for detailed results of this mixed model.

[12] As groups significantly differed in terms of baseline FFMQ-AA, an analysis of covariance (ANCOVA) was also conducted to control for baseline scores. Results of this ANCOVA revealed the same pattern of results with a significant effect of testing group, $F(1,58) = 15.47$, $p < .001$.

*Table 7.6.* Results of linear mixed model: Change in mind wandering during ESM from T1 to T2

| | Change in mind wandering |
|---|---|
| | **β (SE), [CI]** |
| Group[a] | 33.62 (2.48), [28.70, 38.54] |
| Time[b] | -.04 (3.72), [-7.45, 7.37] |
| Group*Time | -15.57 (4.88), [-25.33, -5.82] |
| | **Estimation (SE)** |
| Random intercept (Participant) | 90.86 (35.08), [42.63, 193.66] |
| Random slope (Time) | 118.55 (30.93), [71.09, 197.68] |

*Note* –PA= positive affect, NA = negative affect. β = regression coefficient, SE = standard error. [a] reference category = control group. [b] reference category = testing session one

#### ***7.5.5.2 Change in levels of anhedonic symptoms***

H6 predicted that those in the MBCT condition will report a decrease in anhedonic symptoms from T1 to T2, while those in the control group will show no significant change in levels of anhedonic symptoms. Change in anhedonic symptoms was assessed using a composite measure of MASQ-AD and SHAPS scores as used in previous studies in this thesis. For illustration purposes, raw MASQ-AD and SHAPS scores at T1 and T2 are presented in Table 7.7.

Table 7.7. *Levels of anhedonic symptoms at T1 and T2 in both conditions*

| | Mean (SD) | | | |
|---|---|---|---|---|
| | MASQ-AD | | SHAPS | |
| | T1 | T2 | T1 | T2 |
| MBCT | 68.67 (18.16) | 56.67 (13.94) | 24.65 (7.03) | 19.16 (4.49) |
| Control | 66.22 (17.85) | 65.56 (16.97) | 23.38 (6.19) | 23.44 (6.52) |

*Note* - Data presented for participants with both T1 and T2 data. SHAPS (Snaith Hamilton Pleasure Scale) data valid for 31 participants in MBCT group and 32 participants in control group. MASQ-AD (anhedonic depression subscale of the Mood and Anxiety Symptom Questionnaire) data valid for participants in MBCT group and 32 participants in control group. Scores on the MASQ-AD range from 0-110 and scores on the SHAPS range from 14-56. Higher scores on both scales represent higher levels of anhedonia.

First, a one-way ANOVA was conducted to compare groups on levels of anhedonic symptoms at T1 which revealed no significant difference, $F(1, 101) = 1.73$, $p = .19$.

To compare change in anhedonic symptoms between groups a mixed measures ANOVA was conducted as described above with age and antidepressant usage entered as covariates. Results revealed no significant main effect of time, $F<1$, no significant main effect of group, $F<1$, but a significant time by group interaction, $F(1, 57) = 16.61$, $p < .001$. This interaction was resolved by creating a change score in composite anhedonia from T1 to T2 and comparing this score between groups with a one-way ANOVA. Results revealed a significant effect of group, $F(1, 61) = 18.26$, $p <.001$, with the MBCT group reporting a mean decrease in composite anhedonia of .30 from T1 to T2 and the control group showing a mean increase of .52. Changes in MASQ-AD and SHAPS scores between conditions are depicted in Figure 7.5.

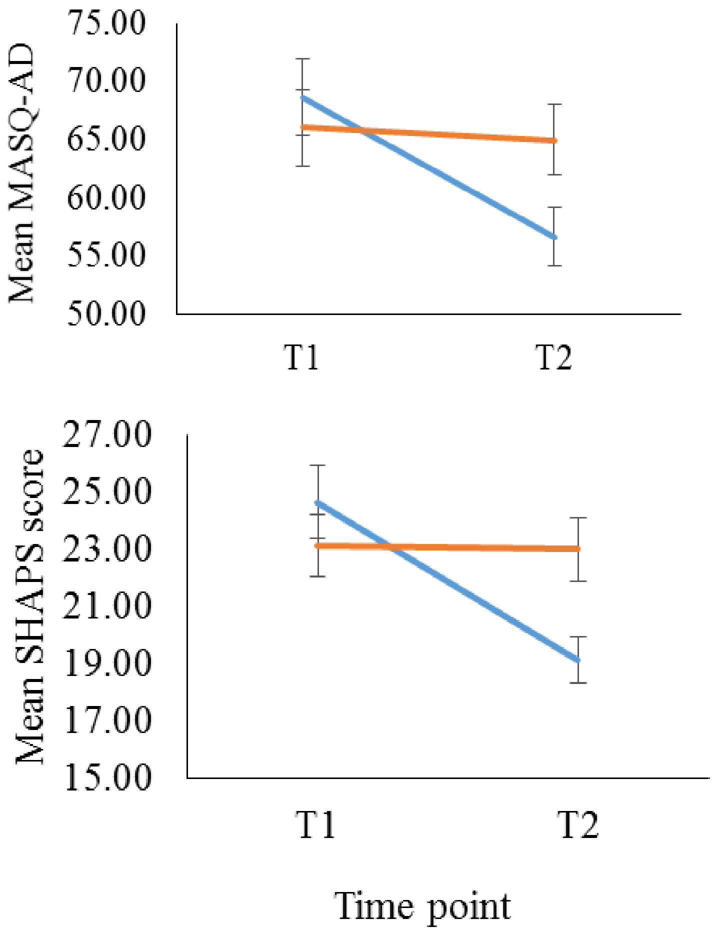
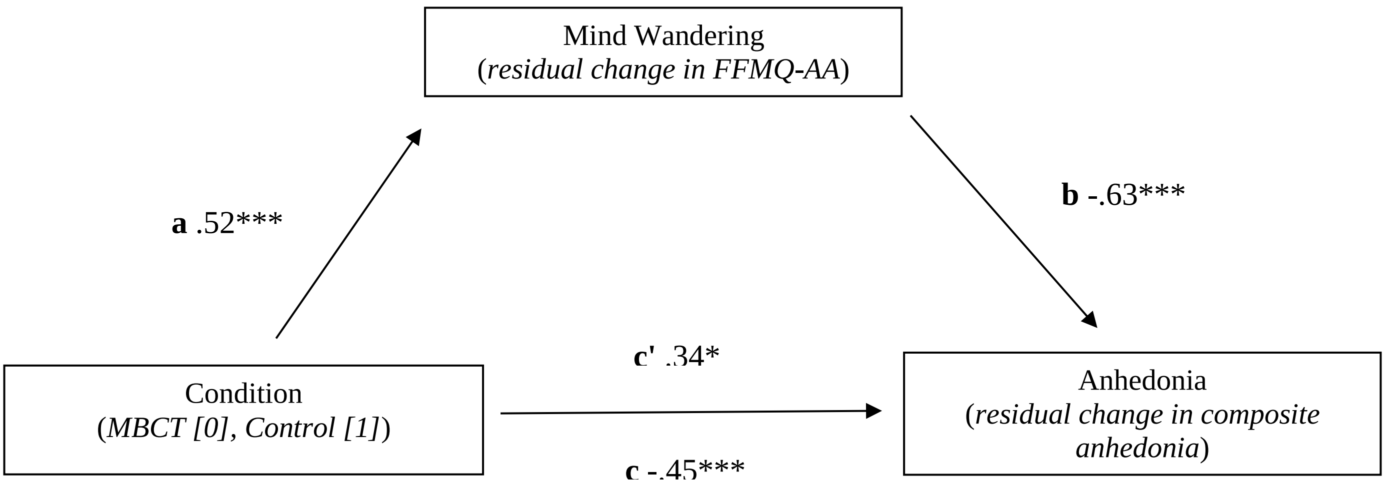



*Figure 7.5.* Graphs of the interaction between group and anhedonic symptoms for T1 and T2. Analyses are controlling for age and antidepressant use. Errors bars are +/- 1 standard error of the mean.

H8 stated that a change in mind wandering from T1 to T2 will mediate a change in self-reported anhedonic symptoms. Analyses in section 7.5.5.1 revealed a significant time by group interaction in FFMQ-AA scores, with participants in the MBCT group reporting a greater increase (less mind wandering) from T1 to T2. As above, there was also a significant interaction in terms of anhedonic symptoms with participants in the MBCT group reporting a greater decrease from T1 to T2. To assess if change in FFMQ-AA scores mediated change in anhedonic symptoms, correlations were conducted between testing group (the IV), change in FFMQ-AA (the mediator) and change in anhedonic symptoms (the DV) to ensure all preconditions for a mediation analysis were met (Baron & Kenny, 1986). These correlation coefficients are presented in the mediation diagram below (Figure 7.6) . Results revealed significant relationships between all variables, Ps< .001.




*Note* - * $p < .05$, *** $p < .001$.

*Figure 7.6*. Mediation between condition (MBCT [0], control [1]) and residual change in FFMQ-AA and composite anhedonia scores from T1 to T2.

The test statistic for the Sobel test was 2.92 with an associated p value of .003. This indicates that the relationship been testing group and change in anhedonic symptoms is significantly reduced by inclusion of change in FFMQ-AA as a mediator. This provides support for H8, as change in mind wandering from T1 to T2 mediated change in self-reported anhedonia. However, as the correlation between condition and residual anhedonia change is still significant when controlling for FFMQ-AA change, ($r_p = .34$, $p = .01$), this is only partial mediation.

A further mediation analysis was conducted to assess if mind wandering mediated change in anhedonic symptoms whilst controlling for the remaining FFMQ mindfulness facets (describe, nonjudging, nonreacting and observe). The test statistic for this Sobel test was 2.08 with an associated p value of .04. This finding indicates that change in trait mind wandering mediated the association between testing group and change in self-reported anhedonia, over and above remaining mindfulness facets.

#### *7.5.5.3 Change in emotional reactivity to the positive video*

H7 predicted that those in the MBCT condition will report a greater increase in happiness and a greater decrease in composite negative emotion during the positive video task, relative to the control condition. Raw emotion ratings to the positive video task are displayed in Table 7.8.

Table 7.8. *Raw emotion ratings taken before and after the positive video task at T1 and T2*

| | Mean (SD) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Happiness | | | | Composite negative | | | |
| | T1 | | T2 | | T1 | | T2 | |
| | Before | After | Before | After | Before | After | Before | After |
| MBCT | 34.97 (24.59) | 71.17 (21.79) | 41.52 (22.05) | 72.90 (22.50) | 7.28 (10.09) | 7.70 (13.03) | 5.41 (8.61) | 4.97 (6.73) |
| Control | 29.68 (23.21) | 63.29 (27.62) | 32.43 (23.04) | 60.96 (25.09) | 5.71 (8.41) | 6.93 (7.36) | 7.41 (11.36) | 6.96 (10.09) |

*Note* – Data presented for participants with both valid T1 and T2 data (29 in MBCT group and 28 in control group). Composite negative = an average of fear, sadness, anger and disgust ratings. All ratings are from 0 (Not at all) – 100 (Extremely).

First groups were compared in terms of emotional reactivity to the positive video at T1. Residual change in happiness to the positive video was normally distributed and so groups were compared with a one-way ANOVA. Results revealed no significant group difference in happiness reactivity to the positive video, $F<1$. Residual change in composite negative emotion to the positive video was skewed and so groups were compared with the Kruskal-Wallis test. Once again, there was no significant group difference, $H<1$.

To compare change in emotional reactivity to the positive video task, a mixed measures ANOVA was conducted separately for happiness and composite negative emotion as described above, controlling for age and antidepressant use. When comparing residual change in happiness to the positive video results revealed no significant main effect of time, $F(1, 52) = 1.28$, $p = .26$, no significant main effect of group, $F(1, 52) = 1.45$, $p = .23$ and no significant time by group interaction, $F<1$. Therefore, contrary to that predicted, there was no significant difference in residual happiness change to the positive video from T1 to T2, between groups (see Figure 7.7). Similarly, when comparing residual change in composite negative emotion to the positive video results revealed no significant main effect of group, $F(1, 52) = 1.45$, $p =$

.23, no significant main effect of time, $F(1, 52) = 1.28$, $p = .26$ and no significant time by group interaction, $F<1$.[13] Therefore, there was no significant difference in residual happiness change to the positive video from T1 to T2, between groups (see Figure 7.8).

Overall analysis of emotional reactivity to the positive video revealed no support for H7. This means the mediation hypothesis (H8) could not be tested as although groups differed in terms of mind wandering change they failed to differ as expected in response to viewing the positive video task.

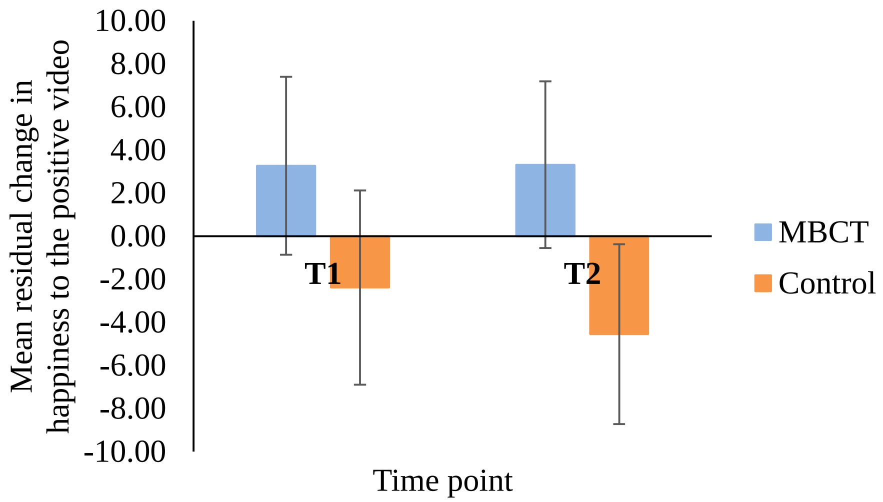



*Figure 7.7.* Graph of the non-significant interaction between group and residual happiness change to the positive video for T1 and T2. Analyses are controlling for age and antidepressant use. Errors bars are +/- 1 standard error of the mean.

[13] As composite negative residual change variables to the positive video were not normally distributed, analyses were also conducted on ranked variables (see Conover & Iman, 1982) and the same pattern of results emerged.

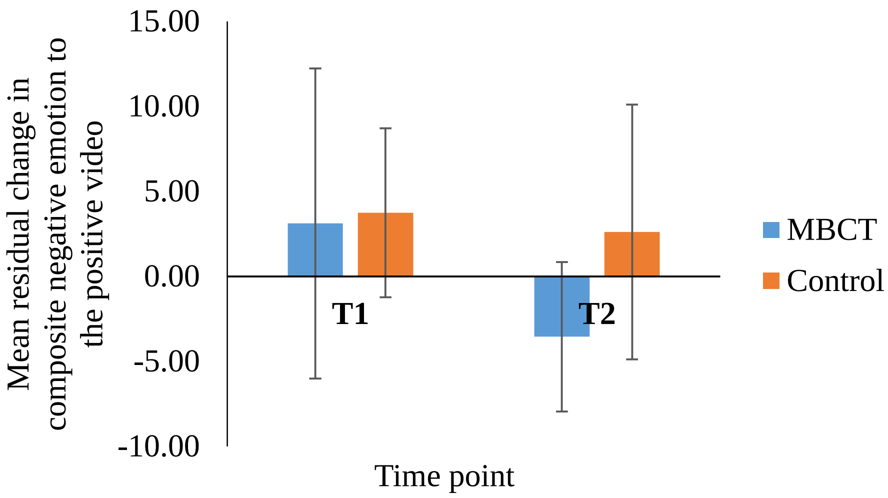



*Figure 7.8.* Graph of the non-significant interaction between group and residual composite negative change to the positive video for T1 and T2. Analyses are controlling for age and antidepressant use. Errors bars are +/- 1 standard error of the mean.

#### *7.5.5.4 Change in emotional reactivity to the positive memory*

H7 also predicted that those in the MBCT condition will report a greater increase in happiness and a greater decrease in composite negative emotion during the positive memory recall task, relative to the control condition. Raw emotion ratings to the positive memory task are displayed in Table 7.9.

Table 7.9. *Raw emotion ratings taken before and after the positive memory task at T1 and T2*

| | Mean (SD) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Happiness | | | | Composite negative | | | |
| | T1 | | T2 | | T1 | | T2 | |
| | Before | After | Before | After | Before | After | Before | After |
| MBCT | 28.48 (25.73) | 80.03 (21.72) | 35.17 (27.13) | 77.28 (25.09) | 10.56 (15.61) | 5.03 (4.56) | 8.63 (12.98) | 3.83 (4.22) |
| Control | 28.78 (21.97) | 68.59 (30.44) | 36.41 (22.98) | 68.74 (25.02) | 7.54 (11.61) | 6.57 (10.17) | 7.35 (10.70) | 5.73 (7.11) |

*Note* – Data presented for participants with both valid T1 and T2 data (29 in MBCT group and 27 in control group). Composite negative = an average of fear, sadness, anger and disgust ratings. All ratings are from 0 (Not at all) – 100 (Extremely).

Once again groups were compared on emotional reactivity to the positive memory stimuli at T1. A one-way ANOVA revealed a trend significant difference in happiness reactivity to the positive memory, $F(1, 96) = 3.62$, $p = .06$, with participants in the MBCT group reporting a slightly greater increase in happiness at T1. A non-parametric Kruskal-Wallis test was used to compare composite negative reactivity to the positive memory at T1 and results revealed no significant difference between groups, $H<1$.

To compare change in emotional reactivity to the positive memory task, a mixed measures ANOVA was conducted separately for happiness and composite negative emotion controlling for age and antidepressant use (as described above). When comparing residual change in happiness to the positive memory results revealed no significant main effect of time, $F<1$, no significant main effect of group, $F(1, 52) = 2.40$, $p = .13$ and no significant time by group interaction, $F(1, 52) = 1.21$, $p = .73$. Therefore, contrary to that predicted, there was no significant difference in residual happiness change to the positive memory from T1 to T2, between groups (see Figure 7.9).[14]

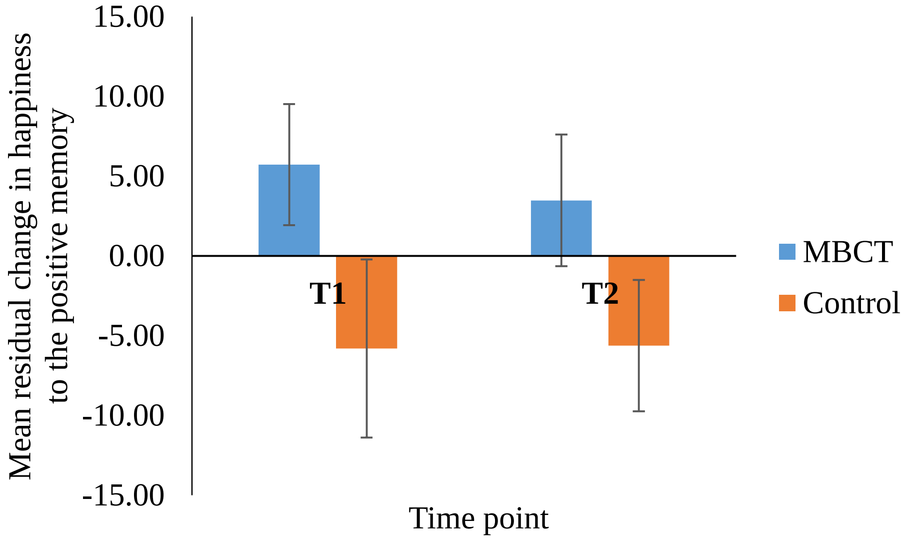



*Figure 7.9.* Graph of the non-significant interaction between group and residual happiness change to the positive memory for T1 and T2. Analyses are controlling for age and antidepressant use. Errors bars are +/- 1 standard error of the mean.

[14] As groups trend significantly differed in terms of baseline happiness reactivity to the positive memory, an ANCOVA was also conducted to control for baseline scores. Results of this ANCOVA revealed the same pattern of results with a non-significant effect of testing group, $F(1,56) = 1.10$, $p = .30$.

Similarly, when comparing residual change in composite negative emotion to the positive memory results revealed no significant main effect of time, $F(1, 52) = 1.81$, $p = .19$, no significant main effect of group, $F(1, 51) = 2.01$, $p = .16$ and no significant time by group interaction, $F<1$.[15] Therefore, analysis of emotional reactivity to the positive memory task revealed no support for H7 as there was no significant difference between groups in residual composite negative change to the positive memory from T1 to T2 (see Figure 7.10). Therefore once again, in terms of reactivity to the positive memory task, the mediation hypothesis (H8) could not be tested.

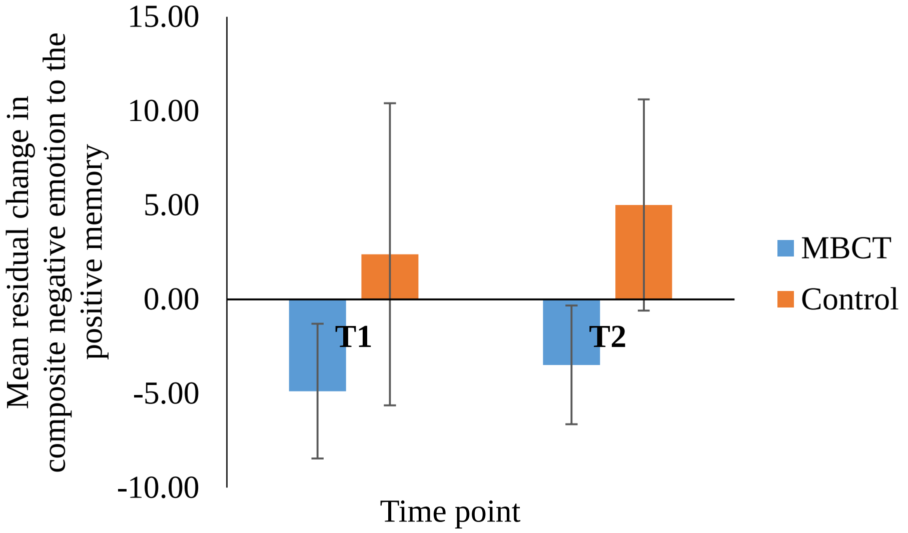



*Figure 7.10.* Graph of the non-significant interaction between group and residual composite negative change to the positive memory for T1 and T2. Analyses are controlling for age and antidepressant use. Errors bars are +/- 1 standard error of the mean.

#### *7.5.5.5 Change in emotional reactivity during ESM*

H7 stated that participants in the MBCT condition would show an increase in levels of PA and decrease in levels of NA during ESM from T1 to T2, relative to the control condition.

[15] As composite negative residual change variables to the positive memory were not normally distributed this analysis was also conducted on rank transformed variables and a similar pattern of results emerged.

Change in average PA and NA between conditions is depicted in Figure 7.11. As detailed in section 7.4.4, this hypothesis was tested using linear mixed models. As with all analyses above, groups were first compared in terms of averaged levels of PA, NA and activity enjoyment at T1 using a one-way ANOVA. There was no significant group difference in average levels of PA, $F<1$, NA, $F(1, 79) = 1.08$, $p = .30$, or activity enjoyment $F(1, 79) = 2.54$, $p = .12$.

First, a model assessing the effects of MBCT on change in PA, relative to the control group was examined. Support for H7 is through a significant categorical (testing group; MBCT vs. Control) by categorical (testing session; T1, T2) interaction. Results revealed a significant interaction, $\chi^2$ (1) = 231.00, $p < .001$. In the MBCT group PA increased from 3.16 (out of 7) to 3.94 and in the control group PA decreased from 3.59 to 3.22. Next, a model assessing the effects of MBCT on change in NA, relative to the control group was examined. Again there was a significant time by group interaction, $\chi^2$ (1) = 189.57, $p < .001$. The MBCT group showed a decrease in NA from 1.17 to 0.56 and the control group exhibited an increase in NA from 0.94 to 1.21. See Table 7.10 for detailed results of these mixed models.

*Table 7.10.* Results of linear mixed models: Change in PA and NA from T1 to T2

| | PA<br>**β (SE), [CI]** | NA<br>**β (SE), [CI]** |
|---|---|---|
| Group[a] | 3.05 (.17), [2.71, 3.39] | .33 (.21), [-.09, .75] |
| Time[b] | -.29 (.19), [-.67, .09] | 1.34 (.19), [.96, 1.72] |
| Group*Time | 1.09 (.25), [.59, 1.59] | -.86 (.23), [-1.33, -.38] |
| | **Estimation (SE)** | **Estimation (SE)** |
| Random intercept (Participant) | .83 (.18), [.54, 1.27] | .62 (.15), [.38, .99] |
| Random slope (Time) | .30 (.08), [.18, .49] | .28 (.07), [.17, .47] |

*Note* –PA= positive affect, NA = negative affect. β = regression coefficient, SE = standard error. [a] reference category = control group. [b] reference category = testing session one

H7 also predicted that participants in the MBCT condition would show an increase in rating everyday activities as enjoyable, relative to the control condition. Construction of the model revealed that the BIC was not reduced upon inclusion of a random slope for time and so instead included testing group and testing session as fixed effects and a random intercept for participant. Once again, results revealed a significant interaction between group and time, ($\beta = .60$, $SE = .13$, 95% CI [.34, .87], $\chi^2$ (1) = 20.68, $p < .001$). Specifically, the MBCT group showed an increase from 4.43 (out of 7) to 4.71 and the control group showed a decrease in activity enjoyment from 4.70 to 4.21. Change in activity enjoyment is depicted in Figure 7.11.

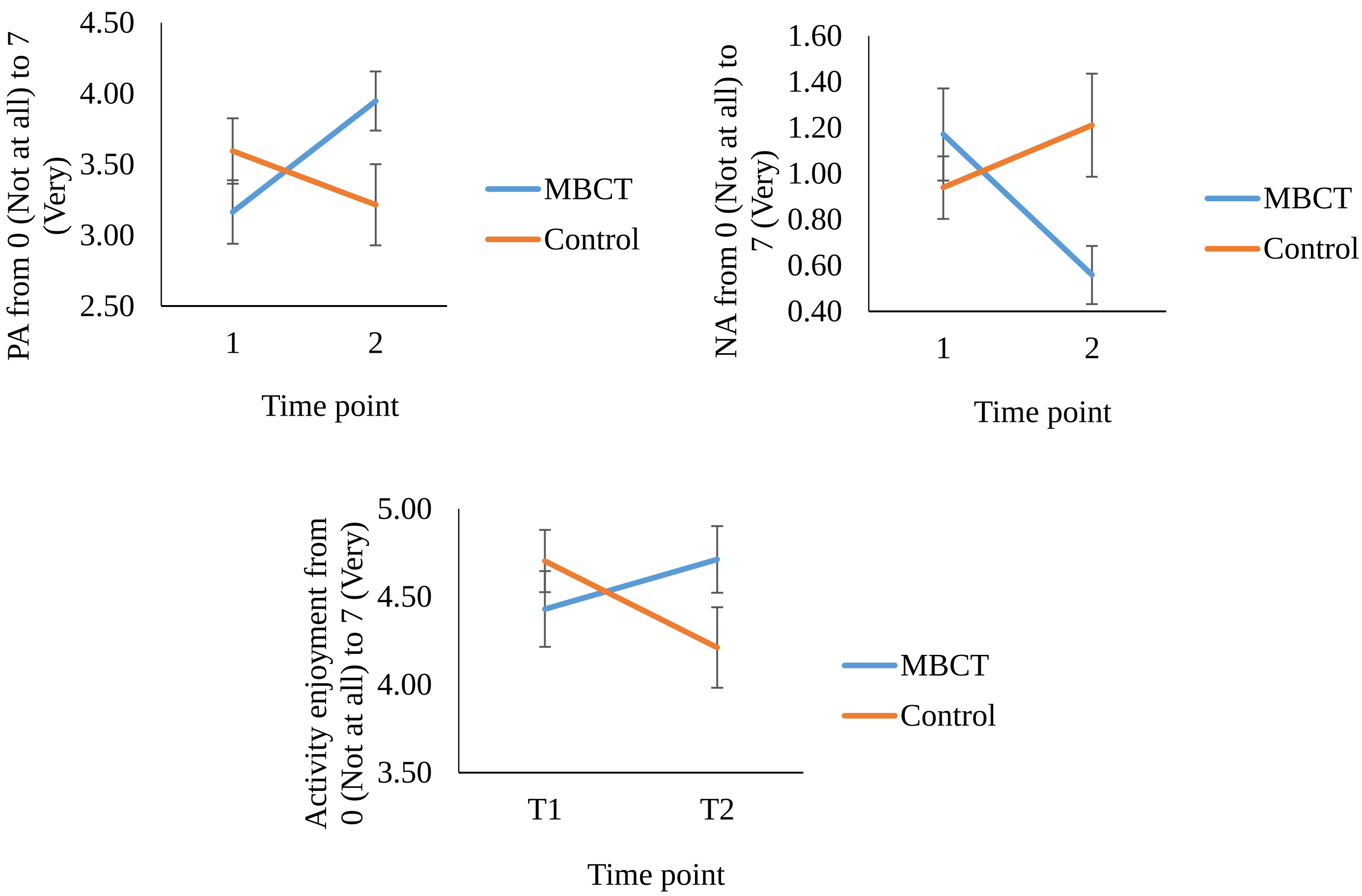



*Figure 7.11.* Graphs of the significant interactions between group and PA, NA and activity enjoyment during ESM for T1 and T2. Analyses are controlling for age and antidepressant use. Errors bars are +/- 1 standard error of the mean.

H8 stated that a change in mind wandering from T1 to T2 measured during ESM will mediate the change in levels of PA, NA and activity enjoyment. Analyses in section 7.5.5.1 revealed a significant time by group interaction in averaged mind wandering during ESM, with participants in the MBCT group reporting a greater decrease in levels of mind wandering from T1 to T2. As above, there was also a significant interaction in terms of levels of PA, NA and activity enjoyment with participants in the MBCT group reporting a greater increase in PA, greater decrease in NA and greater increase in activity enjoyment from T1 to T2. To assess if change in mind wandering mediated change in affect ratings during ESM, first correlations were conducted between testing group (the IV), change in levels of mind wandering (the mediator) and change in levels of PA, NA and enjoyment (the DVs) to ensure all preconditions for a mediation analysis were met (Baron & Kenny, 1986). These correlation coefficients are presented in Table 7.11. Results revealed significant relationships between condition and residual mind wandering change, $p = .01$ and significant relationships between condition and PA, NA and enjoyment change, Ps< .01.  Mind wandering change was found to significantly correlate with both residual PA and NA change, Ps< .01, but did not significantly correlate as expected with enjoyment change, $p = .14$. Therefore, for change in levels of PA and NA all preconditions were met. However a mediation analysis is not possible for change in activity enjoyment as the mediator did not significantly relate to the DV.

Table 7.11. *Correlations between condition (MBCT [0], control[1]) and residual change in mind wandering, PA, NA and activity enjoyment during ESM from T1 to T2*

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1 Condition | - | | | | |
| 2 Residual change MW | .41* | - | | | |
| 3 Residual change PA | -.56*** | -.43** | - | | |
| 4 Residual change NA | .52** | .47** | -.61*** | - | |
| 5 Residual change in activity enjoyment | -.45** | -.24 | .48** | -.17 | - |

*Note* - ** $p < .01$, *** $p < .001$

To investigate if change in mind wandering during ESM mediated change in levels of PA the Sobel test was conducted. The test statistic for the Sobel test was -1.41 with an associated p value of .16. This indicates that the relationship been testing group and change in levels of PA during ESM is not significantly reduced by inclusion of change in levels of mind wandering as a mediator. This does not support H8, as change in mind wandering from T1 to T2 does not mediate change in levels of PA. A further mediation analysis was conducted to assess if mind wandering mediates change in levels of NA. The test statistic for this Sobel test was 1.73 with an associated p value of .08. This finding indicates that change in levels of mind wandering measured using ESM mediates at a trend level the association between testing group and change in levels of NA, thus partially supporting H8.

## 7.6 Discussion

Study 5 of this thesis aimed to causally manipulate levels of mind wandering through use of a formal mindfulness based intervention – MBCT. This study was designed to investigate the mediating role of mind wandering on the effect of MBCT on change in positive emotional experience. Change in positive emotional experience on self-report questionnaires of anhedonia, positive mood tasks and during everyday life using ESM was compared in a group of recovered depressed adults undertaking MBCT (n = 52) and recovered depressed adults who were not undergoing any intervention (n = 50). Due to the pre-post design of this study, it was possible to examine both associations at T1 and change from T1 to T2.

First in the analysis of cross-sectional relationships at T1, results revealed only limited support for H1, as levels of depression were found to be unrelated to mind wandering measured behaviourally on the SART and average level of mind wandering measured using ESM thought probes. However, depression was found to significantly correlate with trait levels of mind wandering measured using the FFMQ-AA. Furthermore, there was only limited support for H2 as depression was unrelated to residual happiness and composite negative emotion change to both positive mood tasks. Contrary to these null findings, levels of depression at T1 were found to correlate with average momentary PA and NA during ESM. There was once again inconsistent support for H3, with a lack of support for the relationship between mind wandering and emotional experience in the analysis of the positive mood tasks but clear support in analysis of ESM data. Levels of mind wandering (indexed on the SART and FFMQ-AA) were found to be unrelated to residual happiness change to both the positive video and positive memory tasks. Conversely, linear mixed model analysis revealed full support for H3 as mind wandering during ESM related to lower PA and NA. Due to lack of significant cross-sectional relationships, H4 was not tested as preconditions for a mediation analysis had not been met.

Next, in the analysis of change from T1 to T2, analysis of H5 revealed mind wandering was successfully manipulated through participation in the MBCT programme. Participants in the MBCT testing group reported a significantly greater decrease in trait mind wandering from T1 to T2 relative to the control condition. In addition, the MBCT group reported a greater decrease in mind wandering measured using everyday ESM thought probes relative to the control condition. Contradicting these two findings, there was no significant time by group interaction in terms of SART performance, revealing the MBCT group did not make fewer lapses of attention on this task as predicted. There was however full support for H6 as participants in the MBCT group reported a greater decrease in self-reported anhedonic symptoms (in comparison control participants reported a minor increase in anhedonia from T1 to T2).

As above, analysis of H7 revealed no support in terms of emotional reactivity to the positive mood tasks but clear support when analysing ESM data. Participants in the MBCT group showed no significant change from T1 to T2 with regards to residual happiness and composite negative emotion experience during the positive video and positive memory tasks. In contrast, linear mixed model analysis exposed a significant time by group interaction, with participants in the MBCT group reporting a greater increase in PA, greater decrease in NA and greater increase in rating activities as enjoyable relative to the control condition.

In support of H8, change in FFMQ-AA was found to mediate changes in self-reported anhedonic symptoms. This significant mediation also held when controlling for the four remaining mindfulness facets measured using the FFMQ, revealing that a reduction in trait mind wandering is a highly important contributor to decreased anhedonia after completion of MBCT. A mediation analysis was also conducted to investigate if a reduction in mind wandering during ESM mediated change in levels PA and NA. Change in mind wandering did not mediate change in levels of PA but was found to mediate at trend level reductions in levels of NA, thus only partially supporting H8.

The finding that depression was unrelated to mind wandering measured using the SART and ESM thought probes is inconsistent with prior research (Farrin et al., 2003; Deng, Li & Tang, 2014). For example, study 2 of the present thesis found a significant correlation between greater depression and increased mind wandering on the SART. This inconsistency could be due to different versions of the SART, different testing environments and differences in samples. Participants in study 2 completed a SART at a slower pace and in a controlled laboratory environment. Although advised to complete the online battery in a quiet and distraction free environment, it is unknown whether participants in the current study were able to fulfil this instruction. As reported in section 7.5.3, participants at T1 made on average 13.16 commission errors (44%) which is a much higher error rate than previously reported with a similar SART (Manly, Robertson, Galloway & Hawkins, 1999). It is therefore possible that completion of the SART online did not allow for participants to ask questions and to become familiar with the task (participants in study 2 underwent a SART training session under supervision of the experimenter). Consequently, the lack of relationship between depression and mind wandering on the SART could be due to such methodological problems and thus causing a high error rate across participants, independent of their depression score. The game-like nature of the SART might also make this measure more familiar to younger participants (study 2 mean age = 19.80 years, study 5 mean age = 48.27). However, that depression was found to be unrelated to mind wandering during ESM is unlikely to be due to methodological reasons. Nevertheless there was partial support for H1 as depression correlated with lower FFMQ-AA scores (higher trait mind wandering) and this is consistent with studies 1a and 1b of the current thesis where scores on the MASQ and BDI-II were found to negatively relate to this facet (see sections 3.4.1 and 3.8.1). There was also a significant relationship between higher BDI-II scores and lower FFMQ-AA in study 2 (see section 4.5.1.1). Therefore the significant relationship between depression and mind wandering using self-reported questionnaires is now a reliable finding and is in conjunction with previously published work using the FFMQ (see Duggan & Griffith, 2011; Cash & Whittingham, 2010; Bohlmeijer, Peter, Fledderus, Veehof & Baer, 2011).

The finding that depression was unrelated to emotional change to the positive mood tasks at T1 is also conflicting with the majority of published literature to date (see review by Bylsma, Morris & Rottenberg, 2008). As reviewed in section 1.2.2.2 a clear link has been demonstrated between depression and reduced positive affect when viewing positive stimuli (e.g., Dunn et al., 2004; Sloan et al., 2001). However, this finding is in line with previous null findings reported in the current thesis. For example, study 2 found no significant relationships between depression severity and both self-reported and psychophysiological emotional reactivity to positive video and positive memory tasks. A possible reason for these null findings could be that the majority of research published (e.g. most studies cited by Bylsma, Morris & Rottenberg, 2008) measured emotional reactivity to positive stimuli by comparing absolute levels of PA during the positive stimulus to levels during a neutral control stimulus. Instead the present study looked at residual change in PA from immediately before the stimuli (during a 30 second rest period), which is arguably a more sensitive measure. Therefore, there variations in measuring positive emotional reactivity could potentially account for the differences reported. However, these findings should be carefully considered as it is of course possible that the results provided in this study simply go against the popular positive attenuation hypothesis (Bylsma, Morris & Rottenberg, 2008). Indeed, published literature in this field has shown inconsistencies with some studies finding no difference in positive emotional reactivity between depressed participants and control participants (Dichter et al., 2004; Kaviani et al., 2004; Forbes & Dahl, 2005; Gehricke & Shapiro, 2000; Renneberg et al., 2005). Furthermore, it has been debated whether self-reported positive affect in those with depression is really an accurate and reliable measure. For example, it has been found that change in objective skin conductance response to a positive mood induction does not correspond to changes in self-reported emotion (Keedwell et al., 2005). Contrary to the null findings with regards to emotional reactivity to positive stimuli, the present study found evidence for mood deficits in depression as participants with higher levels of depression reported on average lower positive affect and higher negative affect during ESM at T1. A potential interpretation of these findings is that depressed individuals have a lower baseline positive mood but not reduced positive emotional reactivity. A test of this explanation would be to correlate depression with baseline mood prior to the positive mood tasks. In full support of this interpretation, individuals with higher levels of depression at T1 (across both groups) reported significant lower happiness immediately prior to the positive video ($r$ = -.23, $p$ = .01) and positive memory ($r$ = -.24, $p$ = .02). Furthermore, higher levels of depression at T1 correlated with higher levels of negative emotion prior to the positive video ($r_s$ = .21, $p$ = .04) and positive memory ($r_s$ = .31, $p$ = .002). Therefore, in summary the data of the present studies (and previous studies in this thesis) suggest depression is characterised by deficits in general background mood as opposed to emotional reactivity to rewarding stimuli.

The finding that greater levels of mind wandering during ESM at T1 correlated with both lower levels of PA and higher levels of NA supports previously published research reporting a link between mind wandering and positive emotions (e.g., Killingsworth & Gilbert, 2010; Brown & Ryan, 2003; Deng et al., 2012; Atanes et al., 2015). This finding also supports previous significant findings from the current thesis (studies 1a and 1b, study 2, study 3 pre-manipulation). Consequently, the evidence base for the correlation between mind wandering and both positive emotional reactivity and everyday levels of positive affect is now relatively strong.

The present study revealed that MBCT is an effective manipulation of mind wandering as participants in the MBCT group reported reduced mind wandering using the FFMQ-AA and ESM from T1 to T2, relative to the control group. This reduction in mind wandering after MBCT is consistent with previous studies (e.g., Carmody & Baer, 2008; Schroevers & Brandsma, 2010; Bohlmeijer et al., 2011; Gu et al., 2016). However, that mind wandering did not decrease in the MBCT when indexed using the SART is inconsistent with previous work that has used similar behavioural measures (Lutz et al., 2009; Jha et al., 2015). This discrepancy in findings is likely due to the delivery of the SART away from a controlled study environment. As already reported, participants exhibited much higher than normal error rates and thus it is likely the SART in the present study does not provide an accurate index of mind wandering change.

A reduction in self-reported anhedonic symptoms and an increase in levels of PA and activity enjoyment during ESM is fully consistent with prior work reporting the beneficial effects of MBCT. For example, the current findings fully support those previously reported by Geschwind et al., (2011) who utilised a very similar study paradigm. Therefore the replication of earlier work in this study (e.g., Geschwind et al., 2011; Garland, Geschwind, Peeters & Wichers, 2015; Schroevers & Brandsma, 2010) points towards the likelihood that MBCT facilitates the experience of positive emotions (and thus supporting earlier review by Garland et al., 2010). Further to this, the finding that change in scores on the FFMQ-AA partially mediate change in anhedonic symptoms, independent of remaining mindfulness facets sheds light on *how* MBCT builds positive affect. In support of the current thesis predictions, it appears that learning to attend to present moment experiences (and reduce mind wandering) helps to increase hedonic capacity. However, due to temporal precedence criteria it cannot be concluded that change in levels of mind wandering causes a reduction in anhedonia (as change in mind wandering and change in anhedonia were measured at the same time points). Future analysis of T3 will provide this causal evidence if change in levels of mind wandering is found to mediate levels of anhedonic symptoms one year later. This significant mediation was not found with regards to change in levels of mind wandering and PA during ESM. However, this finding could be due to a lack of statistical power as sample sizes for ESM at T2 were relatively small (MBCT n = 26, Control n = 19).

This study has some limitations that need to be considered. First, although the use of an online testing platform provided the opportunity to test individuals from a wider geographical area and minimise participant burden it is possible that tasks were not completed as instructed by the experimenter. Steps were taken to control for this (e.g. advising participants to complete the online tasks on their own without distraction and providing participants with telephone and online support), however the completion of this study in multiple testing environments introduces potential confounds. Second, the attrition rate in this study was relatively high. In the MBCT group, eight participants did not complete T2 as they failed to complete the MBCT course. This introduces the potential for bias as participants who maintained in the study may have found more benefit from MBCT than those who did not complete the course. Third, there was a lack of diversity in the samples as over 90% of the MBCT sample were of White British ethnic origin. This limits the generalizability of the study findings to the general population. Fourth, allocation to testing groups in this study was not randomised. The use of a randomised controlled trial is the most robust way to examine a cause and effect relationship. The present study was instead a pragmatic study of routine MBCT practice in an NHS clinic. Therefore, it cannot be ruled out that a third factor is involved in causing the observed outcomes (randomisation would have ensured no systematic differences between the MBCT and control groups in factors that may affected outcome). Fifth, participants and the experimenter were not blind to condition allocation. This increases chance of experimenter bias, however the study was designed to avoid this, for example, through the use of standardised telephone conversations.

Overall, this study used a formal mindfulness intervention to causally manipulate mind wandering in two recovered depressed samples – a group attending MBCT and a control group receiving no treatment. This manipulation proved effective as MBCT participants reported reduced levels of mind wandering relative to control participants. This change in mind wandering was found to mediate change in anhedonia and therefore the results of the present study point toward a causal relationship between mind wandering and anhedonia. This causal relationship will be further tested in analysis of T3 data.

# Chapter 8: General Discussion

Depression is a debilitating mental health condition which is set to become the leading cause of disability worldwide (WHO; 2015). Despite the high economic and personal costs of depression, current pharmacological and psychological treatments are only partially effective and rates of relapse are high. A potential way to improve outcomes is to target symptoms such as anhedonia which are central to the disorder but are relatively neglected in treatments. The lack of focus on correcting positive affect disturbances in depression is likely due to an absence of scientific data investigating the psychological mechanisms that underpin them. To be able to identify and then explicitly target such mechanisms will likely improve our capacity to treat anhedonia.

The aim of this thesis was to carry out a targeted evaluation of one potential psychological mechanism driving anhedonia in depression– mind wandering. Mind wandering or the shift in contents of thoughts away from an ongoing task to our own thoughts and feelings has already been associated with reductions in positive affect (e.g., Killingsworth & Gilbert, 2010). However the research in this field has so far been correlational in nature and has not considered the relationship between mind wandering and positive affect within the context of depression. This thesis systematically followed the steps needed to evaluate if mind wandering is a causal mechanism, first by studying the association between mind wandering and anhedonia and then by causally manipulating mind wandering to see if this alters positive emotional experience. Throughout the thesis this mechanism has been tested using a triangulation of measures, both in terms of measurement of mind wandering (self-report questionnaires, behavioural tasks, thought probes) and in the measurement of positive affect disturbances (reactivity to positive tasks and background mood) using both self-report and psychophysiological measures of emotion.

This general discussion will begin with a summary of the experimental results from this thesis. The theoretical, methodological and clinical implications of the data collected will then be discussed. Next the strengths and a critique of the methodology adopted in this thesis will be presented and finally suggestions for future research will be considered.

## 8.1 Summary of experimental results

- Chapter three (studies 1a and 1b) examined associations between self-report measures of mind wandering and anhedonia in two samples – community and treatment seeking (total n = 849). Results revealed that trait mind wandering was uniquely related to self-reported anhedonic symptoms. In both studies, mind wandering was uniquely related to anhedonia when controlling for other facets of mindfulness and general depression severity. These studies built on previously published work which had presented mixed findings to establish a robust association between anhedonia and mind wandering.
- Chapter four (study 2) established a significant association between greater depression severity and increased mind wandering (measured using the SART and FFMQ-AA), however no relationship in terms of mind wandering during naturalistic positive events (total n = 70). Contrary to that predicted, depression was found to be unrelated to emotional reactivity (using both self-reported and psychophysiological measures) to the positive laboratory mood induction tasks. Mind wandering did not correlate with emotional reactivity measures to the positive video task and correlated only with increased negative emotional change to the positive memory. Greater mind wandering during naturalistic positive events correlated with reduced residual happiness change and trend correlated with increased sadness change. Altogether, this study provided no support for the view that mind wandering mediates the link between depression and attenuated positive reactivity, largely because depression was not related to positive emotional reactivity in this sample.
- Chapter five (study 3) aimed to evaluate mind wandering as a causal mechanism by creating a short laboratory mind wandering manipulation. Change in emotional reactivity (indexed with self-report and psychophysiological measures) to a positive memory recall task was compared between three experimental conditions; MW+, MW- and control (total n = 90). Manipulation checks revealed that levels of mind wandering did not reliably increase in the MW+ condition and there were no significant condition differences in happiness reactivity post-manipulation. Therefore, study 3 failed to provide causal evidence for the link between mind wandering and positive affect disturbances. However, correlations during the pre-manipulation memory recall revealed a significant correlation between spontaneous levels of mind

wandering and lower self-reported happiness reactivity. Furthermore, trait mind wandering correlated with a greater increase in self-reported negative emotion. Consequently, this study provided further correlational evidence for the link between mind wandering and emotional disturbances. However, because the manipulation of mind wandering was unsuccessful this precluded examination of the causal question.

- Chapter six (study 4) aimed to improve the mind wandering manipulation used in study 3 by using a longer training design delivered over one week. Change in emotional reactivity to naturalistic pleasant walks was compared between three experimental conditions; MW+, MW- and control (total n = 95). There was a successful manipulation of mind wandering however no significant pre-post differences in PA or NA change across the three experimental conditions, thus providing no causal support. Furthermore, there was no significant condition difference in residual PA or NA change when analysing the training walks only. Greater mind wandering during the first pleasant walk (pre-manipulation) only trend correlated with reduced change in PA but significantly correlated with increased change in NA. Therefore, despite mind wandering being successfully manipulated, this still did not change positive reactivity.
- Chapter seven (study 5) used MBCT to causally manipulate mind wandering in two recovered depressed samples – a group attending MBCT and a control group receiving no treatment (total n = 102). Correlational analysis pre-intervention revealed no support for an association between mind wandering and positive reactivity to the lab tasks but mind wandering during ESM did relate to lower PA and higher NA. Participants in the MBCT group demonstrated a reduction in mind wandering using the FFMQ and ESM thought probes, but no change in SART performance. Although no significant change in reactivity to positive mood tasks, participants in the MBCT group reported reduced anhedonic symptoms and increased PA/decreased NA/increased activity enjoyment using ESM. Change in mind wandering using the FFMQ was found to significantly mediate change in self-reported anhedonic symptoms, however change in mind wandering measured using thought probes did not mediate change in PA or activity enjoyment during ESM.

## 8.2 Theoretical implications

The most important implication from the results of the current data is that mind wandering has not been found to be causally related to positive affect disturbances. Results have revealed majority correlational support for the link between increased mind wandering and lower positive affect which is line with the small but growing evidence base from self-report questionnaires (Deng et al., 2012; Atanes et al., 2015; Zvolensky et al., 2006; Branstrom et al., 2010, 2011; Carciofo, Du, Song & Zhang, 2014; Raphiphatthana, Jose & Kielpikowski, 2016), behavioural tasks (Ruby, Smallwood, Engen & Singer, 2013; Marchetti, Koster & De Raedt) and ESM (Brown & Ryan, 2003; Franklin et al., 2013; Killingsworth and Gilbert, 2010; McVay, Kane & Kwapil, 2009). However, this thesis primarily aimed to establish causal evidence and from the five studies that have been conducted there are not yet firm conclusions that can be drawn regarding the role of mind wandering in anhedonia. A hint of a causal relationship was found in study 5 as change in levels of trait mind wandering after MBCT were found to mediate change in anhedonic symptoms. However, the lack of temporal precedence makes this evidence currently weak as change in the mediator variable (mind wandering) was not measured prior to change in the outcome variable (anhedonia). An analysis of the one year follow up data will allow for true causation to be assumed. For example, firm causal evidence will be established if change in levels of mind wandering is found to mediate levels of anhedonic symptoms at T3 in study 5. The mediation analyses in study 5 were only significant for self-reported questionnaire measures of mind wandering and anhedonia and were not significant when examining ESM variables (i.e. daily life mind wandering and levels of positive affect). However, this may reflect a lack of statistical power in the ESM analyses, as results were in the expected direction. With a lack of causal evidence we cannot be sure if mind wandering drives reduced positive affect or vice versa. It could be that mind wandering diminishes happiness but the reverse could also be true, that diminished happiness triggers mind wandering. A similar challenge has presented itself when examining the causal role of mind wandering in the experience of negative affect. Thus far, the majority of research linking mind wandering with negative affect has also been correlational (e.g., Stawarczyk, Margerus & D’Argembeau, 2013; Smallwood, Fitzgerald, Miles & Phillips, 2009). This has led some authors to discuss the concept of ‘spurious correlations’ (Mason, Brown, Mar & Smallwood, 2013). A spurious correlation occurs when two variables are found to be closely related but not due to any direct relationship and instead a third unexplained variable might be responsible for the displayed findings. Possible third variables that have been discussed for the relationship between mind wandering and negative affect are invariability/slow pace (monotonous tasks and activities are likely to increase mind wandering and increase negative affect), unresolved personal concerns (an unfulfilled goal is likely to increase thoughts about the goal and doubts about attaining it might increase negative affect) and disconcerting news. Other conceivable third variables include individual dispositions such as depression and neuroticism (see Mason, Brown, Mar & Smallwood, 2013).

Following on from this, it is also possible that mind wandering is more linked to experiences of increased negative affect rather than decreased positive affect. For example, study 1a of the current thesis found that the FFMQ-AA had a larger zero-order correlation with MASQ general distress ($r = -.49$) compared to the relationship with anhedonic depression ($r = -.41$). The FFMQ-AA was also found to be uniquely correlated to general distress when controlling for other mindfulness facets and MASQ symptom components. These findings were replicated in study 1b as once again the relationship between FFMQ-AA and BDI-other symptoms was stronger than the relationship with the BDI-anhedonia factor. There was once more a unique relationship between FFMQ-AA and BDI-other symptoms when controlling for remaining facets and BDI-anhedonia. Therefore, just as chapter three concluded that there is a robust association between trait mind wandering and anhedonia, the same is the case for the relationship between trait mind wandering and the negative symptoms of depression. Furthermore in study 2, the only significant relationship to emerge when relating mind wandering with emotional reactivity to the mood stimuli was with composite negative emotion change to the positive memory. Results revealed that increased mind wandering (measured using the SART) was related to a greater change in negative emotion and mind wandering was unrelated to happiness reactivity. This was further corroborated by study 3 as greater trait mind wandering correlated with increased negative emotion change to the positive memory pre-manipulation, but did not correlate with happiness reactivity. However, it should be noted that this is inconsistent with subsequent results that found greater spontaneous state mind wandering was related to lower happiness reactivity but was not significantly related to negative emotion reactivity. It can be argued that this spontaneous state measure of mind wandering is a superior measure as it is more likely to reflect the mind wandering occurrence that happened during the mood induction. Thus, the relationships emerging between trait mind wandering and increased negative affect could instead be due to a third unexplained variable rather than the direct effect of mind wandering itself.

Nevertheless, one further finding from the current thesis which strengthens the case that mind wandering is linked to negative affect is in study 5. Here a trend mediation was established between change in mind wandering during ESM and change in levels of momentary negative affect. In contrast, change in levels of momentary positive affect were not found to be significantly mediated by change in levels of mind wandering. Therefore, evidence from this thesis suggests that mind wandering is as related to increases in negative affect as it is decreases in positive affect, so it cannot be viewed as an anhedonic specific mechanism.

Overall, the status of mind wandering as a mechanism driving anhedonia is unclear. This thesis included three causal studies and of these studies only two were found to successfully alter levels of mind wandering (studies 4 and 5). In study 4, results revealed no link to positive affect disturbances, however this could be due to a weak manipulation which did not have a large impact on levels of mind wandering. In study 5, which used a more systematic training design, results did reveal some links to positive affect disturbances and a hint of a mediation. Consequently, it can be concluded that this thesis provides some (albeit very weak) support for mind wandering as a causal driver of anhedonia. There are now two options to take this research field further. First, to conduct further research examining mind wandering but using better methods (e.g. with more representative samples) or second, to conclude that mind wandering is not the primary driver of anhedonia. The latter option is likely to most constructive as if mind wandering does drive anhedonia the effects are very small and are not easily replicable. As a next step it may be worth redirecting attention to other mechanisms.

Chapter one of this thesis briefly introduced an emerging basic science literature base revealing a couple of other promising mechanisms (see section 1.3; see also Dunn & Roberts, 2016). Evidence from the current thesis that other mechanisms are likely involved in driving anhedonia is in studies 1a and 1b. Results revealed that in a community sample, the FFMQ-AA (when controlling for other mindfulness facets) accounted for only 7% of the total variance in anhedonic symptoms and only 6% of anhedonic symptoms in a treatment-seeking sample. Therefore as discussed in chapter 3, there are possibly many other mechanisms implicated. For example, there is developing research to show that depressed individuals differ in how they appraise positive events in their lives (Dunn & Roberts, 2016). The Response to Positive Affect questionnaire (RPA; Feldman et al., 2008), describes three appraisal types including emotion-focus savouring, “think about how happy I feel”; self-focus savouring, “think I am living up to my potential” and dampening, “think I don’t deserve this.”

Research has demonstrated that depressed individuals are more likely to utilise dampening appraisals in the light of something positive which reduces their levels of happiness (Feldman, Joorman & Johnson, 2008; Bijttebier, Raes, Vasey & Feldman, 2012; Eisner, Johnson & Carver, 2009; Nelis, Holmes & Raes, 2015). Cross-sectional associations have already been established between a dampening appraisal style and anhedonia (Raes , Smets, Nelis & Schoofs, 2012; Raes et al., 2014) and dampening has been found to be unique to anhedonia when controlling for other symptoms of depression (Werner-Seidler, Banks, Dunn & Moulds, 2013). Unpublished work has since begun to explore the causal connection between appraisal style and positive affect disturbance with consistent results. This work has included manipulation of appraisal style in a laboratory setting prior to a positive memory exercise (Hunt, Burr, Bunker-Smith, Dadgostar, & Dunn, in prep) and anticipatory pleasure exercise (Bos et al., in prep) and has extended to more ecologically valid settings with the use of event scheduling (Burr, Javaid & Dunn, in prep).

Another potential mechanism that may underlie anhedonia is a disconnection from bodily feedback which amplifies positive affect (Dunn & Roberts, 2016). Interoceptive awareness (i.e. an individual's perception and interpretation of their physiological signals) has been found to be impaired in depression (Dunn et al., 2007; Dunn et al., 2010; Furman, Waugh, Bhattacharjee, Thompson & Gotlib, 2013). There is also emerging evidence that deficits in interoceptive awareness are associated with anhedonia (Dunn et al., 2010; Furman et al., 2013; Harshaw, 2015). However, it should be noted that the observing facet of mindfulness (Baer et al., 2008), which measures attention to the body, has been found to be less consistently linked to positive affect (e.g., Desrosiers, Klemanski and Nolen-Hoeksema, 2013) which is inconsistent with interoceptive awareness as a driving mechanism. Overall, there are likely to be further mechanisms than the two that have been discussed here (e.g. positive situation selection and modification, see review by Quoidbach, Mikolajczak & Gross, 2015). Research is needed to carry out a systematic evaluation of all mechanisms as has been done for mind wandering in the present thesis.

A final theoretical implication of the current work is what it tells us about the nature of emotional disturbances in depression. Results have revealed a lack of significant correlations between depression and emotional reactivity to the positive mood tasks. For example in study 2, depression severity was unrelated to both self-reported and physiological emotional reactivity to the positive video and positive memory tasks. Similarly in study 5, depression did not correlate with happiness or negative reactivity to the positive video and memory tasks. These unexpected findings contradict those from a meta-analysis of emotional reactivity in depression (Bylsma, Morris & Rottenberg, 2008). This meta-analysis of 19 studies which compared emotional reactivity in healthy control participants with that of depressed individuals, concluded that depression is characterised by reduced emotional reactivity to positively valenced stimuli. Indeed, research has also found that depressed individuals respond with reduced emotional reactivity to negatively valenced stimuli, suggesting an overall global flattening of emotion (Bylsma, Morris & Rottenberg, 2008). However, not all published research has found this to be the case. In line with the findings from this thesis, one study found no differences between depressed and non-depressed samples with regards to cardiovascular measures, self-report ratings or facial expressions of happiness in response to amusing film clips (Tsai, Pole, Levenson & Munoz, 2003). No significant difference has also been found in startle response (Allen, Trinder & Brennan 1999; Dichter, Tomarken, Shelton & Sutton, 2004; Kaviani et al., 2004) or neural response to positive stimuli (Forbes & Dahl, 2005; Keedwell, Andrew, Williams, Brammer & Phillips, 2005; Mitterschiffthaler et al., 2003; Surguladze et al., 2005). Instead, this thesis provides clear support for reduced positive affect during everyday life in depression. Participants in study 5 with higher levels of depression reported significantly lower positive affect and higher negative affect during ESM. Anhedonia has been considered both a deficit in terms of longer-lasting background mood without the presence of a particular trigger and deficits in state positive affect in response to positive stimuli (see Rottenberg, 2005). The findings from this thesis would support the former definition and this has also been found in previous work (e.g., Peeters et al., 2003; Thompson et al., 2012). However, it is worth considering an alternative explanation for the lack of relationship between depression and emotional reactivity in studies 2 and 4. Firstly, as discussed in study 6, research has previously debated the accuracy of self-reported ratings of positive affect in those with depression (e.g. Keedwell et al., 2005). Furthermore these studies recruited student samples and evidence has suggested that younger populations report a reduced number of positive events rather than respond to positive events with less reactivity (van Roekel et al., 2015). However, this explanation would fail to explain the null findings in study 5 which utilised an adult sample. Another possible explanation is that this thesis utilised a better index of positive emotional reactivity (i.e. change in positive affect from before to after a mood induction), whereas much of the earlier literature in this field used a single absolute rating taken during the mood induction. An absolute measure of emotional response is likely to be confounded by baseline differences in emotion at set-point. As previously discussed, it is vital to consider temporal dynamics of affect over time (Davidson, 1998). Davidson stated that individuals may differ in terms of threshold (the level of intensity of a stimulus needed to induce an emotion), peak response (the maximum level of emotion experienced), rise time to peak (how long it takes for an individual to achieve a peak response) and recovery time (how long an emotion is maintained). This therefore highlights the importance of measuring affect over multiple time points. Overall, adding to the literature base on positive emotional reactivity in depression is always valuable as in order to improve our capacity to treat anhedonia it is important to fully understand the form it takes in depression.

## 8.3 Methodological implications

A clear methodological implication of the research in this thesis is the development of a novel and effective mind wandering manipulation tool. Results of study 4 indicated that participants engaging in a week-long training to either attend to the moment or follow their train of thought, reported significant differences in levels of mind wandering. The effects of this training successfully transferred to an event (walk 7) in which participants were not following an audio tape. The use of mindfulness prompts to reduce levels of mind wandering was consistent with previous studies that have used a short eight minute audio exercise (Mrazek, Smallwood & Schooler, 2012). The benefits of the manipulation designed in study 4 is that it is easy to implement (a trained mindfulness instructor is not needed) and can be listened to away from the laboratory and in multiple environments. Therefore, the identification of a method that reliably changes level of mind wandering could be used to see how it relates to other psychological phenomena. An example could be testing whether differing levels of mind wandering drive other features of depression such as rumination. An additional advantage is that this mind wandering manipulation can be delivered via smartphone app and therefore in ecologically valid environments whilst collecting ESM data.

A further methodological implication arose after completion of study 5. Within study 5, a SART was used as a behavioural measure of mind wandering and was delivered to participants via a secure online platform. As a result, participants were able to complete the SART whilst at home with the intention that this would reduce participant burden. However, it is clear from the results of study 5 that delivery of the SART in this way is not feasible. Error rates on the SART were extremely high and did not match those of participants completing a very similar SART in the laboratory. Errors of commission were 11 times more likely in the present study 5 compared to participants who report high levels of attentional lapses and were 22 times more likely than participants who report low levels (Manly, Robertson, Galloway & Hawkins, 1999). Such extreme differences in error rate is unlikely to be caused by differences in samples and more likely caused by differences in how the SART was delivered. Therefore, an important implication is the level of instruction given to participants prior to completing such cognitive experimental tasks and careful consideration is needed if these tasks are delivered away from a controlled laboratory environment.

The use of smartphone technology played a pivotal role in the research reported in this thesis. Due to the vast increase in the use of smartphone technology over recent years it is now relatively easy to harness digital technology in research and clinical settings. Utilising smartphone applications in studies 2, 4 and 5 enabled participants to be tested in their real-world environments and for larger datasets to be collected. Harnessing technology in study 5 in particular highlights a possibility of using ESM to collect outcome data after psychological interventions. Technology has recently been used to deliver clinical interventions (e.g., Gotink et al., 2016; Schueller & Parks, 2014; Kramer et al., 2014) and to provide individuals with personalised feedback (e.g., Hartmann et al., 2015). Therefore methods similar to those used in the current thesis are likely to provide a way forward for collecting ecological valid outcome measures and to deliver interventions to a wider population.

There are findings from the current thesis that support the use of dimensional measures rather than diagnostic categories when researching mental health. Diagnostic categories provide clear advantages in clinical settings, for example aiding communication about patients and informing therapists of the likely course of a disorder. However, a clear disadvantage of diagnostic categories is the vast individual differences that are present within one category which become overlooked. An example of this is in study 5 of the present thesis. Participants were recruited if they met ‘recovered depressed’ criteria, in other words they had previously met DSM-IV criteria for a major depressive episode but were currently feeling well. However, the use of the BDI-II provided an insight into the spread of depression severity in this one category. Although all meeting the same diagnostic criteria, 36.5% of MBCT participants displayed minimal symptoms, 15.4% mild symptoms, 34.6% moderate symptoms and 13.5% severe symptoms of depression. This wide spread of scores supports using a continuous measure of depression severity. Particularly in research on MBCT, this intervention has been recommended for patients with three of more past episodes of depression (Ma & Teasdale, 2004), thus suggesting that it is not beneficial to patients with only one or two past episodes. However, in support of a continuous view of depression severity, MBCT has more recently been found to reduce depressive symptoms irrespective of number of past episodes of depression (Geschwind, Peeters, Huibers, van Os & Wichers, 2012).

## 8.4 Clinical implications

This thesis has found that mind wandering is associated with reduced positive emotional reactivity, however from the data presented it cannot be concluded that mind wandering causes such emotional deficits. Nevertheless, the findings of study 5 demonstrate that a change in trait mind wandering mediates change in positive affect after MBCT and so there is potential that mind wandering will be found to be a causal mechanism in future research. By targeting anhedonic symptoms directly it is hoped this will lead to improvements in treatment outcomes. For example, Behavioural Activation (BA; Lewinsohn & Graf, 1973) has recently been reported to have a large acute effect size when comparing BA with a control condition (Hedges g = -.74) and a moderate effect size when comparing BA with antidepressant medication (Hedges g = -.42) (Ekers et al., 2014). In terms of relapse rates, approximately 50% will relapse in 12 months (Dobson et al., 2008). Altogether, this evidence highlights the potential of working to better target positive affect in BA and improve acute and relapse outcomes. Mechanism research such as that conducted in the present thesis will increase understanding of what stops enjoyment of positively scheduled events. For example, if mind wandering is found to causally influence positive disturbances, then supplementing BA with mindfulness skills that teach clients to remain in the moment as they complete positive events might be a way to advance this treatment. This mindfulness supplement could take a form very similar to that used as a MW- manipulation in study 4.

The results of study 3 provide very tentative evidence of how MBCT could be adapted for clients presenting with high levels of anhedonic symptoms. By correlating a multi-faceted measure of trait mindfulness skills with the MASQ (a measure of the tripartite model of depression and anxiety symptoms), results indicated that anhedonic clients would benefit most from skills relating to the facets of acting with awareness, nonreacting and observe. Similarly, anxious clients might benefit particularly well from skills relating to nonreacting. This idea of tailoring an intervention to meet a client’s needs is referred to as ‘personalised medicine.’ Such a personalised approach has been used in the physical health domain with success (Meric-Bernstam, Farhangfar, Mendelsohn & Mills, 2013). However, although the advantages of such an approach are clear (by helping a client to deal with their most pressing needs) there are pragmatic issues. One issue is how to determine which kind of intervention is most needed for which client. This tailored approach has clear economic implications and as such it could be most useful instead to make broad interventions (that teach a range of skills) available to a wider demographic.

Another key clinical implication is that examining possible mechanisms of MBCT will provide an opportunity to streamline the delivery and enhance the efficacy of MBCT via an emphasis of these mechanisms. However at present, the data from this thesis has limited implications for the delivery of MBCT. Continued mechanism research is important as MBCT is an alternative to ongoing antidepressant medication (Kuyken et al., 2015; Bondolfi et al., 2010) and clients often say that they would like alternative treatment to help them recover from depression in the long-term. Currently, research into mechanisms of change in MBCT is relatively slim in comparison to research demonstrating its efficacy. The results of study 5 revealed that MBCT improves daily positive affect, reduces daily negative affect and increases perception of activities as enjoyable. These results are in line with an emerging field of research linking MBCT with improved positive processing (e.g., Geschwind et al., 2011; Garland, Geschwind, Peeters & Wichers, 2015; Easterlin & Cardena, 1998; Erisman & Roemer, 2010). The addition of a one year follow up in study 5 will allow for conclusions to be drawn regarding whether increases in positive affect are an active ingredient of MBCT and thus protect people from further depression.

Chapter one of the present thesis stated how important it is to treat anhedonia. However, an important discussion point arises as it should be questioned how much positive affect is too much? Interestingly, research has shown that too much positive emotion is not necessarily a good thing and can lead to unbalanced emotional processing. For example, too much positive emotion can also develop into feelings of mania (Schwartz et al., 2002; Mansell & Pedley, 2008). Furthermore, a small amount of negative emotion is adaptive. Feeling sad is a motivator behind behavioural change and feeling scared helps us to escape a situation (Fredrickson & Losada, 2005). Therefore, when targeting mechanisms that maintain anhedonia there should be consideration regarding an optimal level of positive affect. However, it is relatively unlikely for clients with severe anhedonia to present with such extreme levels of positivity. Overall this highlights a need to design adapted treatments carefully and to consider how much emphasis is placed on the building of positive emotions.

Another important consideration is what has previously been termed the ‘Pollyanna problem’ (Dunn, 2012). The Pollyanna problem refers to the sensitivity that is needed when promoting positive emotions in clients that are severely depressed and potentially suicidal. This has already been critiqued as the pitfall of positive psychology approaches (Dunn & Roberts, 2016) and it is possible that methods used to target anhedonia mechanisms could backfire (e.g., Wood, Perunovic & Lee, 2009; Sin, Della Porta, & Lyubomirsky, 2011; Huffman et al., 2014).

## 8.5 Strengths of the research

The main strength of the research presented is the careful systematic steps that were taken in evaluation of mind wandering as a mechanism. The combination of both correlational research (studies 1a, 1b and 2) with causal manipulation designs (studies 3, 4 and 5) enables true conclusions to be drawn with regards to the role of mind wandering in anhedonia. The triangulation of measures throughout the thesis ensured results were not tied to one particularly methodology and results were likely to be most reflective of a participants behaviour.

The use of ESM is a particular strength of the research presented in this thesis. Event-contingent designs (also referred to as event scheduling) were used in studies 2 and 4 and a signal-contingent design (also referred to as experience sampling) was used in study 5. ESM has a number of clear benefits including the ability to test psychological phenomena in multiple settings and increasing ecological validity by the ability to generalise findings to real life settings. ESM was particularly beneficial when investigating mind wandering as it minimised memory bias that would typically result from the use of retrospective measures. A combination of both controlled laboratory testing and ESM within the same study (for example in studies 2 and 4) is particularly advantageous as emotional reactivity in the laboratory and real world can be compared within the same participants and provides a balance between experimental control and ecological validity.

A further strength of the research was the use of online technology to deliver measures in study 5. Although presenting with its own caveats (e.g. in delivery of the SART as discussed in section 8.3), in general this approach proved valuable for a number of reasons. First, participants were from a wider geographical area than would have been possible if testing had been limited to the Exeter region. This allowed for participants to be recruited from more than one therapy centre (North Devon and Exeter) and this increases the representativeness of the study findings. Second, completing the measures at home minimised burden and disruption to the participant's life. Third, completing the measures away from the laboratory reduces the chance of experimenter bias and the 'observer-expectancy' effect.

## 8.6 Limitations of the research

There were also a number of limitations to the research reported in this thesis. Firstly, studies 1a and 1b utilised only questionnaire data which can be criticised for its lack of ecological validity. It is questionable how much self-reported mind wandering and anhedonia represent real life behaviour. This argument can also be raised for the positive mood tasks that were used in studies 2, 3 and 5 as these tasks are likely to be different to activities participants choose in their daily lives to generate positive affect. However, in research there is always a careful balance (and to some extent a trade-off) between ecological validity and the degree of experimental control.

A further limitation is that the mind wandering manipulation paradigms used in studies 3 and 4 were not well validated prior to use. Consequently, it was unknown prior to conducting these studies how effective these manipulations would be. However, as there was not yet any published methodology that would have been suitable there was a risk that it would not be effective, as is often the case in research when developing something new. As an example, the manipulation used in study 3 failed to change levels of mind wandering between conditions and therefore causal evidence could not be established.

Another limitation is the measurement of psychophysiological measures of emotional reactivity in studies 2 and 3. The methods chosen (EDA and heart rate) can be criticised. For example, changes in EDA are ambiguous and can result from a wide range of psychological processes rendering this data hard to interpret (see Roth, Dawson & Filion, 2012). Similarly, heart rate data is just as difficult to interpret as an increase in heart rate can be a result of increased sympathetic and decreased parasympathetic activity. For this reason an analysis of heart rate variability (HRV) is often preferred as it enables separation of sympathetic and parasympathetic influences on the heart (Appelhans & Luecken, 2006; Porges, 2007). However, this analysis was not feasible in the current thesis as in study 2 the signal was not collected at a sufficiently high sampling rate and in study 3 due to movement artefacts in the ECG signal. EDA and heart rate measurements could also be criticised for being only peripheral measures of bodily activity and so an improvement would have been an inclusion of electromyography (EMG) recording to provide a fuller picture of emotional responding.

A significant limitation of the work in this thesis is the lack of a state measure of mind wandering during the positive mood tasks in study 2 and study 5. As a result, correlations were conducted between trait and behavioural measures of mind wandering and emotional reactivity to these tasks. This was a potential oversight as it would have been more accurate to see how mind wandering occurring during these tasks correlated with emotional reactivity. Indeed, study 3 used this approach and found a significant correlation between state spontaneous mind wandering and reduced happiness reactivity. This inconsistency between studies might provide an explanation for the lack of significant findings between mind wandering and emotional reactivity to the mood tasks used in studies 2 and 5.

A limitation of study 3 and study 4 is a lack of in-activity ratings of emotional experience. Within these studies, positive affect was measured immediately prior to the positive activity (e.g. memory recall/walk) and immediately after. It was designed this way in order to minimise disruption to the positive activities, however future studies might benefit from brief in-activity ratings of PA and NA as opposed to relying on retrospective ratings as this will more sensitively assess change in positive emotional experience.

Another limitation to highlight is the relatively high attrition rate between testing sessions in study 5. Due to this attrition rate sample sizes at the second testing session were relatively small which has a knock on effect on the generalizability of findings from this study. Furthermore, attrition can lead to bias in the sample as those that dropped out of the study may have been fundamentally different to those that decided to remain in the study. For example, those in the MBCT group that did not complete the second testing session may not have found MBCT to be as beneficial as those that remained in the group.

An important limitation is that none of the studies in this thesis were conducted on a clinically depressed sample. Therefore, caution has to be taken when generalising the present findings to acute clinical depression.

A final limitation to consider is the sole focus on liking disturbances in this thesis. Within the Research Domain Criteria (RDoC) developed by the National Institute of Mental Health (NIMH), anhedonia has been characterised as a construct consisting of all components of the reward system including the ability to pursue (‘wanting’), experience (‘liking’) and learn from pleasure (‘learning’) (Berridge & Kringlebach, 2008). A recognition of anhedonia as more than just a liking deficit should play a pivotal role when considering how anhedonia is repaired in psychological interventions. Of similar importance is anticipatory pleasure, i.e. the pleasure felt when anticipating an upcoming reward. Analysis of how mind wandering (and other mechanisms) interact with these tasks will further advance understanding of anhedonia and how to treat it. For example, if a driving mechanism is found to disturb anticipatory pleasure then a client might not have the want or motivation to engage with the positive event.

## 8.7 Future directions

The next section of this chapter will present recommendations for future research. These recommendations will include specific research questions to be investigated through data collected in this thesis, mind wandering specific recommendations and recommendations for a broader understanding of anhedonia.

### *8.7.1 Remaining analyses from data collected in the current thesis*

Initial future recommendations include further analyses of study 5 as data collection for testing session three (one year follow up) and the never depressed control group is still ongoing. First, analysis of the one year follow up will determine if changes in positive emotional experience as a result of completing MBCT (reduced anhedonic symptoms, increased PA, decreased NA, increased activity enjoyment), drive reductions in relapse rates 12 months later. Further, analyses will be conducted to examine if changes in mind wandering as a result of completing MBCT drive reductions in anhedonic symptoms 12 months later. If found to be significant, this result will indicate a causal role of mind wandering. Next, analyses of the never depressed control group (tested at the first testing session only) will be conducted. Scores from the never depressed participants will be compared to both recovered depressed samples to examine the extent of residual deficits in positive affect in individuals who have a history of depression. In particular, reactivity to the positive mood tasks and levels of affect during ESM will be compared. It would also be valuable to examine the levels of mind wandering in both groups to assess if individuals with no prior history of depression exhibit a significantly lower tendency to mind wander.

### *8.7.2 Mind wandering specific recommendations*

As described in chapter one, anhedonia is not a unitary construct and so far research in this thesis has only explored how mind wandering relates to consummatory disturbances. Therefore, future research would benefit from exploring if and how mind wandering relates to the pleasure experienced when anticipating a forthcoming reward. Although most heavily researched with regards to schizophrenia, previous research has demonstrated that individuals with depression show impaired anticipatory pleasure (Sherdell, Waugh & Gotlib, 2012). It is important for treatments to target all presentations of anhedonia and in order to do so future research must determine driving mechanisms at each level of the symptom.

Second, future research should explore the connection between mind wandering and a cognitive mechanism known to drive increased negative affect in depression – rumination (Nolen-Hoeksema, 2000; Mor & Winquist, 2002; Kirkegaard Thomsen, 2006). It is apparent that these two constructs are highly related as low levels of trait mindfulness are associated with a tendency towards rumination (Raes & Williams, 2010). However, compared to the relatively fleeting nature of mind wandering, rumination is referred to instead as “sticky thinking” (Joormann, Levens & Gotlib, 2011) and is characterised by repetitively thinking and dwelling on causes and consequences of negative experiences. Ruminative processes are therefore extremely detrimental to mental wellbeing (e.g., Spasojević & Alloy, 2001; Moulds, Kandris, Starr & Wong, 2007) and although currently conjecture it would be interesting for research to examine if an increased tendency to mind wander is a precursor to rumination. This research could be prospective, measuring both the tendency to mind wander and ruminate several months apart. Analyses could then be carried out to assess if mind wandering predicts future rumination when controlling for levels of rumination at baseline. If significant, mind wandering could be treated prior to developing into depressive rumination.

Third, research could investigate the content of mind wandering and how this relates to positive affect disturbances in depression. According to the Content Regulation Hypothesis (Smallwood & Schooler, 2015), the relationship between mind wandering and outcomes (e.g. mood) is likely to depend on the qualitative nature of mind wandering experiences. Research so far has explored the role of temporal focus (e.g. past or future thinking) and negative affect, with negative moods and depression associated with a retrospective bias (Smallwood & O’Connor, 2011). Further, only mind wandering of a negative nature was found to predict sad mood (Poerio, Totterdell & Miles, 2013). In a similar way, it would be beneficial to determine whether specific types of mind wandering are more or less related to lower positive emotion and it could be that a causal relationship between mind wandering and anhedonia is established when accounting for its content. Possible questions that could be asked include; temporal orientation, valence, personal concerns and level of interest.

Fourth, the mind wandering manipulation paradigm established in study 4 could be used in future research to explore the role of mind wandering in other psychological phenomena and disorders. For example, anhedonia is also a feature of schizophrenia (e.g., Horan, Kring & Blanchard, 2006; Blanhard, Mueser & Bellack, 1998). In the same way as the present thesis, it is important to understand the drivers of anhedonia in this condition. Thus, a study similar to that used in study 4 could be completed on individuals with schizophrenia to explore if mind wandering is a cause of blunted emotional reactivity in this disorder. Furthermore, this thesis did not evaluate the role of mind wandering in positive emotional experiences in acute clinical depression. A next step could be to use methods similar to that in the present study to examine if there is a different (and possibly clearer) relationship between mind wandering and positive affect in clinically depressed individuals.

Finally, a qualitative study could be conducted on individuals who have completed MBCT. This qualitative study could address a number of questions with the main focus on the experiences of positive emotions. It would be interesting to ask clients what they think is a contributor to feeling happier. This study of mindfulness and positivity from a completely different angle might provide further insight into how MBCT works to bolster positive affect.

### *8.7.3 Recommendations for a broader understanding of anhedonia*

The steps used in the current thesis could be used to evaluate other potential driving mechanisms of anhedonia. Steps have included; examining associations between self-reported measures, examining associations in the laboratory and in real world settings, causal manipulation of mechanism in the laboratory, causal manipulation of mechanism in the real world and finally examination of the mechanism within the context of treatment. As already discussed other potential mechanisms that have received some empirical support already include positive appraisal styles and awareness of bodily feedback (see Dunn & Roberts, 2016). However, other mechanisms should also be considered including deficits in selecting and initially attending to positive material. For example, depressed individuals have displayed an increased tendency to avoid happy faces (Bradley, Mogg, Falla & Hamilton,

1998) and display preference for mood congruent or negative material (e.g. Gotlib, Krasnoperova, Yue & Joormann, 2004). The following steps could therefore be taken to examine if an attentional bias is a driver of anhedonic symptoms. First, correlations between attentional bias measures (e.g. dot probe task; MacLeod, Mathews, and Tata, 1986) with measures of depression and anxiety symptoms (e.g. MASQ-S) should be conducted in order to explore if a significant association exists and additionally if an attentional bias is unique to anhedonia. Next, manipulation of attentional bias in the laboratory (e.g. with cognitive bias modification techniques; see Hallion & Ruscio, 2011) to observe effects on positive emotional reactivity, followed by manipulation in the real world. It could then be formally observed how treatments designed to reduce negative attentional bias and increase positive attentional bias change anhedonic symptoms and positive processing with a longitudinal follow up to assess if a modified bias drives changes in symptoms.

Future research could also explore driving mechanisms underlying anhedonia in child and adolescent populations. Depressed children have been found to report anhedonia and show less involvement in seeking rewards (Kazdin, 1989). As also discussed in section 1.2.3.1, adolescents that display subthreshold anhedonia are 3.76 times more likely to develop depression (Georgiades, Lewinsohn, Monroe & Seeley, 2006). This research highlights the importance of studying anhedonia in younger populations and it should not be assumed that mechanisms found to drive reduced positive affect in adults are also apparent in children.

## 8.8 Overview

This thesis aimed to evaluate mind wandering as a causal mechanism driving anhedonia in depression. Taking the findings from this thesis together, two main concluding points can be made. First, mind wandering has been found to be related to reduced positive affect in multiple domains; self-report questionnaires of anhedonia, reactivity to real world events, reactivity to a laboratory positive memory recall task and levels of affect in daily life. However, interpretation of this relationship is difficult as it is unknown if a third unexplained variable is responsible, resulting in spurious correlations. Second, this thesis provides only very weak support for mind wandering as a driver of anhedonia. In the two studies that successfully manipulated levels of mind wandering there was either no effect on emotional reactivity or only a hint of a mediation. Consequently, a key recommendation for future research is to redirect attention to other driving mechanisms that may produce larger effects and are more easily replicable. A further recommendation is to potentially steer away from basic science research and to enhance depression treatments using other methods with greater ecological validity. For example, a practice of incorporating standardised anhedonia measures into existing intervention trials along with measures of hypothesised mechanisms (as in study 5) will enable conclusions about how effective interventions are at targeting different mechanisms and if these mechanisms are related to beneficial outcomes. This will then enable a more global picture of if and how treatments work to build positive affect using representative samples.

Altogether, research continuing our understanding of positive affect disturbances in depression is greatly advised. Anhedonia predicts the onset of depression, poorer depression prognosis and the presence of positive affect is an important protective factor. Research into this poorly understood symptom is likely to substantially improve acute and relapse prevention treatment outcomes as we learn to successfully target both increased negative affect *and* decreased positive affect in depression.

# Appendices

## APPENDIX ONE: Mood Disorders Centre risk protocol

**THOUGHTS**

*"I see that you've said / you mentioned that……… These are thoughts / feelings that people suffering from depression often have, but it's important to make sure you are receiving the right kind of support. So I would now like to ask you some more questions that will explore these feelings in a little more depth."*

---

**PLANS**

1 Do you know how you would kill yourself? Yes / No

If **yes –** details

2 Have you made any actual plans to end your life? Yes / No

If **yes –** details

---

**ACTIONS**

3 Have you made any actual preparations to kill yourself? Yes / No

If **yes –** details

4 Have you ever attempted suicide in the past? Yes / No

If **yes –** details

---

**PREVENTION**

5 Is there anything stopping you killing or harming yourself at the moment? Yes / No

If **yes –** details

6 Do you feel that there is any immediate danger that you will harm or kill yourself? Yes / No

Details:

---

FOLLOW-UP FROM PREVIOUS CONTACT

7 **If Action B was enacted at previous assessment and level B risk is identified at current assessment**: Last time we met I suggested that you spoke to your GP about these thoughts, and I also wrote to your GP about this. Have you been able to speak with your GP about these thoughts since we last met? Yes / No

**See risk table overleaf for appropriate actions**

**Researcher Risk Protocol** To be used following any indication of risk from questionnaire items, responses to interview questions or any other sources. Look at answers from the sheet to determine the level of risk, A B or C:

| **Actions by Researcher** | ***Tell Participant*** |
|---|---|
| All answers 'no' apart from Q5 'yes': **A** | *I can see that things have been very difficult for you, but it seems to me these thoughts about death are not ones you would act on – would this be how you see things? (if they say yes) I would advise you to make an appointment to see your GP to talk about these feelings* ***(as per trial protocol)****.* |
| 'Yes' for any **one** of Qs 1-4; plus 'yes' for Q5 and 'no' for Q6 **B1** | *Things seem to be very hard for you right now and I think it would help if you were to speak to your GP about these feelings. I will be writing to your GP to tell them that you have been here today and have been having some troubling thoughts. I would also advise you to make an appointment to see your GP to talk about these feelings. (***as per trial protocol).*** |
| 'Yes' for any **one** of Qs 1-4; plus 'yes' for Q5 and 'no' for Q6 **and** 'no' to Q7 B2 | *I think it's important that your GP knows how difficult things are for you right now. I will be telephoning your GP to speak with him/her and suggest that you meet with one another. I also advise that you make an appointment to see your GP to talk about these feelings.* ***(as per trial protocol****).N.B: telephone call to GP to be followed up by letter. The letter should include the statement "*the clinical management of this patient remains your responsibility, but it is part of our protocol to inform you of any risks disclosed to ourselves so that you can take account of them in your care plan.*"* |
| Scoring 'no' to Q5 or 'yes' to Q6 **C** Actively Suicidal | *I am very concerned about your safety at this moment, I am not a clinician but I would like you to talk to one right now. I am going to make some telephone calls now to your GP Care Co-ordinator / Crisis Management team/the emergency services to let them know how you are feeling and to arrange for you to receive immediate help.* |

Action to take in the case of immediate risk:
Participant needs immediate help – **do not leave them alone, or if on telephone, do not hang up**. Follow your trial's chain of supervisory clinical contact in order to involve

supervisory clinician right away. Then either yourself or the supervisory clinician* should follow the chain of contact below:

**1. GP / out of hours GP**; <u>if not</u>

**2.Crisis team;** <u>if not</u>

**3. Call ambulance; if this does not result in ambulance attending 4..Clinician accompanies to A&E** (by taxi rather than private car)

**Individual projects should determine in advance whether clinician or researcher (with clinician support) enacts steps 1-4*

**<u>P.T.O.</u>**

**<u>Action to take after responding to immediate risk:</u>**

1. Document action taken.
2. Fax letter to GP documenting information gathered and action taken.
3. Seek / offer supervision around support and debriefing as appropriate.

## Risk Report

Patient name: ______________________ DOB: _________________

*Suicide risk information:*

*Include whether the participant has reported any of the following:*

- *History of previous suicide attempts*
- *Current suicidal ideation*
- *Relevant inventory scores (e.g., BDI item 9)*
- *Suicide plans / preparations*
- *Protective factors*
- *Regular contact with GP?*

*Date reported:* ___/___/___

*Additional notes / actions taken:*

*As part of the MDC risk protocol, suicide risk is **managed** by the patient's GP.*

*Date action taken:* ___/___/___

APPENDIX TWO: Poster advert used to recruit dysphoric sample in study 2

# Take part in research at the University of Exeter

**Have you recently been suffering from a depressed mood and/or a loss of interest or pleasure in life activities?**

You are invited to take part in research that is being conducted within the Mood Disorders Centre at the University of Exeter. We are particularly interested in people who feel they may have been suffering from depression symptoms but everyone is welcome to take part. **<u>However, you must be aged 18 or over.</u>**

You will have the opportunity to help out upcoming research looking at how people experience positive activities in their everyday lives. You will be required to attend a 2 hour appointment at the university where you will be asked to fill in several questionnaires about mood and how you react in certain situations and then complete simple tasks on the computer. During this appointment we will also be measuring your biological responses such as heart rate using non-invasive stick-on sensors. This research is using innovative methods to study psychological phenomena in the real world. We will therefore ask you to answer some questions when completing 3 positive activities (e.g. walking the dog, listening to music) of your choice in your own time the following day.

**If you would like further information about this study and how you can take part please contact Grace Fisher (PhD student) at [gf238@exeter.ac.uk](mailto:gf238@exeter.ac.uk) or telephone 01392 722638.**

Grace Fisher
gf238@exeter.ac.uk

Grace Fisher
gf238@exeter.ac.uk

Grace Fisher
gf238@exeter.ac.uk

Grace Fisher
gf238@exeter.ac.uk

Grace Fisher
gf238@exeter.ac.uk

Grace Fisher
gf238@exeter.ac.uk

Grace Fisher
gf238@exeter.ac.uk

Grace Fisher
gf238@exeter.ac.uk

Grace Fisher
gf238@exeter.ac.uk

Grace Fisher
gf238@exeter.ac.uk

APPENDIX THREE: Ethical approval for study 2

Psychology Research Ethics Committee

Psychology, College of Life & Environmental Sciences

Washington Singer Laboratories
Perry Road
Exeter
EX4 4QG

Telephone +44 (0)1392 724611
Fax +44 (0)1392 724623
Email Marilyn.evans@exeter.ac.uk

| | |
|---|---|
| **To:** | **Grace Fisher** |
| **From:** | **Cris Burgess** |
| **CC:** | **Barney Dunn** |
| **Re:** | **Application 2012/528 Ethics Committee** |
| **Date:** | **June 11, 20173** |

The School of Psychology Ethics Committee has now discussed your application, ***2012/528 – Does mind wandering act as an underlying mechanism for anhedonia – exploration with an event scheduling method .*** The project has been approved in principle for the duration of your study.

The agreement of the Committee is subject to your compliance with the British Psychological Society Code of Conduct and the University of Exeter procedures for data protection (http://www.ex.ac.uk/admin/academic/datapro/). In any correspondence with the Ethics Committee about this application, please quote the reference number above.

I wish you every success with your research.

Cris Burgess

Chair of Psychology Research Ethics Committee

APPENDIX FOUR: Complete block structure of the SART in study 2

| Higer order block | 1 | | | | | 2 | | | | | 3 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Block number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| No. targets | 22 | 18 | 26 | 14 | 10 | 26 | 14 | 22 | 10 | 18 | 26 | 22 | 18 | 10 | 14 |
| Seconds | 55 | 45 | 65 | 35 | 25 | 65 | 35 | 55 | 25 | 45 | 65 | 55 | 45 | 25 | 35 |
| 1 | 6 | 7 | 7 | 9 | 9 | 5 | 8 | 2 | 7 | 7 | 2 | 4 | 4 | 2 | 7 |
| 2 | 3 | 8 | 6 | 2 | 6 | 4 | 4 | 3 | 1 | 5 | 6 | 7 | 7 | 9 | 5 |
| 3 | 9 | 3 | 1 | 1 | 8 | 9 | 1 | 5 | 9 | 4 | 7 | 2 | 6 | 6 | 6 |
| 4 | 7 | 2 | 3 | 8 | 3 | 6 | 9 | 1 | 2 | 8 | 9 | 5 | 5 | 5 | 8 |
| 5 | 2 | 4 | 9 | 3 | 4 | 8 | 2 | 9 | 3 | 6 | 8 | 8 | 6 | 3 | 8 |
| 6 | 1 | 5 | 5 | 4 | 1 | 1 | 3 | 4 | 8 | 1 | 5 | 3 | 1 | 1 | 3 |
| 7 | 8 | 2 | 2 | 4 | 5 | 3 | 6 | 7 | 4 | 9 | 1 | 6 | 3 | 2 | 7 |
| 8 | 4 | 9 | 9 | 3 | 7 | 2 | 5 | 8 | 7 | 3 | 4 | 4 | 9 | 9 | 3 |
| 9 | 5 | 4 | 3 | 7 | 2 | 7 | 7 | 6 | 5 | 2 | 3 | 1 | 5 | 1 | 5 |
| 10 | 9 | 6 | 6 | 1 | 9 | 8 | 8 | 1 | 6 | 4 | 2 | 9 | 7 | 4 | 4 |
| 11 | 5 | 8 | 1 | 5 | TP | 7 | 8 | 5 | TP | 5 | 7 | 8 | 3 | TP | 2 |
| 12 | 6 | 3 | 8 | 8 | | 9 | 4 | 3 | | 1 | 8 | 9 | 2 | | 6 |
| 13 | 3 | 7 | 4 | 2 | | 6 | 6 | 9 | | 3 | 5 | 1 | 8 | | 9 |
| 14 | 1 | 1 | 7 | 6 | | 3 | 7 | 2 | | 2 | 4 | 3 | 1 | | 1 |
| 15 | 4 | 5 | 9 | TP | | 2 | TP | 3 | | 8 | 9 | 6 | 4 | | TP |
| 16 | 7 | 8 | 6 | | | 5 | | 9 | | 9 | 6 | 2 | 4 | | |
| 17 | 2 | 4 | 2 | | | 1 | | 8 | | 7 | 3 | 7 | 7 | | |
| 18 | 8 | 2 | 3 | | | 4 | | 5 | | 6 | 1 | 5 | 8 | | |
| 19 | 5 | TP | 5 | | | 5 | | 2 | | TP | 8 | 4 | TP | | |
| 20 | 6 | | 4 | | | 6 | | 1 | | | 6 | 9 | | | |
| 21 | 1 | | 7 | | | 3 | | 6 | | | 3 | 8 | | | |
| 22 | 9 | | 1 | | | 9 | | 4 | | | 7 | 2 | | | |
| 23 | TP | | 8 | | | 7 | | TP | | | 5 | TP | | | |
| 24 | | | 6 | | | 1 | | | | | 9 | | | | |
| 25 | | | 7 | | | 4 | | | | | 1 | | | | |
| 26 | | | 5 | | | 2 | | | | | 2 | | | | |
| | | | TP | | | TP | | | | | TP | | | | |

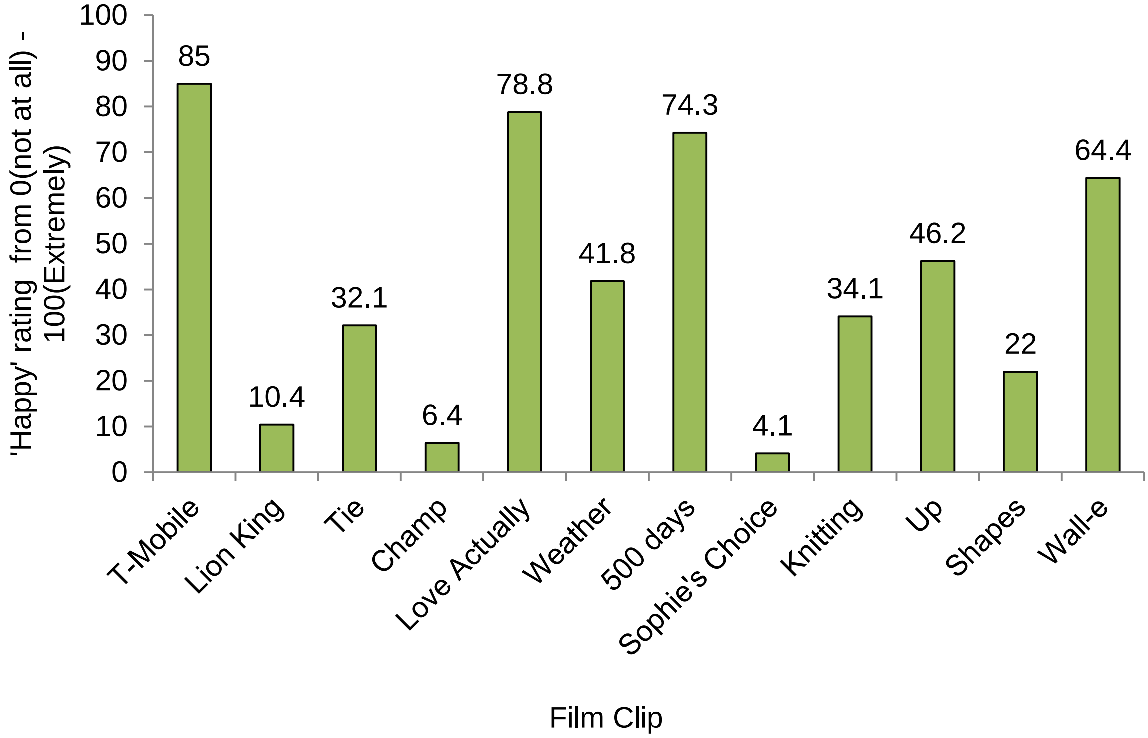
| Higer order block | 4 | | | | | 5 | | | | | 6 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Block number | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| No. targets | 18 | 14 | 26 | 22 | 10 | 14 | 22 | 10 | 26 | 18 | 14 | 26 | 10 | 18 | 22 |
| Seconds | 45 | 35 | 65 | 55 | 25 | 35 | 55 | 25 | 65 | 45 | 35 | 65 | 25 | 45 | 55 |
| 1 | 4 | 6 | 4 | 6 | 4 | 9 | 7 | 8 | 9 | 8 | 9 | 5 | 8 | 5 | 1 |
| 2 | 8 | 1 | 3 | 5 | 6 | 4 | 4 | 5 | 1 | 5 | 5 | 8 | 3 | 2 | 8 |
| 3 | 3 | 5 | 8 | 2 | 8 | 3 | 9 | 6 | 6 | 7 | 2 | 3 | 4 | 8 | 5 |
| 4 | 6 | 4 | 5 | 3 | 2 | 2 | 3 | 4 | 4 | 4 | 8 | 7 | 5 | 3 | 2 |
| 5 | 2 | 9 | 2 | 4 | 3 | 6 | 2 | 3 | 7 | 6 | 6 | 4 | 9 | 9 | 8 |
| 6 | 1 | 7 | 8 | 7 | 5 | 1 | 1 | 1 | 2 | 3 | 7 | 6 | 1 | 3 | 9 |
| 7 | 7 | 8 | 7 | 2 | 1 | 7 | 6 | 9 | 3 | 1 | 4 | 5 | 4 | 7 | 3 |
| 8 | 5 | 2 | 5 | 3 | 4 | 5 | 7 | 7 | 5 | 2 | 1 | 8 | 9 | 1 | 7 |
| 9 | 9 | 3 | 9 | 1 | 7 | 8 | 4 | 2 | 8 | 9 | 3 | 1 | 7 | 6 | 4 |
| 10 | 3 | 7 | 3 | 9 | 9 | 6 | 3 | 8 | 5 | 7 | 2 | 7 | 6 | 5 | 5 |
| 11 | 1 | 6 | 6 | 8 | TP | 1 | 5 | TP | 7 | 3 | 9 | 3 | TP | 8 | 2 |
| 12 | 8 | 9 | 1 | 6 | | 2 | 9 | | 4 | 9 | 1 | 9 | | 4 | 6 |
| 13 | 5 | 2 | 4 | 5 | | 8 | 8 | | 6 | 4 | 4 | 2 | | 3 | 1 |
| 14 | 7 | 1 | 4 | 4 | | 5 | 1 | | 3 | 6 | 6 | 4 | | 2 | 8 |
| 15 | 2 | TP | 8 | 3 | | TP | 2 | | 1 | 1 | TP | 6 | | 7 | 4 |
| 16 | 4 | | 6 | 2 | | | 3 | | 2 | 8 | | 2 | | 9 | 6 |
| 17 | 9 | | 2 | 7 | | | 5 | | 9 | 5 | | 5 | | 4 | 3 |
| 18 | 6 | | 1 | 1 | | | 7 | | 7 | 2 | | 9 | | 6 | 7 |
| 19 | TP | | 3 | 9 | | | 6 | | 9 | TP | | 7 | | TP | 1 |
| 20 | | | 5 | 8 | | | 9 | | 3 | | | 3 | | | 5 |
| 21 | | | 9 | 6 | | | 8 | | 8 | | | 8 | | | 9 |
| 22 | | | 7 | 5 | | | 4 | | 1 | | | 1 | | | 2 |
| 23 | | | 8 | TP | | | TP | | 4 | | | 7 | | | TP |
| 24 | | | 7 | | | | | | 2 | | | 1 | | | |
| 25 | | | 9 | | | | | | 5 | | | 2 | | | |
| 26 | | | 1 | | | | | | 6 | | | 6 | | | |
| | | | TP | | | | | | TP | | | TP | | | |

APPENDIX FIVE: Washout used in emotional reactivity lab task in study 2 and study 5

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 2 | | | | | | 2 | | | 3 | | * | | 1 | | | | |
| 3 | | | % | | 1 | | | | | | | | | 2 | | | | | 2 |
| | | | | | | | | # | | | 1 | | | | | 3 | | 1 | |
| | 2 | | | | 3 | | | | | | | | | | | | | | |
| | | | | | | | | | 1 | | 2 | | ^ | | 2 | | | | |
| | | | | 1 | | | | | | | | | | | 1 | | | 3 | |
| 1 | | | 3 | | | | | | 3 | | ? | | | | | | | | 3 |
| | | £ | | | | | | 2 | | | | | | | | @ | | | |
| | | | | | | | | | | | | | 2 | | | | | | 2 |
| = | | | | | | | 1 | | | | 1 | | | | | | | | |
| | | | 1 | | | | | | | | | | | | | | | | |
| 2 | | 3 | | | | 1 | | | | | 3 | | | 1 | | | 2 | 1 | |
| | | | | | | | | | | | | | | | | | | | |
| | | | | 2 | | | 2 | | 3 | | | | | | 3 | | | | |
| | | | | | | | | | | | | | 2 | | | | | | |
| | 1 | | | | | | & | | | | | 1 | | | | | | | 1 |
| | | 3 | | | | | | | | 2 | | | | | | $ | | 2 | |
| 2 | | | | | 3 | | | | | | | | | | | | | | + |
| | | | | | | 1 | | | | | | | 1 | | | | | | |
| 3 | | 1 | | * | | | | | 3 | | | | | 2 | | | 3 | | 1 |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | | | | | | | | C | | | | A | | | | | | | B |
| | | C | | | B | | | | | | B | | | | | # | | | C |
| @ | | | | | | | | A | | | | | C | | | | | | |
| | | | | | B | | | | | C | | | | | | | A | | |
| | | A | | | | | | | | | | B | | | = | | | C | |
| B | | | | | | A | | | | £ | | | | | | | | | |
| | | | | | | | | | | | | | | | A | | | | A |
| | | | | C | | | | | C | | | | | | | | | | B |
| | | | | | | | | | | | | A | | | | | | | |
| | | A | | | ? | | A | | | | | | | | | $ | | C | |
| C | B | | | | | | | | | | | | C | | | | | | |
| | | | | | | | C | | | | B | | | | | | B | | |
| A | | | | | | | | | A | | | | | | A | | | | A |
| | | | | B | | | | | | | | | | | | | C | | |
| A | | | | | | | | | C | | | | | | | | | | |
| | | | | * | | | | | | | | A | | C | | | | | |
| | | | | | | | B | | | A | | | | | | | B | | A |
| C | | | A | | | | | | | | | | | ^ | | | | | |
| | | | | | | A | | | | | | | | | | A | | | |
| + | | B | | | | | & | | C | | B | | | | | | | * | C |

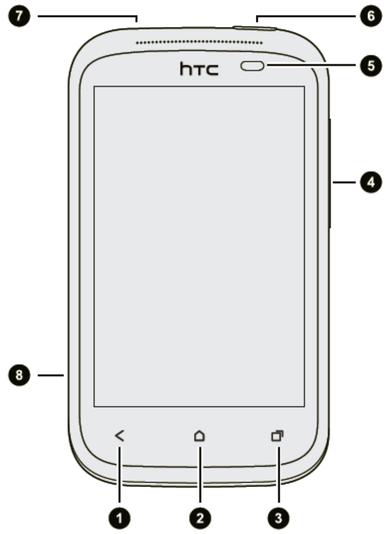
APPENDIX SIX: Results from film clip pilot study




In order for a film clip to be deemed appropriate for use in a positive mood induction it needs to elicit the 'target' emotion to a high enough intensity. For the purposes of this study it was decided that a mean score of 65 (on a scale of 1-100) for happiness would be sufficient. Three of the clips, T-mobile (=85), Love Actually (=78.8) and 500 days (74.3) met the criteria for a happiness inducing clip. A closer look at the type of positive affect (Gilbert et al, 2008) that these clips induce is also important. All three of these clips elicit high levels of *Active* positive affect (measured with the ratings of the adjectives lively, energetic and excited). T-Mobile elicits the highest level of this dimension with a mean score of 75.1 (Love Actually = 68.7, 500 days = 68.7). The T-Mobile clips also elicits the highest amount of *Relaxed* positive affect (relaxed, calm, peaceful) and *Safe/Warm* positive affect (safe, secure, content). Scores for Relaxed positive affect (T-Mobile = 61.9, Love Actually = 56.2, 500 days = 54.6). Scores for Safe/Warm positive affect (T-Mobile = 72, Love Actually = 64.2, 500 days = 60.6).

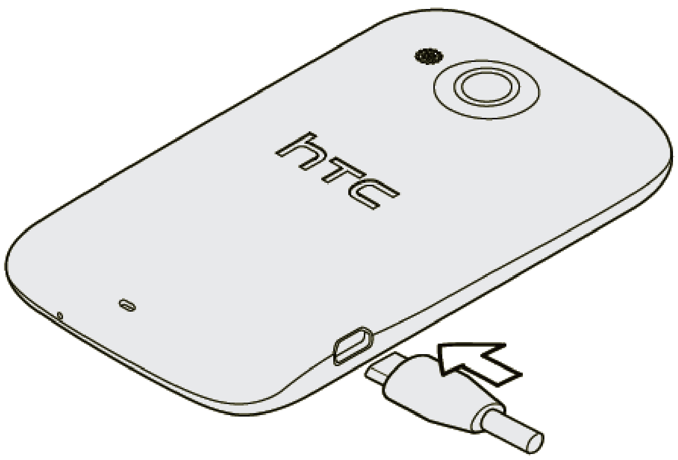
Thus, as the **T-Mobile** clip elicits the highest intensity for happiness and for each of the three dimensions of positive affect it is deemed most appropriate for use in a positive mood induction.

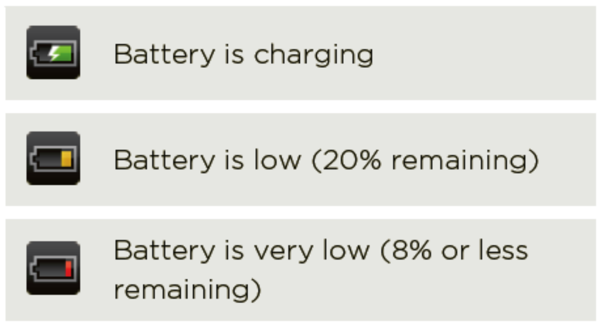
APPENDIX SEVEN: Smartphone guide for participants in study 2




**Charging the phone battery**

Insert the small end of the USB cable into the USB connector




Insert the other end of the USB cable into the power adapter
Plug in the power adapter to an electrical outlet to start charging the battery

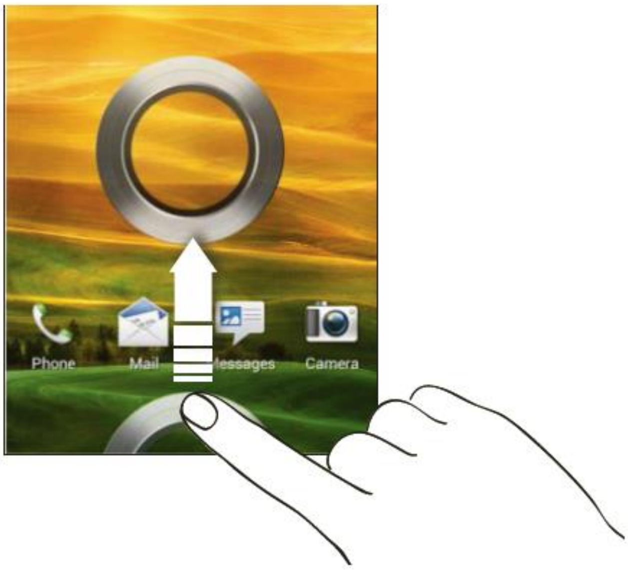
Please check the battery every night and charge overnight if needed. The alarms will not signal if the battery runs out and the phone turns off.

**Unlocking the screen**

Press button 6.

Pull the ring up to unlock the screen.

To lock the phone again press button 6.




**Turning the phone on and off (please avoid doing this if you can)**

Press and hold the power button for a few seconds (button 6).

**Adjusting the volume**

Please always keep the phone on a high volume so that you always hear the ringtone. However, if you need to adjust it press the down or up button on the side of the phone. (button 4). Please also note that if you press the volume button to the lowest setting then it puts it on a vibrator setting.

**Opening the app**

The symbol that you need to press in order to open the application looks like this:
This is displayed on the home screen of the phone. Tap once to open the app.

**Closing the app**

In order to close the application, tap the symbol that looks like a little house at the bottom of the phone.

**The App questions**

You only need to answer questions on the app when you hear the phone alarm.

There are various question types in this application including multiple choice and slider based questions. To use the slider control, press the blue dot and drag along the scale.

**The menu**

The menu that is displayed in the top right hand corner of the application is not for participant use. This is pin controlled. If you encounter an error whilst you are using the application then it might be that the researcher gives you a pin number to guide you through reprogramming the alarms. If at any point you are asked to do this you will see the below screens:

**Other applications on the phone**

This is a multi-function smartphone. However, please **DO NOT** use the phone for any other reason that for the research study you are taking part in.

**If you encounter any problems when using the phone please do not hesitate to get in touch on the contact details below. If possible please note down what happened when the error occurred and any error messages that you see.**

**Grace Fisher**
**01392 262444 gf238@exeter.ac.uk**

APPENDIX EIGHT: Ethical approval for study 3

# Ethical Approval system

Your application (2015/649) entitled The Effect of Mindfulness Meditation on Mood has been accepted

Please visit http://www.exeter.ac.uk/staff/ethicalapproval/

Please click on the link above and select the relevant application from the list.

APPENDIX NINE: Meditation transcripts used in lab manipulation study 3

MW-

MW+

So, begin by finding a comfortable position. If you are sitting on a chair, allowing your feet to be flat on the floor, with your legs uncrossed and align your spine to be straight so that your posture supports your intention to be awake and aware. So the posture can be comfortable, not stiff or tensed up. Allowing your eyes to close if that feels comfortable or lowering your gaze.

Roll your shoulders slowly forward and then slowly back. Lean your head from side to side, lowering your left ear toward your left shoulder, and then your right ear toward your right shoulder. Relax your muscles. Your body will continue to relax as you meditate.

And when you are ready, become aware of the fact that you are breathing. Notice how your breath flows in and out. Make no effort to change your breathing in any way, simply notice how your body breathes. Spend some time now just feeling the breath, coming into the body and leaving the body.

(pause)

Sooner or later you will probably find that the mind wanders away from the breath, to thinking, planning, remembering or day dreaming. When this happens there is no need to criticise yourself. Simply, registering where the mind had wandered to, then gently bringing your attention back to the breath. This mind wandering might happen over and over again, so each time, remembering that the aim is simply to notice where the mind has been then gently bringing your mind back to the breath. And using the stretches of silence in this exercise now, to practice this by yourself.

Sooner or later you will probably find that the mind wanders away from the breath, to thinking, planning, remembering or day dreaming. When this happens simply allow your mind to go to these places. There is no need to criticise yourself, just register where the mind has wandered to and follow your train of thought there. This mind wandering might happen over and over again, this is ok, simply use this time to freely explore the contents of your mind. And using the stretches of silence in this exercise now, to practice this by yourself.

(pause – 25 seconds)

**Again feel the breath coming into the body and out of the body. Truly focusing on the sensation of breathing. And allow your mind to be free.

(pause – 25 seconds)

Feeling each breath come and go of its own accord. And when your attention wanders, as it will… just focus back again on your breathing/ just allow yourself to go along with these thoughts and allow your mind to wander.

(pause – 25 seconds)

**Notice how your breath continues to flow...deeply and calmly. Bring full attention to each breath in each moment. If your mind wanders, follow each thought, wherever it might take you.

(pause – 25 seconds)

Once more a reminder that as thoughts intrude, not to criticise oneself but simply register where the mind has wandered to and then allow the thoughts to pass, and return your attention to your breathing/ simply allow your mind to drift off to wherever it takes you, really exploring these thoughts and the contents of your mind.

(pause – 25 seconds)

**Feel your breath's natural rhythm, not changing, just noticing each breath. And if you feel your mind wandering, gently bring your attention back to the present and focus once more on the flow of your breathing. Letting your mind feel unrestricted and free to pursue any thoughts that occur.

(pause – 25 seconds)

Remain fully alive to the sensations of breathing. For the full duration of each in breath and the full duration of each out breath. Not trying to control the breath in any way at all, simply letting the breath breathe itself. And when you notice that you mind is no longer on the breath, then noticing what is on your mind in that moment… and then gently letting go of whatever it is and letting it be, as we bring our attention back to this breath, whether it's an in-breath or an out-breath / and allowing yourself to think about this and letting your mind simply discover whatever it wants to in this current moment.

(pause – 25 seconds)

**Simply experience the breath as the air moves in and out of your body. Being totally present in each moment with each breath. And allow your mind right now to think about whatever it wants to.

(pause – 25 seconds)

Spending the rest of this exercise now, bringing your mind back to the breath, gently but firmly over and over again. You will then hear the sound of a bell, to signal the end of this exercise.

Spending the rest of this exercise now, allowing your mind to wander, freely and without restraint. You will then hear the sound of a bell, to signal the end of this exercise.

(long pause – 1 minute)

APPENDIX TEN: Nominating cue words for memories in study 3

**Participant code __________**

**Nominate your two positive memories:**

We are going to ask you to think of positive memories to draw upon later in the study, please write down **one sentence** to describe these memories below:

1.

2.

Can you now give both these memories a **cue word/phrase** that you can identify these memories by later:

1.

2.

APPENDIX ELEVEN: Ethical approval study 4


Psychology Research Ethics Committee

Psychology, College of Life & Environmental Sciences

Washington Singer Laboratories
Perry Road
Exeter
EX4 4QG

Telephone +44 (0)1392 724611
Fax +44 (0)1392 724623
Email Marilyn.evans@exeter.ac.uk


| | |
|---|---|
| **To:** | **Grace Fisher** |
| **From:** | **Cris Burgess** |
| **CC:** | **Barney Dunn** |
| **Re:** | **Application 2013/550 Ethics Committee** |
| **Date:** | **June 11, 20174** |

The School of Psychology Ethics Committee has now discussed your application, ***2013/550 – Does an intervention to reduce mind wandering lead to an increase in positive emotional reactivity during the completion of naturalistic positive events?*** The project has been approved in principle for the duration of your study.

The agreement of the Committee is subject to your compliance with the British Psychological Society Code of Conduct and the University of Exeter procedures for data protection (http://www.ex.ac.uk/admin/academic/datapro/). In any correspondence with the Ethics Committee about this application, please quote the reference number above.

I wish you every success with your research.

Cris Burgess
Chair of Psychology Research Ethics Committee

APPENDIX TWELVE: ESM manipulation transcripts for study 4

**MW MINUS CONDITION**

Welcome to today's activity.

The purpose of this exercise is for you to complete this activity, in this instance a 20 minute walk, with your full attention, focusing on your experience as it unfolds moment by moment.

During this walk you will hear occasional prompts to remind you of this. Between these prompts will be stretches of silence where you should then continue with your walk. The prompts that you hear will remind you to let go of any distracting thoughts or images that may have entered your mind and have taken you away from the present moment. You may for example have thoughts or images to do with what you plan on doing later today, an image of what friends and family could be doing, thoughts about something that is worrying you, thoughts about something you regret from the past or even thoughts about this experiment and what it's purpose might be. These distracting thoughts and images are what we term 'mind wandering' and it might happen over and over again throughout today's walk. Your aim is to simply notice when your mind goes off course like this and then gently guide it back to your walk and what you are currently doing.

So, if you find your mind has drifted from the present moment to thinking about something else, simply bring it back to whatever you are experiencing NOW (this for example might include your sensory experience such as sight or sound; perhaps bodily sensations like your heart beating or your how your muscles are feeling; or even what emotions you are currently experiencing).

When you are ready, please begin walking. And remember that this recording will be largely silent but occasionally it will give you a reminder to check if your mind has wandered and to bring it back to the current moment.

@ 5.37 mins

So you might have found that your mind *does* naturally wander away from what you are currently doing. When this happens, simply register where the mind has wandered to and then gently bring your attention back to the present moment and back to completing this activity. What is happening right now?

@ 9.40 mins

As you enter the second half of completing this walk, remember that when your attention does wander, as it probably will, to bring it back to what is happening right now, in this moment.

@ 13.25 mins

Once again, if you notice that you mind is no longer on what you are currently doing, then noticing what is on your mind in that moment… and then gently letting go of whatever it is and letting it be, as you bring your attention back to this activity.

@ 17.10 mins

A final reminder that for the rest of this exercise to keep focused on your walking experience and to put aside any wandering thoughts or images that may take you away from it. Remain present and in touch with your current moment.

@ 19.45 mins

This exercise is now coming to an end. Please now follow the prompts on the phone application.

**MW PLUS CONDITION**

Welcome to today's activity.

The purpose of this exercise is for you to complete this activity, in this instance a 20 minute walk, whilst at the same time letting your mind be free. Our minds show a tendency to drift to thoughts and images that are away from the 'here and now'. Whilst you complete this walk you should simply allow yourself to go along with any thoughts or images that you might have and just allow your mind to wander.

During this walk you will hear occasional prompts to remind you of this. Between these prompts will be stretches of silence where you should then continue with your walk. The prompts that you hear will remind you to pursue any distracting thoughts or images that may have entered your mind and have taken you away from the present moment. You may for example have thoughts or images to do with what you plan on doing later today, an image of what friends and family could be doing, thoughts about something that is worrying you, thoughts about something you regret from the past or even thoughts about this experiment and what it's purpose might be. These distracting thoughts and images are what we term 'mind wandering' and it might happen over and over again throughout today's walk. Your aim at these times is to go along with your wandering mind and let yourself freely follow whatever thoughts or images that you have as you complete this walk.

When you are ready, please begin walking. And remember that this recording will be largely silent but occasionally it will give you a reminder to allow your mind to wander to anything that may have entered your mind, despite it taking you away from your present moment experience.

@ 5.11 mins

So you might have found that your mind *does* naturally wander away from what you are currently doing. When this happens, simply allow your mind to freely do this. Let yourself be distracted from your current activity.

@ 9.27 mins

As you enter the second half of completing this walk, remember to simply let yourself be distracted by any thoughts or images that enter your mind. Remember that when your attention does wander, as it probably will, to let yourself freely follow it, allowing your attention to depart from your present moment experience.

@ 13.48 mins

Once again, if you notice that you mind is no longer on what you are currently doing, then noticing what is on your mind in that moment… and simply allow your mind to go here. Whilst you complete this activity, freely follow your mind, wherever it might take you.

@ 17.10 mins

A final reminder that for the rest of this walk to allow your mind to wander, freely and without restraint.

@ 19.48 mins

This exercise is now coming to an end. Please now follow the prompts on the phone application.

## Appendix THIRTEEN: Full set of questions used in experience sampling in Study 5

We would like to ask you some questions about what you are currently doing and your current thoughts and feelings.

1) To what degree during the 5 minutes before you heard the alarm had you been thinking about something other than what you were currently doing?

   0 (I was concentrated fully on what I was doing) – 100 (My mind wandered frequently to thoughts other than what I was currently doing)

2) You have indicated that to some extent you had thoughts about something other than what you were doing in the five minutes before the alarm. Please tick the box which best describes these thoughts.

- I thought about something that happened earlier today
- I thought about something that had happened in the recent past (last few days, but not today)
- I thought about something that happened in the distant past
- I thought about something that might happen in the future

3) Please tick the box which best describes the contents of these thoughts.

- I thought about something pleasant
- I thought about something unpleasant
- I thought about something neutral

4) Please rate how you are feeling at the moment: 0 (Not at all happy) – 7 (Very happy)
5) Please rate how you are feeling at the moment: 0 (Not at all anxious) – 7 (Very anxious)
6) Please rate how you are feeling at the moment: 0 (Not at all satisfied) – 7 (Very satisfied)
7) Please rate how you are feeling at the moment: 0 (Not at all lonely) – 7 (Very lonely)
8) Please rate how you are feeling at the moment: 0 (Not at all guilty) – 7 (Very guilty)
9) Please rate how you are feeling at the moment: 0 (Not at all down) – 7 (Very down)
10) Please rate how you are feeling at the moment: 0 (Not at all cheerful) – 7 (Very cheerful)
11) Please rate how you are feeling at the moment: 0 (Not at all enthusiastic) – 7 (Very enthusiastic)
12) Please rate how you are feeling at the moment: 0 (Not at all strong) – 7 (Very strong)
13) Please rate how you are feeling at the moment: 0 (Not at all curious) – 7 (Very curious)
14) Please rate how you are feeling at the moment: 0 (Not at all suspicious) – 7 (Very suspicious)
15) Please rate how you are feeling at the moment: 0 (Not at all animated) – 7 (Very animated)
16) Please rate how you are feeling at the moment: 0 (Not at all disappointed) – 7 (Very disappointed)
17) Please rate how you are feeling at the moment: 0 (Not at all insecure) – 7 (Very insecure)

18) Which activity best describes what you are doing right now (i.e. when you heard the phone alarm)?

- Rest/Sleep
- Working
- Home computer
- Commuting, travelling
- Grooming, self-care
- Listening to the radio, news
- Doing housework
- Watching television
- Reading
- Relaxing, nothing special
- Taking care of your children
- Shopping, errands
- Preparing food

- Praying/worshipping/meditating
- Eating
- Walking, taking a walk
- Listening to music
- Playing
- Talking, conversation
- Exercising
- Making love
- Other

Please think about the activity you are currently doing and rate the statement below.

19) I enjoy this activity: 0 (Not at all) – 7 (Very)
20) This activity requires effort: 0 (Not at all) – 7 (Very)
21) I would prefer to do something else: 0 (Not at all) – 7 (Very)
22) I am skilled at doing this activity: 0 (Not at all) – 7 (Very)

NHS
Health Research Authority

**NRES Committee South West - Exeter**
Bristol Research Ethics Committee Centre
Whitefriars
Level 3
Block B
Lewins Mead
Bristol
BS1 2NT
Telephone: 0117 342 1332
Facsimile: 0117 342 0445

13 September 2013

Dr Barnaby Dunn
Associate Professor
Mood Disorders Centre
Washington Singer Laboratories
University of Exeter
Exeter
EX4 4QG

Dear Dr Dunn

**Study title: Investigating the impact of Mindfulness Based Cognitive therapy (MBCT) on positive affect: Does MBCT prevent depressive relapse by increasing 'wanting', 'liking' and 'learning' responses?**

**REC reference: 13/SW/0137**
**Protocol number: Protocol_Ethics**
**IRAS project ID: 119257**

Thank you for the e-mail from Grace Fisher of 12 September 2013, responding to the Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

**Confirmation of ethical opinion**
On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the

above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below. I would clarify that what is meant by cross-referencing is each consent form to reference the latest version of the Participant Information Sheet.

With the Committee’s best wishes for the success of this project.

Yours sincerely

Kirsten Peck

**p.p. Dr Denise Sheehan**
**Chair**

Appendix FIFTEEN: Smartphone application guide for study 5

**DOES MBCT PREVENT DEPRESSIVE RELAPSE BY BOOSTING POSITIVE AFFECT?**

SMARTPHONE OPERATING MANUAL

**Charging the phone battery**

Please check the battery every night and charge overnight if it is needed. The alarms will not go off if the battery runs out and the phone turns off.

1) Insert the small end of the USB cable into the USB connector
2) Insert the other end of the USB cable into the power adapter
3) Plug in the power adapter to an electrical outlet to start charging the battery

**Unlocking the screen**

This phone is touch screen and so to unlock the screen you will need to use your finger. The screen will unlock itself when the alarm goes off and it is time to answer the questions.


1) Press button on the top left of the phone (red arrow)
2) Swipe your finger anywhere on the screen to unlock.
3) To lock the phone again simply press button on the top left.

**Turning the phone on and off** (please avoid doing this if you can)

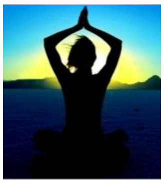
It is advisable to always keep the phone on so that the alarms can go off. However, if you do need to turn the phone off press and hold down the button on the top left (red arrow).

**Adjusting the volume**

It is advisable that you keep the volume turned up high so that you will always hear the alarm when it goes off. However, if you need to adjust the volume you can do this by either pressing the down or up button on the left hand side of the phone (blue arrow). It is fine to put the phone on silent during any situations where it would be inappropriate or unsafe to answer the questions at that time, however we would appreciate if you try to answer as many of the alarms as you can. Please also note that if you adjust the volume to the second to lowest setting this will put it on a vibrator setting. If you want to turn off the vibrator then all you need to do is turn the volume up again or to put on silent press the down button so that it is on the lowest setting.

**Opening the app**

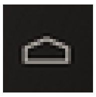
The symbol that you will need to press to open the application looks like this:



This will be displayed on the home screen of the phone. Tap once to open the app. You shouldn't need to do this as when the alarm goes off the app will open itself onto the screen.

**Closing the app**

If you ever want to close the application then tape the symbol that looks like a little house in the centre at the bottom of the phone.

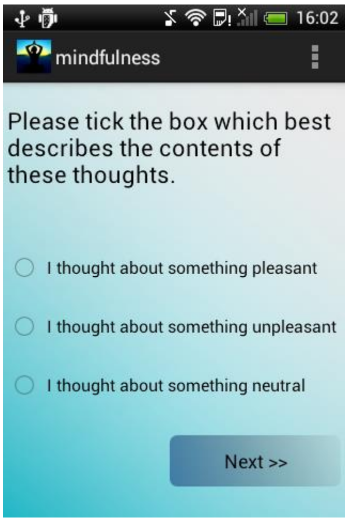


**The App questions**

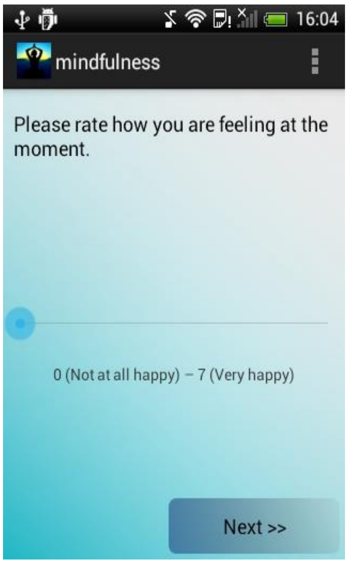
You only need to answer the questions on the app when you hear the phone alarm. At all other times the following message will be displayed, "This application will start automatically at pre-set designated times, and you will hear an alarm and vibrator then."

There are various question types in this application including multiple choice and slider based questions. Below are a few screenshots which illustrate these different question types.

This is an example of a multiple choice question. You are only allowed to select one option before moving on. One of these multiple choice questions will ask you to rate which activity you were completing when you heard the phone alarm. Provided is a long list of 22 activities and you should select which activity best describes what you were doing. **You will need to scroll down** using your finger to see all of the different options that are available.

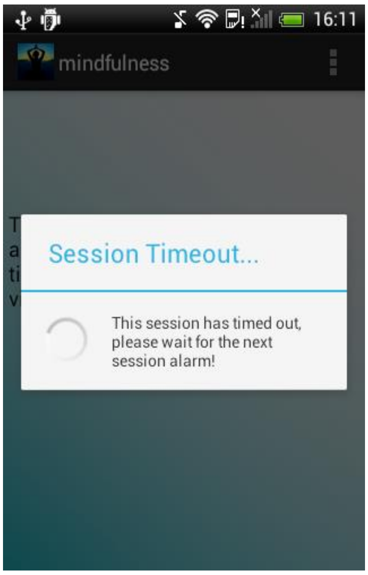



This is an example of a slider based question. You should press and hold the blue dot and drag along the scale to the correct place on the scale. Often for these questions it is only the text underneath the slider than changes (for example when you are asked to rate your mood). Please note that if you wish to answer with the score 0 you still need to move the slider until you see the number. If you attempt to click next without moving the slider it will assume that you haven't answered this question.



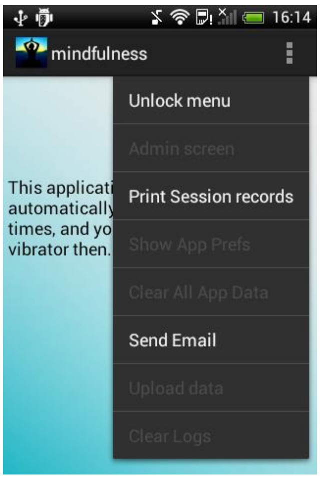
## Question timeout

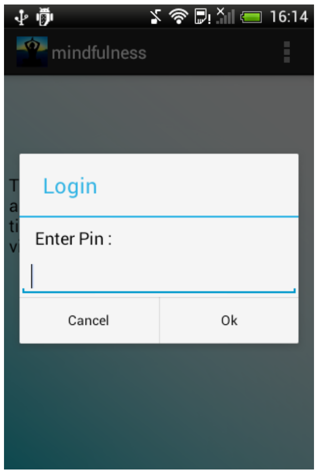
You will have 10 minutes to answer ALL of the question for each separate alarm. After answering all of the questions please click the button that says 'End Questions.' If you have not finished all of the questions after 10 minutes, don't worry, the phone will display the following message, "The session has timed out, please wait for the next alarm!"




## The app menu

The menu that is displayed in the top right hand corner of the application (3 little squares) is not for participant use and is pin controlled. However, if you encounter an error with the application then it might be that the researcher gives you this pin number to guide you through reprogramming the alarms. If at any point you are asked to do this you will see the below screens.




## Other applications on the phone

This is a multi-function smartphone. However we ask that you do not use the phone for any other reason than for the research study that you are taking part in.

## IMPORTANT SAFETY WARNING

Please **do not** attempt to answer any questions whilst you are driving or in any other situation where it would be deemed unsafe to do so. It is okay to miss an alarm as the application will timeout after 10 minutes, please just wait for the next alarm.

**If you encounter any problems when using the phone then please do not hesitate to get in touch on the contact details below. If possible, please note down what happened when the error occurred and any error messages that you see. If the error occurs outside of working hours then please leave a message and the researcher will get back to you as soon as they can.**

**Grace Jell**
**gf238@exeter.ac.uk**

# References


Adler, N. E., Horowitz, M., Garcia, A., & Moyer, A. (1998). Additional validation of a scale to assess positive states of mind. *Psychosomatic Medicine, 60*, 26-32.

Allen, N. B., Trinder, J., & Brennan, C. (1999). Affective startle modulation in clinical depression: Preliminary findings. *Biological Psychiatry, 46,* 542-550.

Allison, P. D. (1990). Change scores as dependent variables in regression analysis. *Sociological Methodology, 20,* 93-114.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC.

Andrews-Hanna, J. R., Kaiser, R. H., Turner, A. E., Reineberg, A., Godinez, D., Dimidjian, S., & Banich, M. (2013). A penny for your thoughts: Dimensions of self-generated thought content and relationships with individual differences in emotional wellbeing. *Frontiers in Psychology, 4*, 900.

Appelhans, B. M., & Luecken, L. J. (2006). Heart rate variability as an index of regulated emotional responding. *Review of General Psychology, 10*, 229-240.

Argyropoulos, S. V., & Nutt, D. J. (2013). Anhedonia revisited: Is there a role for dopamine-targeting drugs for depression?. *Journal of Psychopharmacology, 27*, 869-877.

Arnau, R. C., Meagher, M. W., Norris, M. P., & Bramson, R. (2001). Psychometric evaluation of the Beck Depression Inventory-II with primary care medical patients. *Health Psychology, 20*, 112-119.

Atanes, A. C., Andreoni, S., Hirayama, M. S., Montero-Marin, J., Barros, V. V., Ronzani, T. M., ... & Demarzo, M. M. (2015). Mindfulness, perceived stress, and subjective well-being: A correlational study in primary care health professionals. *BMC Complementary and Alternative Medicine, 15,* 303.

Baer, R. A., Smith, G. T., & Allen, K. B. (2004). Assessment of mindfulness by self-report the Kentucky inventory of mindfulness skills. *Assessment, 11,* 191-206.

Baer, R. A., Smith, G. T., Hopkins, J., Krietemeyer, J., & Toney, L. (2006). Using self-report assessment methods to explore facets of mindfulness. *Assessment, 13*, 27-45.

Baer, R. A., Smith, G. T., Lykins, E., Button, D., Krietemeyer, J., Sauer, S., ... & Williams, J. M. G. (2008). Construct validity of the five facet mindfulness questionnaire in meditating and nonmeditating samples. *Assessment, 15,* 329-342.

Baird, B., Smallwood, J., Mrazek, M. D., Kam, J. W., Franklin, M. S., & Schooler, J. W. (2012). Inspired by distraction mind wandering facilitates creative incubation. *Psychological Science*, doi: 0956797612446024.

Baird, B., Smallwood, J., & Schooler, J. W. (2011). Back to the future: Autobiographical planning and the functionality of mind-wandering. *Consciousness and Cognition, 20,* 1604-1611.

Banks, J. B., Welhaf, M. S., & Srour, A. (2015). The protective effects of brief mindfulness meditation training. *Consciousness and Cognition*, *33*, 277-285.

Barge-Schaapveld, D. Q., Nicolson, N. A., & Berkhof, J. (1999). Quality of life in depression: Daily life determinants and variability. *Psychiatry Research, 88,* 173-189.

Barnhofer, T., Duggan, D. S., & Griffith, J. W. (2011). Dispositional mindfulness moderates the relation between neuroticism and depressive symptoms. *Personality and Individual Differences, 51*, 958-962.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic and statistical considerations. *Journal of Personality and Social Psychology, 51,* 1173-1182.

Barron, E., Riby, L. M., Greer, J., & Smallwood, J. (2011). Absorbed in thought the effect of mind wandering on the processing of relevant and irrelevant events. *Psychological Science,* doi: 10.1177/0956797611404083.

Bartels, M. (2015). Genetics of wellbeing and its components satisfaction with life, happiness, and quality of life: A review and meta-analysis of heritability studies. *Behaviour Genetics, 45*, 137-156.

Batink, T., Peeters, F., Geschwind, N., van Os, J., & Wichers, M. (2013). How does MBCT for depression work? Studying cognitive and affective mediation pathways. *PloS One*, *8*, e72778.

Beck, A. T., & Steer, R. A. (1990). *Manual for the Beck anxiety inventory.* San Antonio, TX: Psychological Corporation.

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *Beck depression inventory-II.* San Antonio, TX: Psychological Corporation.

Berntson, G. G., & Stowell, J. R. (1998). ECG artifacts and heart period variability: Don't miss a beat!. *Psychophysiology, 35*, 127-132.

Berridge, K. C., & Kringelbach, M. L. (2008). Affective neuroscience of pleasure: Reward in humans and animals. *Psychopharmacology*, 199, 457-480.

Bevan, L. W. (1899). *A Textbook of Mental Diseases*. London: Charles Griffin.

Bijttebier, P., Raes, F., Vasey, M. W., & Feldman, G. C. (2012). Responses to positive affect predict mood symptoms in children under conditions of stress: A prospective study. *Journal of Abnormal Child Psychology, 40,* 381-389.

Black, D. S., Semple, R. J., Pokhrel, P., & Grenard, J. L. (2011). Component processes of executive function—mindfulness, self-control, and working memory—and their relationships with mental and behavioral health. *Mindfulness, 2,* 179-185.

Blanchard, J. J., Mueser, K. T., & Bellack, A. S. (1998). Anhedonia, positive and negative affect, and social functioning in schizophrenia. *Schizophrenia Bulletin*, *24*, 413-424.

Bland, J. M., & Altman, D. G. (1997). Statistics notes: Cronbach's alpha. *British Medical Journal, 314*, 572.

Blascovich, J., Vanman, E., Mendes, W. B., & Dickerson, S. (2011). *Social psychophysiology for social and personality psychology.* Sage Publications.

Blascovich, J., & Seery, M. D. (2007). *Visceral and somatic indexes of social psychological constructs. Social psychology: Handbook of basic principles.* New York: Guilford.

Bogdan, R., & Pizzagalli, D. A. (2009). The heritability of hedonic capacity and perceived stress: A twin study evaluation of candidate depressive phenotypes. *Psychological Medicine, 39,* 211-218.

Bohlmeijer, E., Peter, M., Fledderus, M., Veehof, M., & Baer, R. (2011). Psychometric properties of the five facet mindfulness questionnaire in depressed adults and development of a short form. *Assessment*, doi: 1073191111408231.

Bondolfi, G., Jermann, F., Van der Linden, M., Gex-Fabry, M., Bizzini, L., Rouget, B. W., ... & Bertschy, G. (2010). Depression relapse prophylaxis with Mindfulness-Based Cognitive Therapy: Replication and extension in the Swiss health care system. *Journal of Affective Disorders, 122*, 224-231.

Bos, S. C., Macedo, A., Marques, M., Pereira, A. T., Maia, B. R., Soares, M. J., ... & Azevedo, M. H. (2013). Is positive affect in pregnancy protective of postpartum depression?. *Revista Brasileira de Psiquiatria*, 35, 5-12.

Bower, B., Bylsma, L. M., Morris, B. H., & Rottenberg, J. (2010). Poor reported sleep quality predicts low positive affect in daily life among healthy and mood-disordered persons. *Journal of Sleep Research, 19*, 323-332.

Bradley, B. P., Mogg, K., Falla, S. J., & Hamilton, L. R. (1998). Attentional bias for threatening facial expressions in anxiety: Manipulation of stimulus duration. *Cognition & Emotion, 12*, 737-753.

Bränström, R., Duncan, L. G., & Moskowitz, J. T. (2011). The association between dispositional mindfulness, psychological well-being, and perceived health in a Swedish population-based sample. *British Journal of Health Psychology, 16*, 300-316.

Bränström, R., Kvillemo, P., Brandberg, Y., & Moskowitz, J. T. (2010). Self-report mindfulness as a mediator of psychological well-being in a stress reduction intervention for cancer patients—A randomized study. *Annals of Behavioral Medicine, 39*, 151-161.

Brooker, J., Julian, J., Webber, L., Chan, J., Shawyer, F., & Meadows, G. (2013). Evaluation of an occupational mindfulness program for staff employed in the disability sector in Australia. *Mindfulness, 4*, 122-136.

Brown, T. A. (2007). Temporal course and structural relationships among dimensions of temperament and DSM-IV anxiety and mood disorder constructs. *Journal of Abnormal Psychology, 116*, 313-328.

Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology*, *84*, 822-848.

Bylsma, L. M., Morris, B. H., & Rottenberg, J. (2008). A meta-analysis of emotional reactivity in major depressive disorder. *Clinical Psychology Review, 28*, 676-691.

Bylsma, L. M., Taylor-Clift, A., & Rottenberg, J. (2011). Emotional reactivity to daily events in major and minor depression. *Journal of Abnormal Psychology, 120*, 155-167.

Cacioppo, J. T., Tassinary, L. G., & Berntson, G. (Eds.). (2007). *Handbook of psychophysiology*. Cambridge University Press.

Carciofo, R., Du, F., Song, N., & Zhang, K. (2014). Mind wandering, sleep quality, affect and chronotype: An exploratory study. *PloS one, 9*, e91285.

Carmody, J., & Baer, R. A. (2008). Relationships between mindfulness practice and levels of mindfulness, medical and psychological symptoms and well-being in a mindfulness-based stress reduction program. *Journal of Behavioural Medicine, 31*, 23-33.

Carriere, J. S., Cheyne, J. A., & Smilek, D. (2008). Everyday attention lapses and memory failures: The affective consequences of mindlessness. *Consciousness and Cognition, 17*, 835-847.

Carsten Schmitz (2015).  LimeSurvey: An Open Source survey tool. LimeSurvey Project Hamburg, Germany.

Carter, L., Russell, P. N., & Helton, W. S. (2013). Target predictability, sustained attention, and response inhibition. *Brain and Cognition, 82*, 35-42.

Carver, C. S., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: The BIS/BAS scales. *Journal of Personality and Social Psychology, 67,* 319-333.

Cash, M., & Whittingham, K. (2010). What facets of mindfulness contribute to psychological well-being and depressive, anxious, and stress-related symptomatology?. *Mindfulness, 1*, 177-182.

Catalino, L. I., & Fredrickson, B. L. (2011). A Tuesday in the life of a flourisher: The role of positive emotional reactivity in optimal mental health. *Emotion, 11*, 938-950.

Chan, R. C. (2005). Sustained attention in patients with mild traumatic brain injury. *Clinical Rehabilitation, 19*, 188-193.

Cheyne, J. A., Carriere, J. S., & Smilek, D. (2006). Absent-mindedness: Lapses of conscious awareness and everyday cognitive failures. *Consciousness and Cognition, 15*, 578-592.

Cheyne, J. A., Solman, G. J., Carriere, J. S., & Smilek, D. (2009). Anatomy of an error: A bidirectional state model of task engagement/disengagement and attention-related errors. *Cognition, 111*, 98-113.

Christoff, K., Gordon, A. M., Smallwood, J., Smith, R., & Schooler, J. W. (2009). Experience sampling during fMRI reveals default network and executive system contributions to mind wandering. *Proceedings of the National Academy of Sciences, 106,* 8719-8724.

Clark, L. A. (2005). Temperament as a unifying basis for personality and psychopathology. *Journal of Abnormal Psychology, 114*, 505-521.

Clark, D. M., Ehlers, A., McManus, F., Hackmann, A., Fennell, M., Campbell, H., ... & Louis, B. (2003). Cognitive therapy versus fluoxetine in generalized social phobia: a randomized placebo-controlled trial. *Journal of Consulting and Clinical Psychology, 71*, 1058-1067.

Clark, D. M., Salkovskis, P. M., Hackmann, A., Middleton, H., Anastasiades, P., & Gelder, M. (1994). A comparison of cognitive therapy, applied relaxation and imipramine in the treatment of panic disorder. *The British Journal of Psychiatry*, *164*, 759-769.

Clark, L. A., Watson, D., & Mineka, S. (1994). Temperament, personality, and the mood and anxiety disorders. *Journal of Abnormal Psychology, 103*, 103-116.

Cléry-Melin, M. L., Schmidt, L., Lafargue, G., Baup, N., Fossati, P., & Pessiglione, M. (2011). Why don't you try harder? An investigation of effort production in major depression. *PLoS One*, *6*, e23178.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*, 155-159.

Cohn, M. A., Fredrickson, B. L., Brown, S. L., Mikels, J. A., & Conway, A. M. (2009). Happiness unpacked: Positive emotions increase life satisfaction by building resilience. *Emotion, 9,* 361-368.

Conover, W. J., & Iman, R. L. (1982). Analysis of covariance using the rank transformation. *Biometrics,* 715-724.

Conrad, A., Wilhelm, F. H., Roth, W. T., Spiegel, D., & Taylor, C. B. (2008). Circadian affective, cardiopulmonary, and cortisol variability in depressed and nondepressed individuals at risk for cardiovascular disease. *Journal of Psychiatric Research*, *42*, 769-777.

Conradi, H. J., Ormel, J., & De Jonge, P. (2011). Presence of individual (residual) symptoms during depressive episodes and periods of remission: A 3-year prospective study. Psychological Medicine, 41, 1165-1174.

Crane, C., Winder, R., Hargus, E., Amarasinghe, M., & Barnhofer, T. (2012). Effects of mindfulness-based cognitive therapy on specificity of life goals. *Cognitive Therapy and Research*, *36*, 182-189.

Crawford, J. R., & Henry, J. D. (2004). The Positive and Negative Affect Schedule (PANAS): Construct validity, measurement properties and normative data in a large non-clinical sample. *British Journal of Clinical Psychology, 43*, 245-265.

Csikszentmihalyi, M., & Smit, F. (1987). Validity and reliability of the experience sampling method. *Journal of Nervous and Mental Disease, 175*, 526-536.

Cuijpers, P., Berking, M., Andersson, G., Quigley, L., Kleiboer, A., & Dobson, K. S. (2013). A meta-analysis of cognitive-behavioural therapy for adult depression, alone and in comparison with other treatments. *The Canadian Journal of Psychiatry, 58*, 376-385.

Cuijpers, P., Geraedts, A. S., van Oppen, P., Andersson, G., Markowitz, J. C., & van Straten, A. (2011). Interpersonal psychotherapy for depression: A meta-analysis. *American Journal of Psychiatry, 168*, 581-592.

Cuijpers, P., & Smit, F. (2004). Subthreshold depression as a risk indicator for major depressive disorder: A systematic review of prospective studies. *Acta Psychiatrica Scandinavica, 109*, 325-331.

Cuijpers, P., van Straten, A., Andersson, G., & van Oppen, P. (2008). Psychotherapy for depression in adults: a meta-analysis of comparative outcome studies. Journal of *Consulting and Clinical Psychology*, *76*, 909-922.

Cunningham, S., Scerbo, M. W., & Freeman, F. G. (2000). The electrocortical correlates of daydreaming during vigilance tasks. *Journal of Mental Imagery*, *24*, 61-72.

Dale, O., & Hagen, K. B. (2007). Despite technical problems personal digital assistants outperform pen and paper when collecting patient diary data. *Journal of Clinical Epidemiology, 60,* 8-17.

Danner, D. D., Snowdon, D. A., & Friesen, W. V. (2001). Positive emotions in early life and longevity: Findings from the nun study. *Journal of Personality and Social Psychology, 80,* 804-813.

Davidson, R. J. (1998). Affective style and affective disorders: Perspectives from affective neuroscience. *Cognition & Emotion, 12*, 307-330.

Delespaul, P. A. (1995). *Assessing schizophrenia in daily life: The experience sampling method.* Maastrict: Maastrict University Press.

de Mello, M. F., de Jesus Mari, J., Bacaltchuk, J., Verdeli, H., & Neugebauer, R. (2005). A systematic review of research findings on the efficacy of interpersonal therapy for depressive disorders. *European Archives of Psychiatry and Clinical Neuroscience, 255,* 75-82.

Deng, Y. Q., Li, S., & Tang, Y. Y. (2014). The relationship between wandering mind, depression and mindfulness. *Mindfulness, 5,* 124-128.

Deng, Y. Q., Li, S., Tang, Y. Y., Zhu, L. H., Ryan, R., & Brown, K. (2012). Psychometric properties of the Chinese translation of the mindful attention awareness scale (MAAS). *Mindfulness, 3,* 10-14.

DeRubeis, R. J., Hollon, S. D., Amsterdam, J. D., Shelton, R. C., Young, P. R., Salomon, R. M., ... & Gallop, R. (2005). Cognitive therapy vs medications in the treatment of moderate to severe depression. *Archives of General Psychiatry, 62,* 409-416.

Desrosiers, A., Klemanski, D. H., & Nolen-Hoeksema, S. (2013). Mapping mindfulness facets onto dimensions of anxiety and depression. *Behaviour Therapy, 44*, 373-384.

Dichter, G. S., & Tomarken, A. J. (2008). The chronometry of affective startle modulation in unipolar depression. *Journal of Abnormal Psychology, 117,* 1-15.

Dichter, G. S., Tomarken, A. J., Shelton, R. C., & Sutton, S. K. (2004). Early-and late-onset startle modulation in unipolar depression. *Psychophysiology, 41,* 433-440.

Diener, E. (1994). Assessing subjective well-being: Progress and opportunities. *Social Indicators Research, 31*, 103-157.

Dimidjian, S., Hollon, S. D., Dobson, K. S., Schmaling, K. B., Kohlenberg, R. J., Addis, M. E., ... & Atkins, D. C. (2006). Randomized trial of behavioral activation, cognitive therapy, and antidepressant medication in the acute treatment of adults with major depression. *Journal of Consulting and Clinical Psychology, 74*, 658-670.

Di Nicola, M., De Risio, L., Battaglia, C., Camardese, G., Tedeschi, D., Mazza, M., ... & Siracusano, A. (2013). Reduced hedonic capacity in euthymic bipolar subjects: A trait-like feature?. *Journal of Affective Disorders, 147*, 446-450.

Dobson, K. S., Hollon, S. D., Dimidjian, S., Schmaling, K. B., Kohlenberg, R. J., Gallop, R. J., ... & Jacobson, N. S. (2008). Randomized trial of behavioral activation, cognitive therapy, and antidepressant medication in the prevention of relapse and recurrence in major depression. *Journal of Consulting and Clinical Psychology, 76*, 468-477.

Driessen, E., Cuijpers, P., de Maat, S. C., Abbass, A. A., de Jonghe, F., & Dekker, J. J. (2010). The efficacy of short-term psychodynamic psychotherapy for depression: A meta-analysis. *Clinical Psychology Review, 30*, 25-36.

Dunn, B. D. (2012). Helping depressed clients reconnect to positive emotion experience: Current insights and future directions. *Clinical Psychology & Psychotherapy, 19*, 326-340.

Dunn, B. D., Dalgleish, T., Lawrence, A. D., Cusack, R., & Ogilvie, A. D. (2004). Categorical and dimensional reports of experienced affect to emotion-inducing pictures in depression. *Journal of Abnormal Psychology, 113*, 654-660.

Dunn, B. D., Dalgleish, T., Ogilvie, A. D., & Lawrence, A. D. (2007). Heartbeat perception in depression. *Behaviour Research and Therapy, 45*, 1921-1930.

Dunn, B.D., & Roberts, H. (2016). Improving the capacity to treat depression using talking therapies: Setting a positive clinical psychology agenda. In A. M. Wood & J. Johnson (Eds.), *Handbook of positive clinical psychology*. Wiley-Blackwell.

Dunn, J. R., & Schweitzer, M. E. (2005). Feeling and believing: The influence of emotion on trust. *Journal of Personality and Social Psychology, 88*, 736-748.

Dunn, B. D., Stefanovitch, I., Buchan, K., Lawrence, A. D., & Dalgleish, T. (2009). A reduction in positive self-judgment bias is uniquely related to the anhedonic symptoms of depression. *Behaviour Research and Therapy, 47*, 374-381.

Dunn, B. D., Stefanovitch, I., Evans, D., Oliver, C., Hawkins, A., & Dalgleish, T. (2010). Can you feel the beat? Interoceptive awareness is an interactive function of anxiety- and depression-specific symptom dimensions. *Behaviour Research and Therapy, 48*, 1133-1138.

Easterlin, B. L., & Cardeña, E. (1998). Cognitive and emotional differences between short- and long-term Vipassana meditators. *Imagination, Cognition and Personality*, *18*, 69-81.

Ehlers, A., & Clark, D. M. (2000). A cognitive model of posttraumatic stress disorder. *Behaviour Research and Therapy, 38,* 319-345.

Ehlers, A., Clark, D. M., Hackmann, A., McManus, F., & Fennell, M. (2005). Cognitive therapy for post-traumatic stress disorder: Development and evaluation. *Behaviour Research and Therapy, 43*, 413-431.

Eisner, L. R., Johnson, S. L., & Carver, C. S. (2009). Positive affect regulation in anxiety disorders. *Journal of Anxiety Disorders, 23*, 645-649.

Ekers, D., Webster, L., Van Straten, A., Cuijpers, P., Richards, D., & Gilbody, S. (2014). Behavioural activation for depression; An update of meta-analysis of effectiveness and sub group analysis. *PloS one, 9*, e100100.

Ekman, P. (1992). An argument for basic emotions. *Cognition & Emotion*, *6,* 169-200.

Erisman, S. M., & Roemer, L. (2010). A preliminary investigation of the effects of experimentally induced mindfulness on emotional responding to film clips. *Emotion*, *10*, 72.

Evans, S., Ferrando, S., Findler, M., Stowell, C., Smart, C., & Haglin, D. (2008). Mindfulness-based cognitive therapy for generalized anxiety disorder. *Journal of Anxiety Disorders*, *22*, 716-721.

Farrin, L., Hull, L., Unwin, C., Wykes, T., & David, A. (2003). Effects of depressed mood on objective and subjective measures of attention. *The Journal of Neuropsychiatry and Clinical Neurosciences*, *15*, 98-104.

Fava, G. A., Rafanelli, C., Cazzaro, M., Conti, S., & Grandi, S. (1998). Well-being therapy. A novel psychotherapeutic approach for residual symptoms of affective disorders. *Psychological Medicine, 28*, 475-480.

Fawcett, J., Scheftner, W. A., Fogg, L., Clark, D. C., Young, M. A., Hedeker, D., & Gibbons, R. (1990). Time-related predictors of suicide in major affective disorder. *American Journal of Psychiatry, 147*, 1189-1194.

Feldman, G. C., Joormann, J., & Johnson, S. L. (2008). Responses to positive affect: A self-report measure of rumination and dampening. *Cognitive Therapy and Research, 32*, 507-525.

Ferguson, J. M. (2001). SSRI antidepressant medications: Adverse effects and tolerability. *Primary Care Companion Journal Clinical Psychiatry, 3*, 22-27.

First, M. B., Spitzer, R. L., Gibbon, M., & Williams, J. B. (1997). *User's guide for the Structured clinical interview for DSM-IV axis I disorders SCID-I: Clinician version*. Washington DC: American Psychiatric Association.

Forbes, E. E., & Dahl, R. E. (2005). Neural systems of positive affect: Relevance to understanding child and adolescent depression?. *Development and Psychopathology, 17*, 827-850.

Fournier, J. C., DeRubeis, R. J., Hollon, S. D., Dimidjian, S., Amsterdam, J. D., Shelton, R. C., & Fawcett, J. (2010). Antidepressant drug effects and depression severity: A patient-level meta-analysis. *Jama, 303*, 47-53.

Fowles, D. C., Christie, M. J., Edelberg, R., Grings, W. W., Lykken, D. T., & Venables, P. H. (1981). Publication recommendations for electrodermal measurements. *Psychophysiology, 18*, 232-239.

Franken, I. H., Rassin, E., & Muris, P. (2007). The assessment of anhedonia in clinical and non-clinical populations: Further validation of the Snaith–Hamilton Pleasure Scale (SHAPS). *Journal of Affective Disorders, 99*, 83-89.

Franklin, M. S., Mrazek, M. D., Anderson, C. L., Smallwood, J., Kingstone, A., & Schooler, J. (2013). The silver lining of a mind in the clouds: interesting musings are associated with positive mood while mind-wandering. *Frontiers in Psychology, 4*, 583.

Fredrickson, B. L. (2001). The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *American Psychologist, 56*, 218-226.

Fredrickson, B.L., (2004). The broaden-and-build theory of positive emotions. Philosophical Transactions of the Royal Society of London. *Series B Biological Sciences, 359*, 1367–1378.

Fredrickson, B. L., & Branigan, C. (2005). Positive emotions broaden the scope of attention and thought-action repertoires. *Cognition & Emotion, 19*, 313-332.

Fredrickson, B. L., Cohn, M. A., Coffey, K. A., Pek, J., & Finkel, S. M. (2008). Open hearts build lives: positive emotions, induced through loving-kindness meditation, build consequential personal resources. *Journal of Personality and Social Psychology, 95*, 1045-1062.

Fredrickson, B. L., & Losada, M. F. (2005). Positive affect and the complex dynamics of human flourishing. *American Psychologist, 60*, 678-686.

Frewen, P. A., Evans, E. M., Maraj, N., Dozois, D. J., & Partridge, K. (2008). Letting go: Mindfulness and negative automatic thinking. *Cognitive Therapy and Research, 32,* 758-774.

Frijda, N. H., Kuipers, P., & Ter Schure, E. (1989). Relations among emotion, appraisal, and emotional action readiness. *Journal of Personality and Social Psychology, 57*, 212-228.

Frith, C. D., & Allen, H. A. (1983). The skin conductance orienting response as an index of attention. *Biological Psychology, 17,* 27-39.

Furman, D. J., Waugh, C. E., Bhattacharjee, K., Thompson, R. J., & Gotlib, I. H. (2013). Interoceptive awareness, positive affect, and decision making in major depressive disorder. *Journal of Affective Disorders, 151*, 780-785.

Gable, S. L., Gonzaga, G. C., & Strachman, A. (2006). Will you be there for me when things go right? Supportive responses to positive event disclosures. *Journal of Personality and Social Psychology, 91*, 904-917.

Garland, E. L., Fredrickson, B., Kring, A. M., Johnson, D. P., Meyer, P. S., & Penn, D. L. (2010). Upward spirals of positive emotions counter downward spirals of negativity: Insights from the broaden-and-build theory and affective neuroscience on the treatment of emotion dysfunctions and deficits in psychopathology. *Clinical Psychology Review*, *30*, 849-864.

Garland, E. L., Geschwind, N., Peeters, F., & Wichers, M. (2015). Mindfulness training promotes upward spirals of positive affect and cognition: multilevel and autoregressive latent trajectory modeling analyses. *Frontiers in Psychology*, *6*, 15.

Gehricke, J. G., & Shapiro, D. (2000). Reduced facial expression and social context in major depression: Discrepancies between facial muscle activity and self-reported emotion. *Psychiatry Research, 95*, 157-167.

Georgiades, K., Lewinsohn, P. M., Monroe, S. M., & Seeley, J. R. (2006). Major depressive disorder in adolescence: The role of subthreshold symptoms. *Journal of the American Academy of Child & Adolescent Psychiatry, 45*, 936-944.

Geschwind, N., Nicolson, N. A., Peeters, F., van Os, J., Barge-Schaapveld, D., & Wichers, M. (2011). Early improvement in positive rather than negative emotion predicts remission from depression after pharmacotherapy. *European Neuropsychopharmacology, 21*, 241-247.

Geschwind, N., Peeters, F., Drukker, M., van Os, J., & Wichers, M. (2011). Mindfulness training increases momentary positive emotions and reward experience in adults vulnerable to depression: A randomized controlled trial. *Journal of Consulting and Clinical Psychology*, *79*, 618-628.

Geschwind, N., Peeters, F., Huibers, M., van Os, J., & Wichers, M. (2012). Efficacy of mindfulness-based cognitive therapy in relation to prior history of depression: Randomised controlled trial. *The British Journal of Psychiatry*, *201*, 320-325.

Geschwind, N., Peeters, F., Jacobs, N., Delespaul, P., Derom, C., Thiery, E., ... & Wichers, M. (2010). Meeting risk with resilience: High daily life reward experience preserves mental health. *Acta Psychiatrica Scandinavica*, *122*, 129-138.

Gilbert, P., McEwan, K., Mitra, R., Franks, L., Richter, A., & Rockliff, H. (2008). Feeling safe and content: A specific affect regulation system? Relationship to depression, anxiety, stress, and self-criticism. *The Journal of Positive Psychology, 3,* 182-191.

Gotink, R. A., Hermans, K. S., Geschwind, N., Nooij, R., Groot, W. T., & Speckens, A. E. (2016). Mindfulness and mood stimulate each other in an upward spiral: A mindful walking intervention using experience sampling. *Mindfulness, 5*, 1114–1122.

Gotlib, I. H., Hamilton, J. P., Cooney, R. E., Singh, M. K., Henry, M. L., & Joormann, J. (2010). Neural processing of reward and loss in girls at risk for major depression. *Archives of General Psychiatry, 67*, 380-387.

Gotlib, I. H., Krasnoperova, E., Yue, D. N., & Joormann, J. (2004). Attentional biases for negative interpersonal stimuli in clinical depression. *Journal of Abnormal Psychology, 113*, 127-135.

Gruber, J., Oveis, C., Keltner, D., & Johnson, S. L. (2011). A discrete emotions approach to positive emotion disturbance in depression. *Cognition and Emotion, 25*, 40-52.

Gu, J., Strauss, C., Bond, R., & Cavanagh, K. (2015). How do mindfulness-based cognitive therapy and mindfulness-based stress reduction improve mental health and wellbeing? A systematic review and meta-analysis of mediation studies. *Clinical Psychology Review*, *37*, 1-12.

Gu, J., Strauss, C., Crane, C., Barnhofer, T., Karl, A., Cavanagh, K., & Kuyken, W. (2016). Examining the factor structure of the 39-item and 15-item versions of the five facet mindfulness questionnaire before and after mindfulness-based cognitive therapy for people with recurrent depression. *Psychological Assessment*, *28*, 791-802.

Hallion, L. S., & Ruscio, A. M. (2011). A meta-analysis of the effect of cognitive bias modification on anxiety and depression. *Psychological Bulletin, 137*, 940-958.

Hargus, E., Crane, C., Barnhofer, T., & Williams, J. M. G. (2010). Effects of mindfulness on meta-awareness and specificity of describing prodromal symptoms in suicidal depression. *Emotion*, *10*, 34-42.

Harshaw, C. (2015). Interoceptive dysfunction: Toward an integrated framework for understanding somatic and affective disturbance in depression. *Psychological Bulletin, 141*, 311-363.

Hartmann, J. A., Wichers, M., Menne-Lothmann, C., Kramer, I., Viechtbauer, W., Peeters, F., ... & van Os, J. (2015). Experience sampling-based personalized feedback and positive affect: A randomized controlled trial in depressed patients. *PloS one, 10*, e0128095.

Hayes, S. C., Luoma, J. B., Bond, F. W., Masuda, A., & Lillis, J. (2006). Acceptance and commitment therapy: Model, processes and outcomes. *Behaviour Research and Therapy*, *44*, 1-25.

He, J., Becic, E., Lee, Y. C., & McCarley, J. S. (2011). Mind wandering behind the wheel performance and oculomotor correlates. *Human Factors: The Journal of the Human Factors and Ergonomics Society, 53,* 13-21.

Health and Social Care Information Centre. (April, 2015). Prescription Cost Analysis, England – 2014. Retrieved from: http://digital.nhs.uk/catalogue/PUB17274

Heidenreich, T., Tuin, I., Pflug, B., Michal, M., & Michalak, J. (2006). Mindfulness-based cognitive therapy for persistent insomnia: A pilot study. *Psychotherapy and Psychosomatics*, *75*, 188-189.

Hektner, J. M., Schmidt, J. A., & Csikszentmihalyi, M. (2007). *Experience sampling method: Measuring the quality of everyday life*. Sage.

Heller, A. S., Johnstone, T., Shackman, A. J., Light, S. N., Peterson, M. J., Kolden, G. G., ... & Davidson, R. J. (2009). Reduced capacity to sustain positive emotion in major depression reflects diminished maintenance of fronto-striatal brain activation. *Proceedings of the National Academy of Sciences, 106,* 22445-22450.

Heshmati, M., & Russo, S. J. (2015). Anhedonia and the brain reward circuitry in depression. *Current Behavioural Neuroscience Reports, 2,* 146-153.

Hillyard, S. A., Hink, R. F., Schwent, V. L., & Picton, T. W. (1973). Electrical signs of selective attention in the human brain. Science, 182, 177-180.

Hofmann, S. G., Sawyer, A. T., Witt, A. A., & Oh, D. (2010). The effect of mindfulness-based therapy on anxiety and depression: A meta-analytic review. *Journal of Consulting and Clinical Psychology*, *78*, 169-183.

Hölzel, B. K., Lazar, S. W., Gard, T., Schuman-Olivier, Z., Vago, D. R., & Ott, U. (2011). How does mindfulness meditation work? Proposing mechanisms of action from a conceptual and neural perspective. *Perspectives on Psychological Science*, *6*, 537-559.

Horan, W. P., Kring, A. M., & Blanchard, J. J. (2006). Anhedonia in schizophrenia: A review of assessment strategies. *Schizophrenia Bulletin, 32,* 259-273.

Horner, M. S., Siegle, G. J., Schwartz, R. M., Price, R. B., Haggerty, A. E., Collier, A., & Friedman, E. S. (2014). C'mon get happy: Reduced magnitude and duration of response during a positive-affect induction in depression. *Depression and Anxiety, 31*, 952-960.

Huffman, J. C., DuBois, C. M., Healy, B. C., Boehm, J. K., Kashdan, T. B., Celano, C. M., ... & Lyubomirsky, S. (2014). Feasibility and utility of positive psychology exercises for suicidal inpatients. *General Hospital Psychiatry, 36,* 88-94.

Huijbers, M. J., Spijker, J., Donders, A. R. T., van Schaik, D. J., van Oppen, P., Ruhé, H. G., ... & Speckens, A. E. (2012). Preventing relapse in recurrent depression using mindfulness-based cognitive therapy, antidepressant medication or the combination: Trial design and protocol of the MOMENT study. *BioMed Central Psychiatry, 12*, 125.

Huijbers, M. J., Spinhoven, P., Spijker, J., Ruhé, H. G., van Schaik, D. J., van Oppen, P., ... & Blom, M. B. (2015). Adding mindfulness-based cognitive therapy to maintenance antidepressant medication for prevention of relapse/recurrence in major depressive disorder: Randomised controlled trial. *Journal of Affective Disorders, 187*, 54-61.

Iijima, Y., & Tanno, Y. (2012). The effect of cognitive load on the temporal focus of mind wandering. *The Japanese Journal of Psychology, 83*, 232-236.

Isen, A. M., & Daubman, K. A. (1984). The influence of affect on categorization. *Journal of Personality and Social Psychology, 47*, 1206-1217.

Isen, A. M., Daubman, K. A., & Nowicki, G. P. (1987). Positive affect facilitates creative problem solving. *Journal of Personality and Social Psychology, 52*, 1122-1131.

Isen, A. M., Rosenzweig, A. S., & Young, M. J. (1991). The influence of positive affect on clinical problem solving. *Medical Decision Making, 11*, 221-227.

Jennings, J. R., Bberg, W. K., Hutcheson, J., Obrist, P., Porges, S., & Turpin, G. (1981). Publication guidelines for heart rate studies in man. *Psychophysiology, 18,* 226-231.

Jha, A. P., Morrison, A. B., Dainer-Best, J., Parker, S., Rostrup, N., & Stanley, E. A. (2015). Minds “at attention”: Mindfulness training curbs attentional lapses in military cohorts. *PloS one, 10,* e0116889.

Johnson, K. J., Waugh, C. E., & Fredrickson, B. L. (2010). Smile to see the forest: Facially expressed positive emotions broaden cognition. *Cognition and Emotion, 24*, 299-321.

Joiner, T. E., Brown, J. S., & Metalsky, G. I. (2003). A test of the tripartite model's prediction of anhedonia's specificity to depression: patients with major depression versus patients with schizophrenia. *Psychiatry Research, 119,* 243-250.

Joormann, J., Levens, S. M., & Gotlib, I. H. (2011). Sticky thoughts depression and rumination are associated with difficulties manipulating emotional material in working memory. *Psychological Science, 22,* 979-983.

Joormann, J., & Siemer, M. (2004). Memory accessibility, mood regulation, and dysphoria: difficulties in repairing sad mood with happy memories?. *Journal of Abnormal Psychology*, *113*, 179-188.

Joormann, J., Siemer, M., & Gotlib, I. H. (2007). Mood regulation in depression: Differential effects of distraction and recall of happy memories on sad mood. Journal of Abnormal Psychology, *116,* 484-490.

Josefsson, T., & Broberg, A. (2011). Meditators and non-meditators on sustained and executive attentional performance. *Mental Health, Religion & Culture*, *14,* 291-309.

Kabat-Zinn, J. (1994). *Wherever you go, there you are: Mindfulness meditation in everyday life.* Hyperion.

Kabat-Zinn, J. (2003). Mindfulness-based interventions in context: past, present, and future. *Clinical psychology: Science and Practice*, *10,* 144-156.

Kane, M. J., Brown, L. H., McVay, J. C., Silvia, P. J., Myin-Germeys, I., & Kwapil, T. R. (2007). For whom the mind wanders, and when an experience-sampling study of working memory and executive control in daily life. *Psychological Science, 18,* 614-621.

Kappeler-Setz, C., Gravenhorst, F., Schumm, J., Arnrich, B., & Tröster, G. (2013). Towards long term monitoring of electrodermal activity in daily life. *Personal and Ubiquitous Computing*, *17*, 261-271.

Kasch, K. L., Rottenberg, J., Arnow, B. A., & Gotlib, I. H. (2002). Behavioral activation and inhibition systems and the severity and course of depression. *Journal of Abnormal Psychology, 111,* 589-597.

Kaviani, H., Gray, J. A., Checkley, S. A., Raven, P. W., Wilson, G. D., & Kumari, V. (2004). Affective modulation of the startle response in depression: Influence of the severity of depression, anhedonia, and anxiety. *Journal of Affective Disorders, 83,* 21-31.

Kazdin, A. E. (1989). Evaluation of the Pleasure Scale in the assessment of anhedonia in children. *Journal of the American Academy of Child & Adolescent Psychiatry, 28,* 364-372.

Kazdin, A. E. (2007). Mediators and mechanisms of change in psychotherapy research. *Annual Review of Clinical Psychology, 3,* 1-27.

Keedwell, P. A., Andrew, C., Williams, S. C., Brammer, M. J., & Phillips, M. L. (2005). The neural correlates of anhedonia in major depressive disorder. *Biological Psychiatry, 58,* 843-853.

Keedwell, P. A., Andrew, C., Williams, S. C., Brammer, M. J., & Phillips, M. L. (2005). A double dissociation of ventromedial prefrontal cortical responses to sad and happy stimuli in depressed and healthy individuals. *Biological Psychiatry, 58,* 495-503.

Kessing, L. V., Hansen, M. G., Andersen, P. K., & Angst, J. (2004). The predictive effect of episodes on the risk of recurrence in depressive and bipolar disorders–a life-long perspective. *Acta Psychiatrica Scandinavica, 109,* 339-344.

Kessler, R. C., Berglund, P., Demler, O., Jin, R., Koretz, D., Merikangas, K. R., ... & Wang, P. S. (2003). The epidemiology of major depressive disorder: Results from the National Comorbidity Survey Replication (NCS-R). *Jama, 289,* 3095-3105.

Kessler, R. C., Berglund, P., Demler, O., Jin, R., Merikangas, K. R., & Walters, E. E. (2005). Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry, 62*, 593-602.

Kessler, R. C., Petukhova, M., Sampson, N. A., Zaslavsky, A. M., & Wittchen, H. U. (2012). Twelve-month and lifetime prevalence and lifetime morbid risk of anxiety and mood disorders in the United States. *International Journal of Methods in Psychiatric Research, 21*, 169-184.

Keyes, C. L. (2002). The mental health continuum: From languishing to flourishing in life. *Journal of Health and Social Behaviour, 43,* 207-222.

Khalfa, S., Isabelle, P., Jean-Pierre, B., & Manon, R. (2002). Event-related skin conductance responses to musical emotions in humans. *Neuroscience Letters, 328,* 145-149.

Killingsworth, M. A., & Gilbert, D. T. (2010). A wandering mind is an unhappy mind. *Science, 330,* 932-932.

Kirkegaard Thomsen, D. (2006). The association between rumination and negative affect: A review. *Cognition and Emotion, 20,* 1216-1235.

Kirsch, I., & Sapirstein, G. (1998). Listening to Prozac but hearing placebo: A meta-analysis of antidepressant medication. *Prevention & Treatment, 1,* 2a.

Klein, D. F. (1974). Endogenomorphic depression: A conceptual and terminological revision. *Archives of General Psychiatry, 31,* 447-454.

Klein, R. A., Vianello, M., Hasselman, F., Adams, B. A., Adams, R. B., & Alper, S. (2015). Many Labs 2: Investigating variation in replicability across sample and setting. Working paper. Retrieved from http://projectimplicit.net/nosek/ML2protocol.pdf.

Kouros, C. D., Morris, M. C., & Garber, J. (2016). Within-person changes in individual symptoms of depression predict subsequent depressive episodes in adolescents: A prospective study. *Journal of Abnormal Child Psychology, 44*, 483-494.

Kramer, I., Simons, C. J., Hartmann, J. A., Menne-Lothmann, C., Viechtbauer, W., Peeters, F., ... & Os, J. (2014). A therapeutic application of the experience sampling method in the treatment of depression: A randomized controlled trial. *World Psychiatry, 13,* 68-77.

Kraemer, H. C. (2007). DSM categories and dimensions in clinical and research contexts. *International Journal of Methods in Psychiatric Research, 16,* S8-S15.

Kuppens, P., Stouten, J., & Mesquita, B. (2009). Individual differences in emotion components and dynamics: Introduction to the special issue. *Cognition and Emotion, 23*, 1249-1258.

Kuyken, W., Byford, S., Byng, R., Dalgleish, T., Lewis, G., Taylor, R., Watkins, E., Hayes, .R, Lanham, P., Kessler, D., Morant, N., Evans, A. (2010). Study protocol for a randomized controlled trial comparing mindfulness-based cognitive therapy with maintenance anti-depressant treatment in the prevention of depressive relapse/recurrence: The PREVENT trial. *Trials, 11*, 99.

Kuyken, W., Byford, S., Taylor, R. S., Watkins, E., Holden, E., White, K., ... & Teasdale, J. D. (2008). Mindfulness-based cognitive therapy to prevent relapse in recurrent depression. *Journal of Consulting and Clinical Psychology, 76*, 966-978.

Kuyken, W., Crane, R., & Dalgleish, T. (2012). Does mindfulness based cognitive therapy prevent relapse of depression? *British Medical Journal, 345*, e7194.

Kuyken, W., Hayes, R., Barrett, B., Byng, R., Dalgleish, T., Kessler, D., ... & Causley, A. (2015). Effectiveness and cost-effectiveness of mindfulness-based cognitive therapy compared with maintenance antidepressant treatment in the prevention of depressive relapse or recurrence (PREVENT): A randomised controlled trial. *The Lancet, 386,* 63-73.

Kuyken, W., Watkins, E., Holden, E., White, K., Taylor, R. S., Byford, S., ... & Dalgleish, T. (2010). How does mindfulness-based cognitive therapy work?. *Behaviour Research and Therapy*, *48*, 1105-1112.

Kuyken, W., Warren, F. C., Taylor, R. S., Whalley, B., Crane, C., Bondolfi, G., ... & Segal, Z. (2016). Efficacy of mindfulness-based cognitive therapy in prevention of depressive relapse: An individual patient data meta-analysis from randomized trials. *JAMA psychiatry, 73*, 565-574.

Larsen, J. T., Berntson, G. G., Poehlmann, K. M., Ito, T. A., & Cacioppo, J. T. (2008). The psychophysiology of emotion. *Handbook of Emotions, 3*, 180-195.

Larson, C. L., Nitschke, J. B., & Davidson, R. J. (2007). Common and distinct patterns of affective response in dimensions of anxiety and depression. *Emotion, 7*, 182-191.

Layard, R. (2006). The depression report: A new deal for depression and anxiety disorders (No. 15). Centre for Economic Performance, London School of Economics.

Lee, I. A., & Preacher, K. J. (2013). Calculation for the test of the difference between two dependent correlations with one variable in common [Computer software]. Available from http://quantpsy.org.

Lewinsohn, P. M., & Graf, M. (1973). Pleasant activities and depression. *Journal of Consulting and Clinical Psychology*, *41*, 261-268.

Lindquist, S. I., & McLean, J. P. (2011). Daydreaming and its correlates in an educational environment. *Learning and Individual Differences*, *21*, 158-167.

Lopez, A. D., & Murray, C. C. (1998). The global burden of disease 1990-2020. *Nature Medicine, 4,* 1241-1243.

Lutz, A., Slagter, H. A., Rawlings, N. B., Francis, A. D., Greischar, L. L., & Davidson, R. J. (2009). Mental training enhances attentional stability: Neural and behavioural evidence. *The Journal of Neuroscience, 29,* 13418-13427.

Lyubomirsky, S., King, L., & Diener, E. (2005). The benefits of frequent positive affect: Does happiness lead to success?. *Psychological Bulletin, 131*, 803-855.

Ma, S. H., & Teasdale, J. D. (2004). Mindfulness-based cognitive therapy for depression: Replication and exploration of differential relapse prevention effects. *Journal of Consulting and Clinical Psychology, 72,* 31-40.

MacLeod, A. K., Coates, E., & Hetherton, J. (2008). Increasing well-being through teaching goal-setting and planning skills: Results of a brief intervention. *Journal of Happiness Studies*, *9,* 185-196.

MacLeod, C., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *Journal of Abnormal Psychology, 95,* 15-20.

Manly, T., Robertson, I. H., Galloway, M., & Hawkins, K. (1999). The absent mind: Further investigations of sustained attention to response. *Neuropsychologia*, *37*, 661-670.

Mansell, W., & Pedley, R. (2008). The ascent into mania: A review of psychological processes associated with the development of manic symptoms. *Clinical Psychology Review, 28*, 494-520.

Mar, R. A., Mason, M. F., & Litvack, A. (2012). How daydreaming relates to life satisfaction, loneliness, and social support: The importance of gender and daydream content. *Consciousness and Cognition, 21*, 401-407.

Marchetti, I., Koster, E. H., & De Raedt, R. (2012). Mindwandering heightens the accessibility of negative relative to positive thought. *Consciousness and Cognition, 21*, 1517-1525.

Martin, M. (1990). On the induction of mood. *Clinical Psychology Review, 10*, 669-697.

Mason, M., Brown, K., Mar, R. A., & Smallwood, J. (2013). Driver of discontent or escape vehicle: The affective consequences of mindwandering. *Frontiers in Psychology, 4*, 477.

Mason, M. F., Norton, M. I., Van Horn, J. D., Wegner, D. M., Grafton, S. T., & Macrae, C. N. (2007). Wandering minds: The default network and stimulus-independent thought. *Science, 315*, 393-395.

Matthews, G., Joyner, L., Gililand, K., Campbell, S. E., & Faulconner, S. (1999). Validation of a comprehensive stress state questionnaire: Towards a state "Big three"? In: I. Mervielde, I. J. Deary, F. De Fruyt, & F. Ostendorf (Eds.), Handbook of coping: Theory, research and applications (pp. 333–350). Tilburg, NL: Tilburg University Press.

Mauss, I. B., Shallcross, A. J., Troy, A. S., John, O. P., Ferrer, E., Wilhelm, F. H., & Gross, J. J. (2011). Don't hide your happiness! Positive emotion dissociation, social connectedness, and psychological functioning. *Journal of Personality and Social Psychology, 100,* 738-748.

Meehl, P. E. (1962). Schizotaxia, schizotypy, schizophrenia. *American Psychologist, 17,* 827-838.

McCabe, C., Woffindale, C., Harmer, C. J., & Cowen, P. J. (2012). Neural processing of reward and punishment in young people at increased familial risk of depression. *Biological Psychiatry, 72*, 588-594.

McCrone, P., Dhanasiri, S., Patel, A., Knapp, M., & Lawton-Smith, S. (2008). *Paying the price: The cost of mental health care in England to 2026.* London: The King's Fund.

McFarland, B. R., & Klein, D. N. (2009). Emotional reactivity in depression: Diminished responsiveness to anticipated reward but not to anticipated punishment or to nonreward or avoidance. *Depression and Anxiety, 26*, 117-122.

McFarland, B. R., Shankman, S. A., Tenke, C. E., Bruder, G. E., & Klein, D. N. (2006). Behavioral activation system deficits predict the six-month course of depression. *Journal of Affective Disorders, 91*, 229-234.

McMakin, D. L., Olino, T. M., Porta, G., Dietz, L. J., Emslie, G., Clarke, G., ... & Shamseddeen, W. (2012). Anhedonia predicts poorer recovery among youth with selective serotonin reuptake inhibitor treatment–resistant depression. *Journal of the American Academy of Child & Adolescent Psychiatry, 51*, 404-411.

McMakin, D. L., Santiago, C. D., & Shirk, S. R. (2009). The time course of positive and negative emotion in dysphoria. *The Journal of Positive Psychology, 4*, 182-192.

McVay, J. C., & Kane, M. J. (2009). Conducting the train of thought: Working memory capacity, goal neglect, and mind wandering in an executive-control task. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *35,* 196-204.

McVay, J. C., Kane, M. J., & Kwapil, T. R. (2009). Tracking the train of thought from the laboratory into everyday life: An experience-sampling study of mind wandering across controlled and ecological contexts. *Psychonomic Bulletin & Review, 16*, 857-863.

Meric-Bernstam, F., Farhangfar, C., Mendelsohn, J., & Mills, G. B. (2013). Building a personalized medicine infrastructure at a major cancer center. *Journal of Clinical Oncology, 31*, 1849-1857.

Michalak, J., Schultze, M., Heidenreich, T., & Schramm, E. (2015). A randomized controlled trial on the efficacy of mindfulness-based cognitive therapy and a group version of cognitive behavioral analysis system of psychotherapy for chronically depressed patients. *Journal of Consulting and Clinical Psychology*, *83*, 951-963.

Miklowitz, D. J., Alatiq, Y., Goodwin, G. M., Geddes, J. R., Fennell, M. J., Dimidjian, S., ... & Williams, J. M. G. (2009). A pilot study of mindfulness-based cognitive therapy for bipolar disorder. *International Journal of Cognitive Therapy*, *2*, 373-382.

Miner, A., Glomb, T., & Hulin, C. (2005). Experience sampling mood and its correlates at work. *Journal of Occupational and Organizational Psychology, 78*, 171-193.

Mitterschiffthaler, M. T., Kumari, V., Malhi, G. S., Brown, R. G., Giampietro, V. P., Brammer, M. J., ... & Sharma, T. (2003). Neural response to pleasant stimuli in anhedonia: An fMRI study. *Neuroreport, 14*, 177-182.

Moberly, N. J., & Watkins, E. R. (2008). Ruminative self-focus and negative affect: an experience sampling study. *Journal of Abnormal Psychology, 117*, 314-323.

Moberly, N. J., & Watkins, E. R. (2010). Negative affect and ruminative self-focus during everyday goal pursuit. *Cognition & Emotion, 24*, 729-739.

Mor, N., & Winquist, J. (2002). Self-focused attention and negative affect: A meta-analysis. *Psychological Bulletin, 128*, 638.

Morris, B. H., Bylsma, L. M., & Rottenberg, J. (2009). Does emotion predict the course of major depressive disorder? A review of prospective studies. *British Journal of Clinical Psychology, 48*, 255-273.

Morrison, A. B., Goolsarran, M., Rogers, S. L., & Jha, A. P. (2014). Taming a wandering attention: Short-form mindfulness training in student cohorts. *Frontiers in Human Neuroscience, 7*, 897.

Moulds, M. L., Kandris, E., Starr, S., & Wong, A. C. (2007). The relationship between rumination, avoidance and depression in a non-clinical sample. *Behaviour Research and Therapy, 45*, 251-261.

Mrazek, M. D., Franklin, M. S., Phillips, D. T., Baird, B., & Schooler, J. W. (2013). Mindfulness training improves working memory capacity and GRE performance while reducing mind wandering. *Psychological Science*, doi:10.1177/0956797612459659.

Mrazek, M. D., Smallwood, J., & Schooler, J. W. (2012). Mindfulness and mind-wandering: Finding convergence through opposing constructs. *Emotion, 12*, 442-448.

Mueller, T. I., Leon, A. C., Keller, M. B., Solomon, D. A., Endicott, J., Coryell, W., ... & Maser, J. D. (1999). Recurrence after recovery from major depressive disorder during 15 years of observational follow-up. *American Journal of Psychiatry, 156*, 1000-1006.

Murphy, F. C., Macpherson, K., Jeyabalasingham, T., Manly, T., & Dunn, B. D. (2013). Modulating mind-wandering in dysphoria. *Frontiers in Psychology*, *4*, 888.

Myin-Germeys, I., Peeters, F. P. M. L., Havermans, R., Nicolson, N. A., DeVries, M. W., Delespaul, P. A. E. G., & Van Os, J. (2003). Emotional reactivity to daily life stress in psychosis and affective disorder: An experience sampling study. *Acta Psychiatrica Scandinavica, 107*, 124-131.

Nagai, Y., Critchley, H. D., Featherstone, E., Trimble, M. R., & Dolan, R. J. (2004). Activity in ventromedial prefrontal cortex covaries with sympathetic skin conductance level: A physiological account of a "default mode" of brain function. *Neuroimage, 22,* 243-251.

Nakonezny, P. A., Carmody, T. J., Morris, D. W., Kurian, B. T., & Trivedi, M. H. (2010). Psychometric evaluation of the Snaith–Hamilton Pleasure Scale (SHAPS) in adult outpatients with major depressive disorder. *International Clinical Psychopharmacology, 25*, 328-333.

Neff, K. D. (2003). The development and validation of a scale to measure self-compassion. *Self and Identity, 2*, 223-250.

Nelis, S., Holmes, E. A., & Raes, F. (2015). Response styles to positive affect and depression: Concurrent and prospective associations in a community sample. *Cognitive Therapy and Research*, *39*, 480-491.

Nelis, D., Quoidbach, J., Hansenne, M., & Mikolajczak, M. (2011). Measuring individual differences in emotion regulation: The emotion regulation profile-revised (ERP-R). *Psychologica Belgica,* 51, 49-91.

Nelson, D. W. (2009). Feeling good and open-minded: The impact of positive affect on cross cultural empathic responding. *The Journal of Positive Psychology, 4,* 53-63.

Nolen-Hoeksema, S. (2000). The role of rumination in depressive disorders and mixed anxiety/depressive symptoms. Journal of Abnormal Psychology, 109, 504-511.

Nutt, D., Demyttenaere, K., Janka, Z., Aarre, T., Bourin, M., Canonico, P. L., ... & Stahl, S. (2007). The other face of depression, reduced positive affect: The role of catecholamines in causation and cure. *Journal of Psychopharmacology, 21,* 461-471.

O'Connell, R. G., Bellgrove, M. A., Dockree, P. M., & Robertson, I. H. (2004). Reduced electrodermal response to errors predicts poor sustained attention performance in attention deficit hyperactivity disorder. *Neuroreport, 15,* 2535-2538.

Office for National Statistics. (2014). Statistical bulletin: Suicides in the United Kingdom: 2014 registrations. Retrieved from: http://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/suicidesintheunitedkingdom/2014registrations

Olfson, M., Marcus, S. C., Druss, B., Elinson, L., Tanielian, T., & Pincus, H. A. (2002). National trends in the outpatient treatment of depression. *Jama, 287,* 203-209.

Pechtel, P., Dutra, S. J., Goetz, E. L., & Pizzagalli, D. A. (2013). Blunted reward responsiveness in remitted depression. *Journal of Psychiatric Research, 47,* 1864-1869.

Peeters, F., Nicolson, N. A., Berkhof, J., Delespaul, P., & deVries, M. (2003). Effects of daily events on mood states in major depressive disorder. Journal of Abnormal Psychology, 112, 203-211.

Pelizza, L., & Ferrari, A. (2009). Anhedonia in schizophrenia and major depression: State or trait?. *Annals of General Psychiatry, 8,* 1.

Peng, C. K., Henry, I. C., Mietus, J. E., Hausdorff, J. M., Khalsa, G., Benson, H., & Goldberger, A. L. (2004). Heart rate dynamics during three forms of meditation. *International Journal of Cardiology, 95,* 19-27.

Pessiglione, M., Schmidt, L., Draganski, B., Kalisch, R., Lau, H., Dolan, R. J., & Frith, C. D. (2007). How the brain translates money into force: A neuroimaging study of subliminal motivation. *Science, 316,* 904-906.

Philippot, P., Nef, F., Clauw, L., Romrée, M., & Segal, Z. (2012). A Randomized Controlled Trial of Mindfulness-Based Cognitive Therapy for Treating Tinnitus. *Clinical Psychology & Psychotherapy, 19,* 411-419.

Pizzagalli, D. A., Iosifescu, D., Hallett, L. A., Ratner, K. G., & Fava, M. (2008). Reduced hedonic capacity in major depressive disorder: Evidence from a probabilistic reward task. *Journal of Psychiatric Research, 43,* 76-87.

Poerio, G. L., Totterdell, P., Emerson, L. M., & Miles, E. (2015). Love is the triumph of the imagination: Daydreams about significant others are associated with increased happiness, love and connection. *Consciousness and Cognition, 33*, 135-144.

Poerio, G. L., Totterdell, P., & Miles, E. (2013). Mind-wandering and negative mood: Does one thing really lead to another?. *Consciousness and Cognition, 22*, 1412-1421.

Polich, J., & Criado, J. R. (2006). Neuropsychology and neuropharmacology of P3a and P3b. *International Journal of Psychophysiology, 60*, 172-185.

Porges, S. W. (2007). The polyvagal perspective. *Biological Psychology*, *74,* 116-143.

Pratt, L. A., Brody, D. J., & Gu, Q. (2011). Antidepressant use in persons aged 12 and over: United States, 2005-2008. Retrieved from: http://www.cybermed.eu/attachments/article/33763/Antidepressant%20Use%20in%20Persons%20Aged%2012%20and%20Over%20United%20States,%202005%C2%AD2008-1.pdf

Quoidbach, J., Berry, E. V., Hansenne, M., & Mikolajczak, M. (2010). Positive emotion regulation and well-being: Comparing the impact of eight savoring and dampening strategies. *Personality and Individual Differences, 49*, 368-373.

Quoidbach, J., Mikolajczak, M., & Gross, J. J. (2015). Positive interventions: An emotion regulation perspective. *Psychological Bulletin, 141*, 655-693.

Radloff, L. S. (1977). The CES-D scale a self-report depression scale for research in the general population. *Applied Psychological Measurement*, *1*, 385-401.

Raes, F., Smets, J., Nelis, S., & Schoofs, H. (2012). Dampening of positive affect prospectively predicts depressive symptoms in non-clinical samples. *Cognition & Emotion, 26,* 75-82.

Raes, F., Smets, J., Wessel, I., Van Den Eede, F., Nelis, S., Franck, E., ... & Hanssens, M. (2014). Turning the pink cloud grey: Dampening of positive affect predicts postpartum depressive symptoms. *Journal of Psychosomatic Research, 77,* 64-69.

Raes, F., & Williams, J. M. G. (2010). The relationship between mindfulness and uncontrollability of ruminative thinking. *Mindfulness*, *1,* 199-203.

Raichle, M. E., MacLeod, A. M., Snyder, A. Z., Powers, W. J., Gusnard, D. A., & Shulman, G. L. (2001). A default mode of brain function. *Proceedings of the National Academy of Sciences, 98*, 676-682.

Raphiphatthana, B., Jose, P. E., & Kielpikowski, M. (2016). How do the facets of mindfulness predict the constructs of depression and anxiety as seen through the lens of the tripartite theory?. *Personality and Individual Differences*, *93*, 104-111.

Renneberg, B., Heyn, K., Gebhard, R., & Bachmann, S. (2005). Facial expression of emotions in borderline personality disorder and depression. *Journal of Behaviour Therapy and Experimental Psychiatry, 36,* 183-196.

Reidy, J., & Keogh, E. (1997). Testing the discriminant and convergent validity of the Mood and Anxiety Symptoms Questionnaire using a British sample. *Personality and Individual Differences, 23,* 337-344.

Reis, H. T., & Gable, S. L. (2000). Event-sampling and other methods for studying everyday experience. In H. T., Reis & C. M., Judd (Eds.), *Handbook of research methods in social and personality psychology* (190-222). Cambridge: Cambridge University Press.

Reynaud, E., El Khoury-Malhame, M., Rossier, J., Blin, O., & Khalfa, S. (2012). Neuroticism modifies psychophysiological responses to fearful films. *PloS one, 7,* e32413.

Richards, D. A., Ekers, D., McMillan, D., Taylor, R. S., Byford, S., Warren, F. C., ... & O'Mahen, H. (2016). Cost and outcome of behavioural activation versus cognitive behavioural therapy for depression (COBRA): A randomised, controlled, non-inferiority trial. *The Lancet, 388,* 871-880.

Riskind, J. H., Kleiman, E. M., & Schafer, K. E. (2013). "Undoing" effects of positive affect: Does it buffer the effects of negative affect in predicting changes in depression?. *Journal of Social and Clinical Psychology, 32,* 363-380.

Robertson, I. H., Manly, T., Andrade, J., Baddeley, B. T., & Yiend, J. (1997). Oops!': performance correlates of everyday attentional failures in traumatic brain injured and normal subjects. *Neuropsychologia, 35,* 747-758.

Roberts-Wolfe, D., Sacchet, M., Hastings, E., Roth, H., & Britton, W. (2012). Mindfulness training alters emotional memory recall compared to active controls: Support for an emotional information processing model of mindfulness. Frontiers in Human Neuroscience, *6*, 1-13.

Roekel, E., Bennik, E. C., Bastiaansen, J. A., Verhagen, M., Ormel, J., Engels, R. C., & Oldehinkel, A. J. (2015). Depressive symptoms and the experience of pleasure in daily life: An exploration of associations in early and late adolescence. *Journal of Abnormal Child Psychology, 44,* 99-1009.

Rosenzweig, S. (1936). Some implicit common factors in diverse methods of psychotherapy. *American journal of Orthopsychiatry, 6*, 412-415.

Roth, W. T., Dawson, M. E., & Filion, D. L. (2012). Publication recommendations for electrodermal measurements. *Psychophysiology, 49*, 1017-1034.

Rottenberg, J. (2005). Mood and emotion in major depression. *Current Directions in Psychological Science*, *14*, 167-170.

Rottenberg, J., Kasch, K. L., Gross, J. J., & Gotlib, I. H. (2002). Sadness and amusement reactivity differentially predict concurrent and prospective functioning in major depressive disorder. *Emotion, 2*, 135-146.

Ruby, F. J., Smallwood, J., Engen, H., & Singer, T. (2013). How self-generated thought shapes mood—the relation between mind-wandering and mood depends on the socio-temporal content of thoughts. *PloS one*, *8*, e77554.

Russo, S. J., & Nestler, E. J. (2013). The brain reward circuitry in mood disorders. *Nature Reviews Neuroscience*, *14*, 609-625.

Sayette, M. A., Reichle, E. D., & Schooler, J. W. (2009). Lost in the sauce the effects of alcohol on mind wandering. *Psychological Science*, *20*, 747-752.

Segal, Z. V., Williams, J. M. G., & Teasdale, J. D. (2002). *Mindfulness-based cognitive therapy for depression: A new approach to relapse prevention.* New York: Guilford.

Seibert, P. S., & Ellis, H. C. (1991). Irrelevant thoughts, emotional mood states, and cognitive task performance. *Memory & Cognition, 19*, 507-513.

Seli, P., Carriere, J. S., & Smilek, D. (2015). Not all mind wandering is created equal: Dissociating deliberate from spontaneous mind wandering. *Psychological Research, 79*, 750-758.

Schooler, J. W. (2002). Re-representing consciousness: Dissociations between experience and meta-consciousness. *Trends in Cognitive Sciences, 6,* 339-344.

Schooler, J. W., Mrazek, M. D., Franklin, M. S., Baird, B., Mooneyham, B. W., Zedelius, C., & Broadway, J. M. (2014). The middle way: Finding the balance between mindfulness and mind-wandering. *Psychology of Learning and Motivation, 60,* 1-33.

Schooler, J., & Schreiber, C. A. (2004). Experience, meta-consciousness, and the paradox of introspection. *Journal of Consciousness Studies, 11,* 17-39.

Schooler, J. W., Smallwood, J., Christoff, K., Handy, T. C., Reichle, E. D., & Sayette, M. A. (2011). Meta-awareness, perceptual decoupling and the wandering mind. *Trends in Cognitive Sciences, 15,* 319-326.

Schroevers, M. J., & Brandsma, R. (2010). Is learning mindfulness associated with improved affect after mindfulness-based cognitive therapy?. *British Journal of Psychology, 101*, 95-107.

Schueller, S. M., & Parks, A. C. (2014). The science of self-help: Translating positive psychology research into increased individual happiness. *European Psychologist, 19,* 145-155.

Schwartz, R. M., Reynolds III, C. F., Thase, M. E., Frank, E., Fasiczka, A. L., & Haaga, D. A. (2002). Optimal and normal affect balance in psychotherapy of major depression: Evaluation of the balanced states of mind model. *Behavioural and Cognitive Psychotherapy, 30*, 439-450.

Scollon, C. N., Prieto, C. K., & Diener, E. (2009). Experience sampling: Promises and pitfalls, strength and weaknesses. In E. Diener (Ed.), *Assessing well-being* (pp. 157-180). Netherlands: Springer.

Shahar, B., Britton, W. B., Sbarra, D. A., Figueredo, A. J., & Bootzin, R. R. (2010). Mechanisms of change in mindfulness-based cognitive therapy for depression: Preliminary evidence from a randomized controlled trial. *International Journal of Cognitive Therapy, 3*, 402-418.

Shallcross, A. J., Gross, J. J., Visvanathan, P. D., Kumar, N., Palfrey, A., Ford, B. Q., ... & Cox, E. (2015). Relapse prevention in major depressive disorder: Mindfulness-based cognitive therapy versus an active control condition. *Journal of Consulting and Clinical Psychology*, *83*, 964.

Shankman, S. A., Nelson, B. D., Harrow, M., & Faull, R. (2010). Does physical anhedonia play a role in depression? A 20-year longitudinal study. *Journal of Affective Disorders, 120*, 170-176.

Shapiro, S. L., Carlson, L. E., Astin, J. A., & Freedman, B. (2006). Mechanisms of mindfulness. *Journal of Clinical Psychology*, *62*, 373-386.

Sherdell, L., Waugh, C. E., & Gotlib, I. H. (2012). Anticipatory pleasure predicts motivation for reward in major depression. *Journal of Abnormal Psychology, 121,* 51-60.

Silvia, P. J., Kwapil, T. R., Eddington, K. M., & Brown, L. H. (2013). Missed beeps and missing data: Dispositional and situational predictors of nonresponse in experience sampling research. *Social Science Computer Review,* doi: 0894439313479902.

Sin, N. L., Della Porta, M. D., & Lyubomirsky, S. (2011). Tailoring positive psychology interventions to treat depressed individuals. In S. I. Donaldson, M. Csikszentmihalyi, & J. Nakamura (Eds.), Applied Positive Psychology: Improving Everyday Life, Health, Schools, Work, and Society (pp. 79-96). New York: Routledge.

Sloan, D. M., Strauss, M. E., & Wisner, K. L. (2001). Diminished response to pleasant stimuli by depressed women. *Journal of Abnormal Psychology, 110*, 488-493.

Smallwood, J. (2011). Mind-wandering while reading: Attentional decoupling, mindless reading and the cascade model of inattention. *Language and Linguistics Compass, 5*, 63-77.

Smallwood, J. M., Baracaia, S. F., Lowe, M., & Obonsawin, M. (2003). Task unrelated thought whilst encoding information. *Consciousness and Cognition, 12*, 452-484.

Smallwood, J., Beach, E., Schooler, J. W., & Handy, T. C. (2008). Going AWOL in the brain: Mind wandering reduces cortical analysis of external events. *Journal of Cognitive Neuroscience, 20,* 458-469.

Smallwood, J., Davies, J. B., Heim, D., Finnigan, F., Sudberry, M., O'Connor, R., & Obonsawin, M. (2004). Subjective experience and the attentional lapse: Task engagement and disengagement during sustained attention. *Consciousness and Cognition, 13*, 657-690.

Smallwood, J., Fitzgerald, A., Miles, L. K., & Phillips, L. H. (2009). Shifting moods, wandering minds: Negative moods lead the mind to wander. *Emotion*, *9*, 271-276.

Smallwood, J., McSpadden, M., & Schooler, J. W. (2007). The lights are on but no one's home: Meta-awareness and the decoupling of attention when the mind wanders. *Psychonomic Bulletin & Review, 14*, 527-533.

Smallwood, J., McSpadden, M., & Schooler, J. W. (2008). When attention matters: The curious incident of the wandering mind. *Memory & Cognition, 36*, 1144-1150.

Smallwood, J., Nind, L., & O'Connor, R. C. (2009). When is your head at? An exploration of the factors associated with the temporal focus of the wandering mind. *Consciousness and Cognition, 18*, 118-125.

Smallwood, J., Obonsawin, M., & Reid, H. (2003). The effects of block duration and task demands on the experience of task unrelated thought. *Imagination, Cognition and Personality*, *22*, 13–31.

Smallwood, J., & O'Connor, R. C. (2011). Imprisoned by the past: Unhappy moods lead to a retrospective bias to mind wandering. *Cognition & Emotion, 25,* 1481-1490.

Smallwood, J., O'Connor, R. C., & Heim, D. (2005). Rumination, dysphoria, and subjective experience. *Imagination, Cognition and Personality, 24,* 355-367.

Smallwood, J., O'Connor, R. C., Sudbery, M. V., & Obonsawin, M. (2007). Mind-wandering and dysphoria. *Cognition and Emotion, 21*, 816-842.

Smallwood, J., Riby, L., Heim, D., & Davies, J. B. (2006). Encoding during the attentional lapse: Accuracy of encoding during the semantic sustained attention to response task. *Consciousness and Cognition, 15,* 218-231.

Smallwood, J., Ruby, F. J., & Singer, T. (2013). Letting go of the present: Mind-wandering is associated with reduced delay discounting. *Consciousness and Cognition, 22*, 1-7.

Smallwood, J., & Schooler, J. W. (2006). The restless mind. *Psychological Bulletin*, *132,* 946-958.

Smallwood, J., & Schooler, J. W. (2015). The science of mind wandering: Empirically navigating the stream of consciousness. *Annual Review of Psychology, 66,* 487-518.

Snaith, R. P., Hamilton, M., Morley, S., Humayan, A., Hargreaves, D., & Trigwell, P. (1995). A scale for the assessment of hedonic tone the Snaith-Hamilton Pleasure Scale. *The British Journal of Psychiatry, 167,* 99-103.

Snijders, T., & Bosker, R. (1999). Multilevel analysis: An introduction to basis and advanced multilevel modeling. London: SAGE publications Ltd

Sobocki, P., Jönsson, B., Angst, J., & Rehnberg, C. (2006). Cost of depression in Europe. *The Journal of Mental Health Policy and Economics, 9,* 87-98.

Song, X., & Wang, X. (2012). Mind wandering in Chinese daily lives–an experience sampling study. *PloS one, 7,* e44423.

Spasojević, J., & Alloy, L. B. (2001). Rumination as a common mechanism relating depressive risk factors to depression. *Emotion, 1*, 25-37.

Spijker, J., Bijl, R. V., De Graaf, R., & Nolen, W. A. (2001). Determinants of poor 1-year outcome of DSM-III-R major depression in the general population: Results of the Netherlands Mental Health Survey and Incidence Study (NEMESIS). *Acta Psychiatrica Scandinavica, 103,* 122-130.

Stawarczyk, D., Majerus, S., & D’Argembeau, A. (2013). Concern-induced negative affect is associated with the occurrence and content of mind-wandering. *Consciousness and Cognition*, *22*, 442-448.

Stawarczyk, D., Majerus, S., Maj, M., Van der Linden, M., & D'Argembeau, A. (2011). Mind-wandering: Phenomenology and function as assessed with a novel experience sampling method. *Acta Psychologica*, *136,* 370-381.

Stawarczyk, D., Majerus, S., Van der Linden, M., & D'Argembeau, A. (2012). Using the daydreaming frequency scale to investigate the relationships between mind-wandering, psychological well-being, and present-moment awareness. *Frontiers in Psychology, 3,* 363.

Steiger, J. H. (1980). Tests for comparing elements of a correlation matrix. *Psychological Bulletin, 87*, 245-251.

Stern, R. M., Ray, W. J., & Quigley, K. S. (2001). *Psychophysiological recording*. Oxford University Press, USA.

Strauss, C., Cavanagh, K., Oliver, A., & Pettman, D. (2014). Mindfulness-based interventions for people diagnosed with a current episode of an anxiety or depressive disorder: A meta-analysis of randomised controlled trials. *PLoS One, 9,* e96110.

Surguladze, S., Brammer, M. J., Keedwell, P., Giampietro, V., Young, A. W., Travis, M. J., ... & Phillips, M. L. (2005). A differential pattern of neural response toward sad versus happy facial expressions in major depressive disorder. *Biological Psychiatry, 57*, 201-209.

Tarrier, N. (2010). Broad minded affective coping (BMAC): A "positive" CBT approach to facilitating positive emotions. *International Journal of Cognitive Therapy, 3*, 64-76.

Teasdale, J. D., Dritschel, B. H., Taylor, M. J., Proctor, L., Lloyd, C. A., Nimmo-Smith, I., & Baddeley, A. D. (1995). Stimulus-independent thought depends on central executive resources. *Memory & Cognition, 23*, 551-559.

Teasdale, J. D., Moore, R. G., Hayhurst, H., Pope, M., Williams, S., & Segal, Z. V. (2002). Metacognitive awareness and prevention of relapse in depression: Empirical evidence. *Journal of Consulting and Clinical Psychology*, *70*, 275-287.

Telford, C., McCarthy-Jones, S., Corcoran, R., & Rowse, G. (2012). Experience sampling methodology studies of depression: The state of the art. *Psychological Medicine, 42*, 1119-1129.

Thompson, R. J., Mata, J., Jaeggi, S. M., Buschkuehl, M., Jonides, J., & Gotlib, I. H. (2012). The everyday emotional experience of adults with major depressive disorder: Examining emotional instability, inertia, and reactivity. *Journal of Abnormal Psychology*, *121*, 819-829.

Tiitinen, H. T., Sinkkonen, J., Reinikainen, K., Alho, K., Lavikainen, J., & Näätänen, R. (1993). Selective attention enhances the auditory 40-Hz transient response in humans. *Nature, 365*, 59-60.

Treadway, M. T., Buckholtz, J. W., Schwartzman, A. N., Lambert, W. E., & Zald, D. H. (2009). Worth the 'EEfRT'? The effort expenditure for rewards task as an objective measure of motivation and anhedonia. *PloS one, 4,* e6598.

Treadway, M. T., & Zald, D. H. (2011). Reconsidering anhedonia in depression: Lessons from translational neuroscience. *Neuroscience & Biobehavioral Reviews, 35*, 537-555.

Tsai, J. L., Pole, N., Levenson, R. W., & Muñoz, R. F. (2003). The effects of depression on the emotional responses of Spanish-speaking Latinas. *Cultural Diversity and Ethnic Minority Psychology*, 9, 49-63.

Tucker, L. R., Damarin, F., & Messick, S. (1966). A base-free measure of change. *Psychometrika, 31,* 457-473.

Uher, R., Perlis, R. H., Henigsberg, N., Zobel, A., Rietschel, M., Mors, O., ... & Maier, W. (2012). Depression symptom dimensions as predictors of antidepressant treatment outcome: Replicable evidence for interest-activity symptoms. *Psychological Medicine, 42,* 967-980.

Undurraga, J., & Baldessarini, R. J. (2012). Randomized, placebo-controlled trials of antidepressants for acute major depression: Thirty-year meta-analytic review. *Neuropsychopharmacology, 37,* 851-864.

Unsworth, N., Heitz, R. P., Schrock, J. C., & Engle, R. W. (2005). An automated version of the operation span task. *Behaviour Research Methods*, *37,* 498-505.

van Aalderen, J. R., Donders, A. R. T., Giommi, F., Spinhoven, P., Barendregt, H. P., & Speckens, A. E. M. (2012). The efficacy of mindfulness-based cognitive therapy in recurrent depressed patients with and without a current depressive episode: A randomized controlled trial. *Psychological Medicine*, *42,* 989-1001.

van der Velden, A. M., Kuyken, W., Wattar, U., Crane, C., Pallesen, K. J., Dahlgaard, J., ... & Piet, J. (2015). A systematic review of mechanisms of change in mindfulness-based cognitive therapy in the treatment of recurrent major depressive disorder. *Clinical Psychology Review, 37,* 26-39.

Van Oyen Witvliet, C., & Vrana, S. R. (1995). Psychophysiological responses as indices of affective dimensions. *Psychophysiology, 32*, 436-443.

van Roekel, E., Bennik, E. C., Bastiaansen, J. A., Verhagen, M., Ormel, J., Engels, R. C., & Oldehinkel, A. J. (2015). Depressive symptoms and the experience of pleasure in daily life: An exploration of associations in early and late adolescence. *Journal of Abnormal Child Psychology, 44*, 999–1009.

Vittengl, J. R., Clark, L. A., Dunn, T. W., & Jarrett, R. B. (2007). Reducing relapse and recurrence in unipolar depression: a comparative meta-analysis of cognitive-behavioral therapy's effects. *Journal of Consulting and Clinical Psychology, 75*, 475-488.

Wacker, J., Dillon, D. G., & Pizzagalli, D. A. (2009). The role of the nucleus accumbens and rostral anterior cingulate cortex in anhedonia: integration of resting EEG, fMRI, and volumetric techniques. *Neuroimage, 46*, 327-337.

Wadlinger, H. A., & Isaacowitz, D. M. (2006). Positive mood broadens visual attention to positive stimuli. *Motivation and Emotion, 30*, 87-99.

Walach, H., Buchheld, N., Buttenmüller, V., Kleinknecht, N., & Schmidt, S. (2006). Measuring mindfulness—the Freiburg mindfulness inventory (FMI). *Personality and Individual Differences, 40*, 1543-1555.

Wallace, R. K. (1970). Physiological effects of transcendental meditation. *Science, 167*, 1751-1754.

Ward, L. C. (2006). Comparison of factor structure models for the Beck Depression Inventory--II. *Psychological Assessment, 18*, 81-88.

Watson, D. (1988). Intraindividual and interindividual analyses of positive and negative affect: Their relation to health complaints, perceived stress, and daily activities. *Journal of Personality and Social Psychology, 54*, 1020-1030.

Watson, D., & Clark, L. A. (1991). The mood and anxiety symptom questionnaire. Unpublished manuscript, University of Iowa, Department of Psychology, Iowa City.

Watson, D., Clark, L. A., & Carey, G. (1988). Positive and negative affectivity and their relation to anxiety and depressive disorders. *Journal of Abnormal Psychology, 97*, 346-353.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of Personality and Social Psychology, 54*, 1063-1070.

Watson, D., Clark, L. A., Weber, K., Assenheimer, J. S., Strauss, M. E., & McCormick, R. A. (1995). Testing a tripartite model: II. Exploring the symptom structure of anxiety and depression in student, adult, and patient samples. *Journal of Abnormal Psychology, 104,* 15-25.

Watson, D., & Naragon-Gainey, K. (2010). On the specificity of positive emotional dysfunction in psychopathology: Evidence from the mood and anxiety disorders and schizophrenia/schizotypy. *Clinical Psychology Review, 30*, 839-848.

Watts, F. N., MacLeod, A. K., & Morris, L. (1988). Associations between phenomenal and objective aspects of concentration problems in depressed patients. *British Journal of Psychology, 79*, 241-250.

Watts, F. N., & Sharrock, R. (1985). Description and measurement of concentration problems in depressed patients. *Psychological Medicine, 15,* 317-326.

Waugh, C. E., & Fredrickson, B. L. (2006). Nice to know you: Positive emotions, self–other overlap, and complex understanding in the formation of a new relationship. *The Journal of Positive Psychology, 1,* 93-106.

Wegner, D. M., Erber, R., & Zanakos, S. (1993). Ironic processes in the mental control of mood and mood-related thought. *Journal of Personality and Social Psychology*, 65, 1093-1104.

Weitz, E., Hollon, S. D., Kerkhof, A., & Cuijpers, P. (2014). Do depression treatments reduce suicidal ideation? The effects of CBT, IPT, pharmacotherapy, and placebo on suicidality. *Journal of Affective Disorders*, *167*, 98-103.

Werner-Seidler, A., Banks, R., Dunn, B. D., & Moulds, M. L. (2013). An investigation of the relationship between positive affect regulation and depression. *Behaviour Research and Therapy*, *51*, 46-56.

Whitton, A. E., Kakani, P., Foti, D., Van't Veer, A., Haile, A., Crowley, D. J., & Pizzagalli, D. A. (2016). Blunted neural responses to reward in remitted Major Depression: A high-density event-related potential study. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging, 1*, 87-95.

Whitton, A. E., Treadway, M. T., & Pizzagalli, D. A. (2015). Reward processing dysfunction in major depression, bipolar disorder and schizophrenia. *Current Opinion in Psychiatry*, 28, 7-12.

Whyte, J., Grieb-Neff, P., Gantz, C., & Polansky, M. (2006). Measuring sustained attention after traumatic brain injury: Differences in key findings from the sustained attention to response task (SART). *Neuropsychologia, 44*, 2007-2014.

Wichers, M., Lothmann, C., Simons, C. J., Nicolson, N. A., & Peeters, F. (2012). The dynamic interplay between negative and positive emotions in daily life predicts response to treatment in depression: A momentary assessment study. *British Journal of Clinical Psychology, 51*, 206-222.

Wichers, M., Peeters, F., Geschwind, N., Jacobs, N., Simons, C. J. P., Derom, C., ... & Van Os, J. (2010). Unveiling patterns of affective responses in daily life may improve outcome prediction in depression: A momentary assessment study. *Journal of Affective Disorders, 124*, 191-195.

Williams, J. M. G., Crane, C., Barnhofer, T., Brennan, K., Duggan, D. S., Fennell, M. J., ... & Shah, D. (2014). Mindfulness-based cognitive therapy for preventing relapse in recurrent depression: A randomized dismantling trial. *Journal of Consulting and Clinical Psychology*, *82*, 275-286.

Williams, M. J., Dalgleish, T., Karl, A., & Kuyken, W. (2014). Examining the factor structures of the five facet mindfulness questionnaire and the self-compassion scale. *Psychological Assessment, 26*, 407-418.

Williams, L. M., Phillips, M. L., Brammer, M. J., Skerrett, D., Lagopoulos, J., Rennie, C., ... & Gordon, E. (2001). Arousal dissociates amygdala and hippocampal fear responses: Evidence from simultaneous fMRI and skin conductance recording. *Neuroimage, 14,* 1070-1079.

Wilson, K., & Korn, J. H. (2007). Attention during lectures: Beyond ten minutes. *Teaching of Psychology, 34*, 85-89.

Winer, E. S., Nadorff, M. R., Ellis, T. E., Allen, J. G., Herrera, S., & Salem, T. (2014). Anhedonia predicts suicidal ideation in a large psychiatric inpatient sample. *Psychiatry Research, 218*, 124-128.

Wood, A. M., & Joseph, S. (2010). The absence of positive psychological (eudemonic) well-being as a risk factor for depression: A ten year cohort study. *Journal of Affective Disorders, 122*, 213-217.

Wood, J. V., Perunovic, W. E., & Lee, J. W. (2009). Positive self-statements power for some, peril for others. *Psychological Science, 20*, 860-866.

World Health Organization. (1993). *The ICD-10 Classification of Mental and Behavioural Disorders: Diagnostic Criteria for Research.* Geneva: World Health Organization.

World Health Organization. (April, 2016). Depression. Retrieved from http://www.who.int/mediacentre/factsheets/fs369/en/

Yovel, I., & Mineka, S. (2005). Emotion-congruent attentional biases: The perspective of hierarchical models of emotional disorders. *Personality and Individual Differences, 38*, 785-795.

Zelenski, J. M., & Larsen, R. J. (2000). The distribution of basic emotions in everyday life: A state and trait perspective from experience sampling data. *Journal of Research in Personality, 34*, 178-197.

Zvolensky, M. J., Solomon, S. E., McLeish, A. C., Cassidy, D., Bernstein, A., Bowman, C. J., & Yartz, A. R. (2006). Incremental validity of mindfulness-based attention in relation to the concurrent prediction of anxiety and depressive symptomatology and perceptions of health. *Cognitive Behaviour Therapy*, *35*, 148-158.

# List of Abbreviations

| | |
|---|---|
| AOSPAN | Automated Operation Span Task |
| APA | American Psychiatric Association |
| BA | Behavioural Activation (treatment) |
| BAS | Behavioural Activation Scale |
| BDI-II | Beck’s Depression Inventory – second version |
| BIS | Behavioural Inhibition Scale |
| BMAC | Broad Minded Affective Coping |
| BPM | Beats per minute |
| CBT | Cognitive Behavioural Therapy |
| DSM | Diagnostic Statistical Manual of Mental Disorders |
| DSSQ | Dundee Stress State Questionnaire |
| Dundee TRI | Dundee Task Related Interference subscale |
| Dundee TUT | Dundee Task Unrelated Thought subscale |
| DV | Dependent Variable |
| ECG | Electrocardiogram |
| EDA | Electrodermal activity |
| EMG | Electromyography |
| ERP-R | Emotion Regulation Profile – Revised |
| ESM | Experience Sampling Methodology/ Event Scheduling Methodology |
| FFMQ | Five Factor Mindfulness Questionnaire |
| FFMQ-AA | Acting with Awareness subscale of the Five Factor Mindfulness Questionnaire |
| GAP | Goal setting and planning |
| GP | General Practitioner |
| GSR | Galvanic Skin Response |
| HDRS | Hamilton Depression Rating Scale |
| HR | Heart Rate |
| HRV | Heart Rate Variability |
| IAA | Intention, Attention and Attitude |
| ICD-10 | International Classification of Diseases version 10 |
| IPT | Interpersonal Therapy |
| KIMS | Kentucky Inventory of Mindfulness Skills |
| LCD | Liquid crystal display monitor |
| M | Mean |
| MAAS | Mindful Attention Awareness Scale |
| MAO | Monoamine-Oxidase Inhibitors |
| MASQ | Mood Anxiety Symptom Questionnaire |
| MASQ-AA | Mood Anxiety Symptom Questionnaire – Anxious Arousal subscale |
| MASQ-AD | Mood Anxiety Symptom Questionnaire – Anhedonic Depression subscale |
| MASQ-GD | Mood Anxiety Symptom Questionnaire – General Distress subscale |
| MBCT | Mindfulness Based Cognitive Therapy |
| MBCT-TS | Mindfulness Based Cognitive Therapy with support to taper antidepressants |
| MBSR | Mindfulness Based Stress Reduction |
| MDC | Mood Disorders Centre |
| MDD | Major Depressive Disorder |
| MHC-SF | Mental Health Continuum Short Form |
| MRC | Medical Research Council |
| µS | Microsiemens |
| MW | Mind wandering |
| MWd | Absolute level of mind wandering during positive events |
| MW- | Experimental condition (studies 3 and 4) to decrease mind wandering |
| MW+ | Experimental condition (studies 3 and 4) to increase mind wandering |

| | |
|---|---|
| NA | Negative Affect |
| NASSA | Noradrenaline and Specific Serotonergic Antidepressants |
| NHS | National Health Service |
| NICE | National Institute Clinical Excellence |
| NIMH | National Institute Mental Health |
| ONS | Office of National Statistics |
| PA | Positive Affect |
| PANAS | Positive and Negative Affect Schedule |
| PSOM | Positive State of Mind questionnaire |
| PTSD | Post-Traumatic Stress Disorder |
| QRS | Q,R and S wave in an ECG signal |
| RDoC | Research Domain Criteria |
| RCT | Randomised Control Trial |
| RT | Reaction Time |
| RT_CV | Standard deviation of reaction times on SART/mean reaction times |
| SART | Sustained Attention to Response Task |
| SCID | Structured Clinical Interview for Diagnosis |
| SD | Standard deviation |
| SHAPS | Snaith Hamilton Pleasure Scale |
| SSNI | Serotonin and Norepinephrine Reuptake Inhibitors |
| SSRI | Selective Serotonin Reuptake Inhibitors |
| TAU | Treatment as usual |
| TCAs | Tricyclic antidepressants |
| UK | United Kingdom |
| WHO | World Health Organisation |
| 5-HT | Serotonin |