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UNIVERSITY OF SOUTHAMPTON

FACULTY OF SOCIAL, HUMAN AND MATHEMATICAL SCIENCES

School of Psychology

Volume 1 of 1

**Targeting Negative Thought Intrusions in Chronic Worry: the Role of
Mindfulness Interventions and the Use of Experience Sampling**

by

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Thesis for the degree of Doctorate in Clinical Psychology

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ABSTRACT

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Background: Momentary mind wandering has been associated with reduced affect when explored across a range of clinical and non-clinical populations. As a component of mind wandering worry has been identified as a transdiagnostic process. Within this study experience sampling methodology was used to test the differential effects of acceptance and attention based mindfulness exercises on worry and the frequency of thought intrusions.

Method: 75 high worriers were randomised to one of three groups (acceptance, focussed attention or progressive muscle relaxation), and practiced a 10 minute exercise regularly for 18 days. In addition to standardised measures, six times per day participants were prompted via their mobile phones to complete a short survey assessing momentary thought intrusions.

Results: All groups experienced a reduction in worry, with the acceptance exercise having a superior effect. Mind wandering occurred frequently, within 58.82% of responses and the content tended to be related to the future. Momentary future orientated unpleasant thoughts reduced over the course, similarly for each group.

Discussion: The study provides evidence that acceptance and attention-based exercises reduce the frequency of worry in self-reported high worriers.

Table of Contents

Table of Contents	i
List of Tables	iii
List of Figures	iii
DECLARATION OF AUTHORSHIP	vii
Acknowledgements	ix
Chapter 1: Mind Wandering and Mood: Review of the Literature Utilising Experience Sampling Methodology	1
1.1 Introduction.....	1
1.1.1 Transdiagnostic nature of mind wandering.	2
1.1.2 Measuring mind wandering.	3
1.1.3 Clinical utility of experience sampling methodology.....	5
1.1.4 Rationale for this review.....	6
1.2 Method	7
1.3 Using ESM to Capture Momentary Mind Wandering.....	17
1.3.1 Mind wandering item selection.	21
1.3.2 Method of signalling/recording experiences.	23
1.3.3 Signalling Approach (scheduling pattern, number of prompts and response restrictions).	24
1.3.4 Response rates.	26
1.3.5 A note on data analysis.	27
1.4 The Relationship between Mind Wandering and Mood	29
1.4.1 Mind wandering generally.	29
1.4.2 Rumination.	31
1.5 Discussion	35
1.6 Conclusion	37
Chapter 2: Comparing the Effects of Attention and Acceptance-Based Psychological Interventions on Thought Intrusions in Chronic Worriers..	39
2.1 Introduction.....	39

2.2	Method.....	45
2.2.1	Participants.	45
2.2.2	Design and procedure.....	45
2.2.3	Measures.....	47
2.2.4	Intervention conditions.....	51
2.2.5	Data analysis.....	53
2.3	Results	55
2.3.1	Effect of exercise on trait worry.....	55
2.3.2	Effect of exercise on mood.....	57
2.3.3	Effect of exercise on trait mindfulness and mind wandering.	58
2.3.4	Momentary mind wandering.	60
2.4	Discussion.....	65
2.5	Conclusion.....	69
	Appendices.....	71
	Appendix A Additional Information for Chapter 2.....	73
A.1	Confirmation of ethics approval.....	73
A.2	Mean Response Rates for the MMWS	75
A.3	Mean Proportions of Future Orientated Unpleasant Mind Wandering	75
A.4	Mean Anxiety and Sadness Ratings for the MWWS.....	76
	List of References	77

List of Tables

<i>Table 1. Key Findings of Included Studies</i>	10
<i>Table 2. Summary of Methodological Ratings for All Included Studies</i>	19
<i>Table 3. Group characteristics</i>	46
<i>Table 4. Descriptive statistics for standardised questionnaire data at each time point for each group</i>	56
<i>Table 5. Mean overall frequency for each type of thought valence and orientation</i>	61

List of Figures

<i>Figure 1. Study Selection Flow Chart</i>	9
<i>Figure 2. Summary of the ESM design guidance and rating system for the review of included studies.</i>	18
<i>Figure 3. Flowchart demonstrating data collection during each of the four time phases of the intervention.</i>	50
<i>Figure 4. Matrix outlining day of participation and measures completed.</i>	51
<i>Figure 5. Mean worry at baseline and T6 (day21) in each group. Error bars = +/-1SEM.....</i>	57
<i>Figure 6. Mean mindfulness at baseline and T6 (day21) in each group. Error bars = +/-1SEM.....</i>	59
<i>Figure 7. Means for the Proportions of Mind Wandering Type (Valence) by Temporal Direction.</i>	62

DECLARATION OF AUTHORSHIP

I, [please print name]

declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

Targeting Negative Thought Intrusions in Chronic Worry: the Role of Mindfulness Interventions and the Use of Experience Sampling

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Chapter 1: Mind Wandering and Mood: Review of the Literature Utilising Experience Sampling Methodology

1.1 Introduction

Mind wandering is a common phenomenon, experienced by all on a daily basis (Song & Wang, 2012). Operational definitions refer to the experience of having a thought that is decoupled from stimuli present in the current environment, and unrelated to the activity being carried out (Stawarczyk, Majerus, Maj, Van der Linden & D'Argembeau, 2011). Within this review the term mind wandering refers to any momentary experience during which the individual's thoughts were unrelated to the task being carried out at the time. The use of this broad definition allows for the inclusion of processes ranging from the seemingly innocuous daydreams to excessive rumination and worry. Arguably, utilising such a broad definition does not account for the idiosyncrasies of different processes. For example, here daydreaming is considered to reflect mind wandering; however, others have argued it to be a distinct process. Specifically, Mrazek, Phillips, Franklin, Broadway and Schooler (2013) suggest that whilst mind wandering reflects the redirection of attention from a primary task, they argue that daydreaming occurs in the absence of a primary task. However, in the context of the current review it is important to consider all types of task unrelated thought in order to obtain a thorough understanding of its measurement and relationship to mood, thus the use of this broad definition was deemed appropriate.

The opposite state to mind wandering is mindfulness, which refers to the mental state of being consciously aware of the present moment in a particular way with openness, curiosity and acceptance (Bishop et al., 2004). With increasing interest in the therapeutic potential of mindfulness based interventions for clinical populations, such as those experiencing an anxiety disorder (Wong et al., 2016) or depression (Kukyen et al., 2016), a better understanding of the relationship between mind wandering and mood is required. Furthermore, due to the fluctuating nature of attention, the momentary assessment of the experience of mind wandering has the potential to provide valuable insight into the

relationship between mind wandering and mood. Here, momentary assessment refers to any attempt to measure the experience (e.g. of mind wandering) during the moment in which it occurs.

1.1.1 Transdiagnostic nature of mind wandering.

Findings from laboratory-based research have suggested that negative mood is associated with increased mind wandering. For example Stawarczyk, Majerus and D'Argembeau (2013) found that negative affect was maintained by mind wandering following a concern induction task. Ainsworth, Bolderston and Garner (2017) found that increased frequency of negative intrusions following a worry induction task predicted increased levels of self-reported anxiety. Furthermore, within clinical populations rumination has been found to prolong symptoms of depression (Nolen-Hoeksema, Wisco & Lyubomirsky, 2008).

When exploring the implications of mind wandering within clinical populations, research generally adopts a diagnostic approach, involving the clustering of symptoms into categories, such as depression, generalised anxiety disorder (GAD), bipolar disorder etc. Watkins (2015) acknowledged the potential for this diagnostic approach to identify distinct syndromes that respond differentially to particular interventions. This has allowed the establishment of an evidence base and clinical guidance for the treatment of such syndromes, for example the NICE guidance recommending the use of CBT for depression (NICE, 2009). However, this evidence is based on relatively low treatment efficacy rate (Craighead and Dunlop, 2014). For example, Craighead and Dunlop (2014) suggest that only one third of depressed individuals meet the criteria for remission from depression following a single modality treatment, furthermore they emphasise there to be no significant difference in response between different treatment approaches. Watson (2015) argues that this low response rate could be due to the focus on symptom clusters, as opposed to underlying mechanisms. Heterogeneity within disorders is high, and thus Watson (2015) makes the point that two individuals with vastly different presentation, yet sharing one common symptom, could receive the same diagnosis and subsequent treatment, e.g. of depression. Furthermore, Watson (2015) highlights that the high comorbidity of psychiatric diagnoses provides support for the presence of shared underlying mechanisms. Such arguments have led to the increasing interest in the transdiagnostic approach for understanding the aetiology and maintenance of mental health difficulties. In contrast to the diagnostic approach the transdiagnostic approach

emphasises the identification of common maladaptive processes (including cognitive, behavioural, emotional and interpersonal processes) that underpin a range of diagnostic presentations (Newby, McKinnon, Kuyken, Gilbody & Dalgleish, 2015). It is argued that by utilising a transdiagnostic approach and focusing on understanding how underlying mechanisms influence the onset and maintenance of difficulties, the efficacy of treatment could be improved. Another distinction of the transdiagnostic approach is that it allows disorders to be conceptualised as a continuum, whereby normal mechanisms are considered to become dysfunctional, unregulated or oversensitive (Watkins, 2015).

One such transdiagnostic process that could account for the comorbidity between conditions is maladaptive mind wandering. The experience of mind wandering has been explored in a wide range of populations, including mood and anxiety disorders, personality disorders, smoking and other substance misuse, autistic spectrum disorders as well as those considered to be healthy or without any specified condition. Different terms are used to refer to the construct, including worry, rumination, repetitive negative thinking and intrusive thoughts. However, the common feature is the tendency for the thinking to be off-task. McEvoy, Watson, Watkins and Nathan (2013) provide an example of how two of these descriptors are related, specifically worry and rumination. When comparing individuals with a single diagnosis of an anxiety disorder or depression McEvoy et al. (2013) found no significant difference in levels of worry, as measured by the Penn State Worry Questionnaire. In terms of rumination, whilst total levels differed between depression and GAD, social anxiety disorder and panic, there were no significant differences on the subscales of brooding and reflecting. Thus, this research provides support for the argument that whilst the content of mind wandering may differ between diagnoses (for example during worry the content generally focusses on the future, whereas rumination focuses on the past), it is a common feature across conditions.

1.1.2 Measuring mind wandering.

An important consideration within the research on mind wandering is the measurement of the process. Typically, the experience is assessed through the use of retrospective self-report measures of either mind wandering generally, or a particular aspect of the construct, such as worry (e.g. the Penn State Worry Questionnaire (Meyer, Miller, Metzger, & Borkovec, 1990)) or rumination (e.g. the Response Styles Questionnaire (Nolen-Hoeksema & Morrow, 1991)). The key limitation of retrospective measures is their susceptibility to recall bias. In mood-disordered populations, for

example, aan het Rot, Hogenelst and Schoevers (2012) argued that an individual's recall of their symptoms is influenced by their dysfunctional view of themselves and surroundings, which can lead to focussing on, and reporting of, primarily negative aspects of their experiences. Another common method of exploring mind wandering is the use of laboratory experiments. These typically involve the induction of a particular state such as worry and then thought sampling whilst the participant engages in an attention task (e.g. Marchetti, Koster, & De Raedt, 2012). Such findings are however limited in their generalisability to experiences within the natural environment, and do not provide an indication of the natural fluctuation of mind wandering during the day.

An alternative to the methods outlined is the use of experience sampling methodology (ESM). ESM refers to the use of a structured diary completed during normal daily life (Myin-Germeys et al., 2009). Individuals typically complete the same diary entry, or questionnaire, multiple times per day and are either signalled to do so with the use of technology (such as a wrist watch, pager, smartphone or personal digital assistant), complete it at a set time, or following a particular event (event contingent sampling). Questionnaires within ESM typically assess current thoughts, feelings, behaviours and contextual factors, such as activity or situation (Palmier-Claus et al., 2011). The primary benefit of ESM is the potential for high ecological validity, due to capturing momentary experiences in the real world setting. This momentary assessment also improves the accuracy of recall, reducing potential recall bias associated with retrospective measures (Palmier-Calus et al., 2011).

The discrepancy between data obtained by ESM and retrospective measures has been noted. Ben-Zeev, McHugo, Xie, Dobbins and Young (2012) compared ESM and retrospective measures of depressive symptoms over the course of one week in individuals with or without depression. Within the clinical group heightened levels of various symptoms (including sadness and anhedonia) were reported on retrospective measure, compared to the ESM measures. Whilst accurately recalling some symptoms, the non-clinical group demonstrated a positive bias in the retrospective recall of others (including sadness and self-control). Ben-zeev et al. (2012) found that whilst psychotic symptoms were relatively consistent, negative affect was overestimated in a retrospective measure when compared with ESM measures in a clinical population of individuals with a psychotic disorder.

Previous reviews have explored the use of ESM within the literature for specific psychological disorders. Aan het Rot et al. (2012) reviewed the literature on ESM studies conducted with major depression and bipolar disorder populations. Within their review aan het Rot et al. focussed on how the findings of the included studies developed the understanding of the nature of these specific disorders. This included an overview of how ESM studies have explored the impact of contextual factors on affective states. Walz, Nauta and aan het Rot (2014) reviewed the benefits of ESM in the study of anxiety disorders, including panic disorder, generalised anxiety disorder, post-traumatic stress disorder, social phobia and obsessive compulsive disorder, as well as anxiety disorders in youths. They emphasised the value of ESM for monitoring and understanding intra-person fluctuations in anxiety symptoms and related variables in sufferers of anxiety disorders.

1.1.3 Clinical utility of experience sampling methodology.

The use of ESM is not limited to research, it has also been suggested to have clinical utility. A common feature of psychological interventions is the encouragement of self-monitoring of particular experiences, including mood, cognition and behaviour. This is typically achieved through the use of retrospective self-report questionnaires (completed at each session or at various time points during the intervention), or self-prompted diary logs (completed following a particular situation or observation of a particular experience such as worry or low mood). Both methods however, have their limitations. Retrospective measures rely on accurate recall of often extended periods, e.g. over the past week. Such measures are therefore susceptible to recall bias. This is a particular issue in populations who are susceptible to negative recall bias, such as those with anxiety or depression. As for diary logs there is no way to confirm their completion time, leaving them susceptible to being completed the night before the next therapeutic session, or even in the waiting room immediately prior to the appointment. Thus leaving the diary log susceptible to the same recall bias as retrospective measures.

ESM therefore offers an alternative to retrospective measures and diary logs for the monitoring of particular symptoms. Tsanas et al. (2016) developed and validated a questionnaire to be utilised for daily mood monitoring, using a smart phone application for those with bipolar disorder and borderline personality disorder. Furthermore, they aimed to explore how the longitudinal variation of mood in these conditions varied using this monitoring questionnaire, compared to established retrospective measures. The questionnaire required participants to respond to a signal prompting them to rate their

current mood using a range of descriptors (i.e. anxiety, elation, sadness, anger, irritability, energy). Participants were prompted once per day, at a time pre-selected, to complete the diary measure. This has the potential to bias the reports, as the individual can predict the prompt and thus adapt their activity around it, which may influence their mood. However, the study demonstrated the feasibility of such regular assessments of mood within a clinical population, as well as the clinical usefulness of the data beyond that achieved by retrospective measures. Due to the sensitivity of detecting variability in mood, it was possible to differentiate those with bipolar disorder from those experiencing borderline personality disorder. This variability was not evident in the retrospective measures (Tsanas et al., 2016).

1.1.4 Rationale for this review.

As noted, previous reviews have explored the use of ESM within specific populations. However, to the best of our knowledge no review to date has explored the momentary assessment of mind wandering as a transdiagnostic experience. Due to the fluctuating nature of present mindfulness and mood, momentary assessments provide valuable insight into the experiences as they occur in the real world. Furthermore, understanding how to best capture the momentary experience of mind wandering could be useful for the monitoring of thoughts in the outpatient setting. Based on this rationale, the primary aim of the current review is to critique how ESM is used to capture the momentary experiences of mind wandering across a range of conditions. The second aim is to determine the nature of the relationship between present moment mind wandering and concurrent mood, based on the available literature.

1.2 Method

Studies utilising ESM for the measurement of processes reflecting mind wandering (including repetitive negative thinking, worry and rumination) were identified systematically from the online search databases Pubmed and Web of Science. The following search term was applied to both databases:

((Mind wandering OR intrusive thoughts OR off task thinking OR task irrelevant thoughts OR task unrelated thoughts OR worry OR rumination OR mindfulness OR repetitive negative thinking) AND (Experience sampling OR momentary assessment OR thought diary or mood diary OR thought sampling) AND (Mood OR affect OR anxiety OR depression))

In December 2016 this search term returned 1621 results combined. After initial screening and the removal of duplicates, 211 papers were identified. An additional relevant paper (Killingsworth & Gilbert, 2010) was identified within the reference section of a screened paper. A total of 212 papers were therefore identified for full text review, see Figure 1.

This review is restricted to studies that conducted momentary assessment of current thoughts as a measure of mind wandering, as well as concurrent mood. Consistent with previous relevant reviews (aan het Rot et al., 2012; Walz et al., 2014) studies with just one assessment per day and studies lasting less than 24 hours were excluded, due to their inability to detect within-day and between day fluctuations respectively. Studies utilising event contingent sampling were also excluded, due to their reliance on the participant prompting their self-assessment as well as requiring their awareness that the experience of mind wandering was occurring. Studies requiring participants to reflect on their thoughts ‘since the previous prompt’ were excluded, due to not focusing on current momentary thoughts. Laboratory studies were excluded due to sampling occurring in a non-naturalistic setting. Finally, dissertations were excluded from the review. In total 35 papers were identified as meeting the criteria for inclusion within the review. A summary of the key findings of the included studies is provided in Table 1.

The review is divided into two section, reflecting the two distinct aims outlined within the rationale. Not all identified papers appropriately contributed to both aims, therefore the number of papers used within each section differs. The first section explores the methodology for capturing mind wandering within ESM research. This section is the

primary focus of the review, due to the current lack of literature evaluating the use of ESM within thought sampling research. It is important to thoroughly explore the methodology in order to identify the most appropriate way to capture such experiences, providing valuable guidance for relevant future research. Thirty one papers were included within this section, with the remaining four being excluded (namely, Moberly & Watkins, 2008b; Moberly & Watkins, 2010; Selby, Franklin, Carson-Wong & Rizvi, 2013b; Selby, Kranzler, Panza & Fehling, 2016) due to their reporting of secondary data from another included study, of which the methodology was evaluated.

The second section of the review explores the findings of the studies regarding the relationship between mind wandering and mood. Twenty-seven studies were included in this section. The remaining studies (namely; Floridou & Mullensiefen, 2015; Gerteis & Schwerdtfeger, 2016; Huffziger et al., 2013; Slatcher, Robles, Repetti & Fellows, 2010; Takano, Sakamoto & Tanno, 2013; Thompson et al. 2016; Walsh et al., 2016) were excluded as, whilst they measured mind wandering and state affect, they did not explore the relationship between the two constructs specifically.

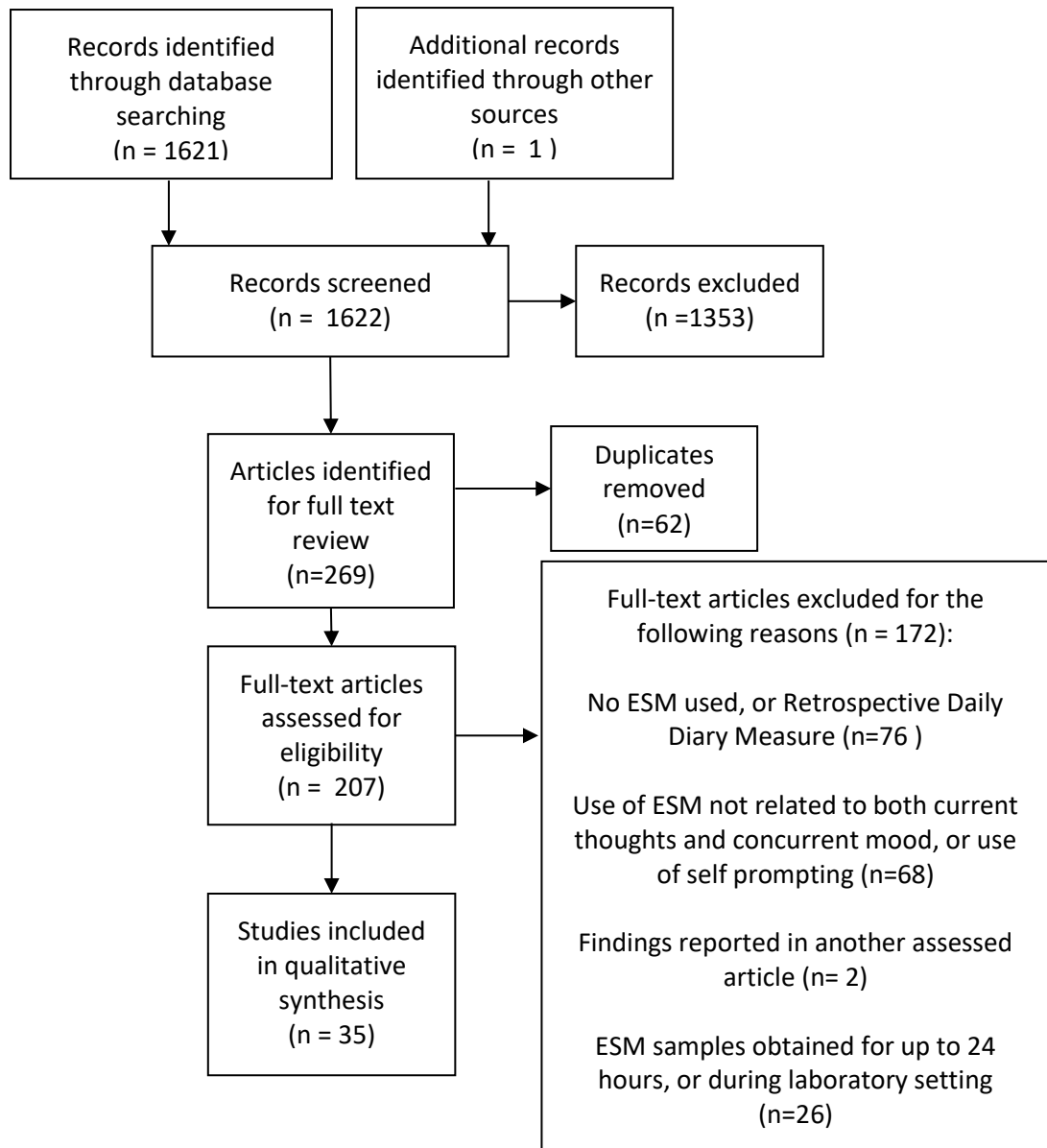


Figure 1. Study Selection Flow Chart

Table 1.

Key Findings of Included Studies

Study ID	Reference	Sample (used in data analysis)	Mind wandering process explored	Key mind wandering findings
1	Borders & Lu (2016).	171 undergraduate students	rumination	Concurrent State anger and state rumination predicted each other. Cross lagged analyses revealed that previous rumination predicted current anger, however previous anger did not predict rumination
2	Fanning et al. (2016).	33 undergraduate students	mind wandering	Momentary mind wandering in conjunction with positive affect predicted engagement in physical activity in the following hour. The opposite was found for negative affect.
3	Floridou & Mullensiefen (2015)	38 undergraduate students	mind wandering	<i>Excluded from this section of the review</i>
4	Franklin et al. (2013)	105 non-clinical, recruited on a university campus	mind wandering	Mind wandering generally was associated with increased negative mood. However when the mind wandered to a topic of interest more positive mood was reported.
5	Gerteis & Schwerdtfeger (2016)	Healthy participants	rumination	<i>Excluded from this section of the review</i>
6	Gotink et al. (2016)	29 completers of MBSR or MBCT course (those in the MBCT course were predominantly diagnosed with recurrent depressive disorder)	mind wandering	Following completion of an MBSR or MBCT course, engagement in a mindfulness walking intervention increased state mindfulness and positive affect. Furthermore, state mindfulness and positive affect enhanced each other prospectively.

Study ID	Reference	Sample (used in data analysis)	Mind wandering process explored	Key mind wandering findings
7	Hare et al. (2016)	9 individuals with high functioning autism	mind wandering	Worrying thoughts were associated with heightened anxiety.
8	Hare et al. (2015)	20 adults with Asperger's syndrome and 20 neuro-typical adults	mind wandering	Periods of rumination lasting longer than 10 minutes, worries about everyday events and a high level of self-focus were all associated with increased anxiety in those with Asperger's syndrome. However, those with Asperger's were just as likely to experience anxiety regardless of whether they considered themselves to be having an anxious thought.
9	Hartley et al. (2014)	32 experiencing psychosis	worry and rumination	Worry and rumination were found to predict psychotic experiences of auditory hallucinations and persecutory delusions, and the distress that result from such experiences.
10	Huffziger et al. (2012)	40 non-clinical community sample	rumination	Ruminative self-focus increased immediately following rumination inductions, and a decrease in concurrent affect was experienced. Depressive symptom levels did not moderate the immediate induction effects, however this was a non-clinical sample
11	Huffziger et al. (2013)	63 remitted depressed patients and healthy controls	rumination	<i>Excluded from this section of the review</i>
12	Killingsworth & Gilbert (2010)	2250	mind wandering	Individuals were less happy when mind wandering, regardless of the activity they were engaged in. Minds were more likely to wander to pleasant topics than neutral or unpleasant ones. Similar ratings of happiness were identified when thinking about a pleasant topic compared to being focused on the current activity. However, individuals were significantly less happy when thinking about a neutral or unpleasant topic.
13	Kubiak et al. (2008)	16 obese adolescents taking part in weight management course	rumination	Daily hassles and concurrent negative affect predicted emotional eating. Rumination added to the predictive power.

Chapter 1: Mind Wandering and Mood Literature Review

Study ID	Reference	Sample (used in data analysis)	Mind wandering process explored	Key mind wandering findings
14	Marcusson-Clavertz et al. (2016)	45 experienced sig. trauma prior to age 17 years	mind wandering	Those reporting greater negative affect also reported higher levels of mind wandering. Unresolved/disorganised attachment did not predict frequency of mind wandering as hypothesised.
15	Moberly & Watkins (2008a)	93 non-clinical, mostly students (subset of Moberly & Watkins 2010)	rumination	Ruminative self-focus is positively associated with concurrent negative affect. Based on time lag analysis rumination predicted negative affect at the subsequent assessment, and negative affect predicted rumination, suggesting a reciprocal relationship.
16	*Moberly & Watkins (2008b)	Same study as Moberly and Watkins (2008)	rumination	As above, however added that negative events were associated with negative affect during the next assessment.
17	*Moberly & Watkins (2010)	Same study as Moberly and Watkins (2008)	rumination	High goal importance and low goal success was positively associated with negative affect. This relationship was marginally mediated by self-focus rumination.
18	Moore et al. (2016)	67 older adults with anxiety and cognitive impairment	mind wandering	Whilst the relationship between concurrent mindfulness and mood was not assessed participant who engaged in a MBSR course experienced an increase in momentary mindfulness and decrease in momentary depressive symptoms, compared to a health education control.
19	Mor et al. (2010)	278 Adolescent students, predominantly at high risk of developing emotional difficulties	rumination	Negative affect was related to self-focus, this relationship was stronger in those with a recent depression compared to those without an emotional disorder as well as other conditions (including anxiety, comorbid anxiety and depression)

Study ID	Reference	Sample (used in data analysis)	Mind wandering process explored	Key mind wandering findings
21	Poerio et al. (2016a)	Case study	mind wandering	Mind wandering predicted dissociative symptoms, particularly when the content of the mind wandering was negative and repetitive. Furthermore, the occurrence of mind wandering predicted feelings of anxiety and depression. Finally, the relationship between mind wandering and dissociation was mediated by anxiety and depression. Specifically, the individual was more likely to experience symptoms of dissociation following mind wandering when experiencing heightened anxiety and depression.
20	Poerio et al. (2016b)	103 students	mind wandering	During the transition to university, social daydreaming was associated with increased feelings of connectedness to others and less loneliness. However, it was not associated with feeling positive. In the later weeks of the transition, participants reported less negative affect. However, change in incidence of daydreaming over time was not assessed; therefore, it is possible that the reduction in negative affect is associated with a reduction in daydreaming, as opposed to an adaptive effect of social daydreaming as suggested by the authors.
22	Real et al. (2014)	10 patients with amyotrophic lateral sclerosis	mind wandering	Thinking about the future, as well as ruminating on the past were associated with reduce wellbeing in individuals with amyotrophic lateral sclerosis.
23	Ruscio et al. (2015)	145 GAD, Major Depressive Disorder (MDD), GAD+MDD and healthy controls	rumination	Diagnosed individuals experienced more event related rumination than healthy controls, following a stressful event. Those with co-morbid GAD and MDD experience greatest level of rumination. More rumination following a stressful event predicted increased negative affect. Rumination mediated the relationship between stress and affect.
24	Seidel et al. (2016)	70 Anorexia nervosa (AN) and Healthy controls	rumination	AN individual's spent more time thinking about food and weight and rumination on food and weight were associated with negative affect.

Chapter 1: Mind Wandering and Mood Literature Review

Study ID	Reference	Sample (used in data analysis)	Mind wandering process explored	Key mind wandering findings
25	Selby et al. (2013a)	47 dysregulated behaviours (16 were diagnosed with BPD)	rumination	Daily experiences of emotional cascades (the experience of upsetting emotions, potentiated by rumination fuelling further rumination and negative affect) predicted the occurrence of nightmares. Higher levels of negative affect were experienced in the day following the nightmare in those diagnosed with BPD.
26	**Selby et al. (2013b)	Same study as Selby et al (2013a)	rumination	During the study 25 incidents of non-suicidal self-injury were reported. Suggest that rather than rumination generally it is instability of rumination that potentially predicts NSSI. Significant relationship between instability of rumination and instability of negative affect. Instability of rumination predicted daily number of self-injuries.
27	**Selby et al. (2016)	Same study as Selby et al (2013a)	rumination	Rumination and negative affect predicted increased levels of each other at subsequent assessments. This synergistic effect predicted impulsive behaviours.
28	Slatcher et al. (2010)	37 married couples	worry	<i>Excluded from this section of the review</i>
29	Song & Wang (2012)	165 Chinese undergraduates	mind wandering	Mind wandering occurred less when in a positive emotion, when concentrating, when attending to their surroundings and when doing something they are good at. Minds wandered more when in a negative mood and when doing something important. Furthermore, the affective states prior to the mind wandering predicted the affective content of the mind wandering in the same direction.
30	Takano & Tanno (2010)	31 undergraduate students	rumination	When exploring ruminative self-focus they distinguished between abstract (overgeneralised) and concrete (contextually specific) thinking. A positive relationship between concurrent ruminative self-focus and negative affect when concrete thinking was low.

Study ID	Reference	Sample (used in data analysis)	Mind wandering process explored	Key mind wandering findings
31	Takano & Tanno (2011)	68 undergraduate students	rumination	Further to Takano and Tanno (2010) they explored the relationship between characteristics of self-focused thought and negative affect. Self-focused thoughts were associated with negative affect when the content was highly unpleasant and the thoughts were deemed uncontrollable. Furthermore those with higher levels of depression were more likely to ruminate during the evening than the morning.
32	Takano et al. (2013)	41 students	rumination	<i>Excluded from this section of the review</i>
33	Takano et al. (2014)	43 students	mind wandering	Repetitive thought in the evening delayed sleep onset. Reduced sleep efficiency was associated with reduced positive mood in the morning. Reduced positive affect in the morning was concurrently associated with increased repetitive thinking.
34	Thompson et al. (2016)	70 females, with either GAD, MDD, comorbid, or healthy control	rumination	<i>Excluded from this section of the review</i>
35	Walsh et al. (2013)	138 students	mind wandering	<i>Excluded from this section of the review</i>

1.3 Using ESM to Capture Momentary Mind Wandering

The methodology used to capture momentary experiences of mind wandering varies greatly within the identified studies. Guidance has been produced, by Palmier-Claus et al. (2011), providing recommendations for how to conduct research using ESM within psychopathology. This guidance was developed by researchers with extensive experience in the use of ESM, in response to a dearth of advice in conducting this complex methodology. This takes into consideration various factors, which potentially influence participant experience as well as the validity of the data generated. Included in this guidance is recommendations regarding the following:

- Item selection for the experience
- The method used to signal participants and record their responses
- The scheduling pattern of the signals.
- The frequency of signals
- Time restrictions on responses
- Data analysis strategy
- Response Rates

Palmier-Claus et al. (2011) emphasise that further research is necessary to determine the optimum ESM procedure for different populations. Within this review the included studies are analysed in terms of their adherence to the guidance regarding each of the methodological factors outlined by Palmier-Claus et al. (2011), noted above. The recommendations of Palmier-Claus et al. (2011) related to each of these factors, as well as the key for rating adherence used within this review are presented in Figure 2. Furthermore, Table 2 provides an overview of the papers in terms of their adherence to the guidance on these factors.

Factor	Summary of Guidance by Palmier-Claus et al. (2011)	Rating Guide for Included Studies	Rating
Mind wandering Item Selection	Items need to assess momentary experiences which occur in the flow of daily life; the language used should reflect that used by the target population; number of open questions should be limited	Single item reflecting whether the current thinking is on or off task	1
		Single item reflecting the presence of on/off task thinking with addition questions regarding the content of the thought (such as where their attention was)	2
		Multiple items reflecting whether thinking was on or off task	3
		A limited number of selected items from an existing measure (e.g. of rumination)	4
		The use of an open question regarding current thinking, the content of which was subsequently coded by the researcher.	5
Method of signalling/recording experience	Broadly, 3 methods are used pen and paper diaries are cost effective however easy to back-fill (i.e. complete outside of the signalled time). Personal Digital Assistants (PDAs) overcome this and signalling schedule can be randomised; however, the devices can be cumbersome and easily left or ignored during the day. Smart phones are convenient as the participant already has this available, however software can be costly and difficult to programme.	Smartphone	
		PDA	
		paper and watch or other signalling device e.g. heart rate monitor	
Scheduling pattern	Within fixed sampling the signals can be predictable, potentially resulting in participants changing their behaviour to account for the ESM signals. Whereas Random sampling reduces this reactivity.	Random	
		Fixed	
Number of prompts	Research has typically used between 5 and 10 signals per day for 6 days (between 30 and 60 in total). A balance needs to be struck between capturing broad range of experiences and minimising participant burden	40-80	
		20-39, 81 += moderate (Amber)	
		<20	
Response time restriction	Restricting the time to respond improves the likelihood of the responses reflecting the moment in which they were signalled. Typically responses are restricted to within 15 minutes of the signal.	<15 minute	
		15-30 minutes	
		>30 minute	
Data analysis	Due to the multi-level nature of the data, it is typically appropriate to use HLM or aggregation, instead of normal statistical tests.	HLM or Aggregation	
		Normal statistical test without explanation of management of multi-level nature.	
Response rate	Due to the high potential for missing data, rates of 66% are considered good. It is typical for data for participants with a less than 33% response rate to be excluded from the analysis.	Above 66%	
		33%-66%	
		Below 33%	
Overall rating	Based on overall adherence to the guidance above	4 out 6 categories rated as good	
		3 out of 6 categories rated as good	
		less than 3 out of 6 categories rated as good	

Figure 2. Summary of the ESM design guidance and rating system for the review of included studies.

Table 2.

Summary of Methodological Ratings for All Included Studies

Study ID	Reference	Mind Wandering Item Selection	Focus of items	Method of Signalling/recording experience	Scheduling pattern	Number of prompts	Repose time restriction	Data analysis	Response rate	Overall rating
1	Borders & Lu (2016).	3	Rumination				NS			
2	Fanning et al. (2016).	1	mind wandering				NS			
3	Floridou & Mullensiefen (2015)	2	mind wandering				NS			
4	Franklin et al. (2013)	2	mind wandering				NS			
5	Gerteis & Schwerdtfeger (2016)	1	Rumination							
6	Gotink et al. (2016)	4	mind wandering			variable			NS	
7	Hare et al. (2016)	5	mind wandering							
8	Hare et al. (2015)	5	mind wandering							
9	Hartley et al. (2014)	3	Worry/rumination							
10	Huffziger et al. (2012)	3	Rumination							
11	Huffziger et al. (2013)	3	Rumination							
12	Killingsworth and Gilbert (2010)	1	mind wandering			variable	NS			
13	Kubiak et al. (2008)	4	Rumination				NS			
14	Marcusson-Clavertz et al. (2016)	1	mind wandering				NS			
15	Moberly & Watkins (2008a)	3	Rumination							
16	*Moberly & Watkins (2008b)									
17	*Moberly & Watkins (2010)									
18	Moore et al. (2016)	4	mind wandering		NS		NS		NS	
19	Mor et al. (2010)	5	rumination							
20	Poerio et al. (2016a)	2	mind wandering				NS			
21	Poerio et al. (2016b)	2	mind wandering				NS			
22	Real et al. (2014)	2	mind wandering				NS			
23	Ruscio et al. (2015)	3	Rumination							
24	Seidel et al. (2016)	4	Rumination							
25	Selby et al. (2013a)	3	Rumination							
26	**Selby et al. (2013b)									
27	**Selby et al. (2016)									
28	Slatcher et al. (2010)	1	worry	NS			NS		NS	
29	Song & Wang (2012)	2	mind wandering				NS		NS	
30	Takano & Tanno (2010)	2	rumination							
31	Takano & Tanno (2011)	2	rumination							
32	Takano et al. (2013)	2	rumination						NS	
33	Takano et al. (2014)	2	rumination							
34	Thompson et al. (2016)	1	rumination						NS	
35	Walsh et al. (2013)	3	mind wandering							

Note. * Data from study conducted by Moberly and Watkins (2008a); ** Data from study conducted by Selby et al. (2013a) NS = not specified; green = good adherence to guidance; amber = moderate adherence; red = poor adherence.

1.3.1 Mind wandering item selection.

A key consideration with any ESM research is the items used within the experience sampling measure. The guidance provided by Palmier-Claus et al. (2011) suggests that items need to capture the momentary experience occurring in the context and flow of daily life. Therefore, the language used should reflect that generally used by individuals, not necessarily the psychological terms often utilised within existing questionnaires. The questionnaire should be quick to complete, taking no more than 2 to 3 minutes (Palmier-Claus et al., 2011). Based on these two points it is not generally appropriate to use existing questionnaires without adaptation.

When assessing current thoughts specifically, the items used within the included studies fit into five broad categories, including:

- A single item reflecting whether the current thinking is on or off task
- A single item reflecting the presence of on/off task thinking with additional questions regarding the content of the thought (such as where their attention was)
- Multiple items reflecting whether thinking was on or off task (not based on an existing measure)
- A limited number of selected items from an existing measure (of rumination for example)
- The use of an open question regarding current thinking, the content of which was subsequently coded by the researcher.

Typically, these items formed part of a larger questionnaire consisting of other items including mood and current activity. The content of the thought specific items were naturally related to the specific research questions, with some focussing on mind wandering generally (2,3,4,6,7,8,12,14,18,20,21,22,29,35) and others focussing on specific forms of mind wandering, the most widely explored being rumination (1,5,10,11,13,15,19,23,24,25,30,31,32,33,34). The remaining papers focussed on worry (28) or worry and rumination in relation to delusional thoughts (9).

When assessing momentary mind wandering generally the most common approach was to either use a single item to determine its presence (2,12,14), or a single item with follow up questions about the content of the mind wandering (3,4,20,21,22,29). In all cases the initial item typically followed the format initially used by Killingsworth and

Gilbert (2010), i.e. “Are you thinking about something other than what you are currently doing”, possible responses depended on whether follow up items were used. For example Killingsworth and Gilbert (2010) obtained additional information regarding the pleasantness of the thought within the response to the initial item, e.g. ‘yes, pleasant, or yes unpleasant etc.’ Additional items within other studies included exploring the temporal direction of the thought, such as whether it was past or present focussed (Song & Wang, 2012), and the extent to which the thought reflected particular aspects of mind wandering, such as daydreaming, fantasising or worry (Floridou & Mullensiefen, 2015). A common feature of these was the consistency with which they were short and quick to answer and they reflected language generally used within daily life.

The use of an open question to describe the thought was less common, within just two of the papers exploring mind wandering generally (7,8). Whilst potentially obtaining a more detailed reflection of the individuals’ current thought this approach has a number of limitations. Firstly, it requires an ability of the participants to accurately convert the thought into words, within a short sentence, often difficult if the thought reflected images. This also required more time and cognitive effort on the part of the participants. Furthermore, this approach relied upon the consistent coding of the thoughts by the researcher.

Only two of the papers (6,18) used selected items from an existing measure to assess mind wandering generally. Gotink et al. (2016) used four items from the Five Factor Mindfulness Scale and Moore, Depp, Wetherell and Lenze (2016) used four items from the Cognitive and Affective Mindfulness Scale - Revised. Both of these are measures of state mindfulness. There is no guarantee that using a select few items from established questionnaires maintain their validity when used within momentary assessments (Palmier-Claus et al., 2011). Furthermore, it is recommended that items within momentary assessments reflect experiences that are commonplace and prosaic (Palmier-Claus et al., 2011). A potential limitation of the use of mindfulness measures is their tendency to use specific examples. For example, one question used by Gotink et al. (2016) was “I pay attention to sensations, such as the wind in my hair or sun on my face”. When such specific examples are used it may be difficult for participants to answer the question in a range of ordinary situations (Palmier-Claus et al., 2011).

1.3.2 Method of signalling/recording experiences.

An important consideration when designing ESM research is the choice of method used to collect the momentary data. A range of methods were used within the studies reviewed, each with their distinct advantages and disadvantages.

Arguably, the most basic method is the use of paper diary entries to be completed when signalled by an electronic device, such as a wrist watch, pager or a physiological monitoring device (e.g. an ambulatory heart monitor). This method was by far the least common approach within the identified studies, used within just four. For example, when investigating within-day fluctuations of negative affect and the association with self-focus and stress in adolescents, Mor et al. (2010) used wrist watches to prompt the completion of paper diary forms. The benefits of this method are the low cost of equipment, an important consideration particularly for studies with a large sample size such as the sample of 278 in the study by Mor et al. (2010). However, as noted by Palmer-Claus et al., (2011) the pen and paper method is highly susceptible to back or forward filling their entries, making it difficult to confirm the validity of the responses.

A more common method within the studies was the use of a Personal Digital Assistant (PDAs), used within 14 of the studies (1, 5, 7, 8, 9, 10, 11, 13, 14, 15, 23, 25, 34, 35). PDAs are portable hand held devices used for signalling participants to complete the survey, which are hosted on the device. A key advantage of the use of PDAs over pen and paper diaries is the ability to lock the devices so that questionnaires can only be completed within specific time windows. Alternatively, due to the ability to record completion times, it is possible to exclude data completed outside of specific time windows. For example, Ruscio et al. (2015) excluded responses that were complete more 15 minutes following than the signal from their analysis. This improves the validity of the entries included. The key dis-advantages of PDAs, however, is the cost of the devices and the increased likelihood of the devices being forgotten by the individual (Palmer-claus et al., 2011), resulting in the increased potential for missing data.

The other method utilised, within 12 of the studies (2, 4, 6, 12, 18, 20, 21, 24, 30, 31, 32, 33), was the use of participants own smart phones for both signalling and responding to surveys. In general, this approach has the additional benefit over PDAs of reducing the burden of carrying an extra device throughout the day (Palmer-Claus et al., 2011). Furthermore, the wide availability of smartphones enables the researcher to access individuals within a wide geographical area, as they are not restricted by the need for

participants to return equipment. This was highlighted by Killingsworth and Gilbert (2010), who when exploring the relationship between off-task thinking and happiness obtained a sample of 2250 adults across different countries (73.9% within the US).

Generally, within the literature the use of smart phones took one of two forms, the use of an application, or use of SMS or email to prompt completion of a website based questionnaire. The development of an application can be costly (Palmier-Claus et al., 2011), whereas SMS services and email are widely available. However, signalling via SMS or email is highly dependent on mobile or internet network availability. Furthermore, all phone-based methods rely on the participant having their phone set up appropriately in order to receive and respond to signals, such as having their device set to loud or vibrate.

The method for signalling and recording responses was the least consistent factor across the studies, with less than half rated as good. This highlights the need for more consistent methodology, and for ESM research to capitalise on the advantages of the wide availability of smart phones.

1.3.3 Signalling Approach (scheduling pattern, number of prompts and response restrictions).

Due to the longitudinal nature of ESM research, requiring participants to complete questionnaires multiple times per day for multiple days, the research commonly suffers from high drop-out and lowered response rates (Palmier-Claus et al., 2011). Attempts made to minimise participant burden through the sampling approach could have a beneficial effect on compliance. The frequency of the signals is thus a key consideration. Palmier-Claus et al. (2011) noted that, based on the mental health literature, previous research has typically used between five and 10 signals over six days.

Within this review it was possible to extract enough information regarding the sampling approach from 29 of the studies in order to perform a comparison. The remaining two (Gotink et al., 2016; Killingsworth & Gilbert, 2010) were excluded due to the use of different sampling procedures within the same study. For example within Killingsworth and Gilbert (2010) whilst the default was set to three signals per day, participants chose the frequency of signals and the number of days in which they took part. This resulted in the total number of responses provided per participant ranging from one to 39 ($M = 7.9$, $SD=5.8$). This wide range renders it difficult to compare with more consistent sampling procedures.

Within the remaining 29 studies the frequency of signals ranged from two to 16 per day, with the majority using between six and 10 prompts (1,3,4,7,8,9,10,11,14,15,20,23,24,28,29,30,31,32,33,34,35), consistent with the recommendation by Palmier-Claus et al., (2011). Only two studies (2,5) used more than 10 signals per day and six studies used fewer than six signals per day (13,18,19,21,22,25). The key limitation of using fewer signals is the decreased likelihood of capturing a representative picture of the experience being explored (Palmier-Claus et al., 2011). This is the key limitation of Mor et al. (2010), who signalled participants just three times per day. A limitation of employing a method using more signals is the increased burden placed on participant, increasing the likelihood of a reduced response rate and possible drop outs. In addition to the frequency of signals, duration of participation is a key consideration. Of the 29 studies the most common number of days signals were sent was seven days (1,2,3,4,13,15,22,28,29,30,31,32,33,34,35), and ranged between two days and 40 days. Nine studies sampled for fewer than seven days (5,7,8,9,10,11,14,19,23) and five studies for more than seven days (18,20,21,24,25). Palmier-Claus et al. (2011) highlight that high sampling loads, resulting from either high frequency of signals or sampling over a longer period can desensitise the individual to the procedure. This can make the signals predictable or can result in the individual being overly focussed on the signals. This can detract from the experience being assessed. In total the signals per participant ranged between nine and 240, (mean of 54.72, SD. = 41.81). The number of signals will naturally differ between studies, based on the specific research question. However, extreme deviation from the mean could result in the design experiencing the limitations discussed.

Another consideration regarding the sampling approach was whether the timings of the signals were fixed or random, during a set period of the day (typically waking hours). The benefit of randomising the samples is that it reduces predictability of the signals, and thus preparation for their completion (Palmier-Claus et al., 2011). This is particularly relevant to the assessment of mind wandering as predictable scheduling may influence the individual's attention in anticipation of the signal. Of the 29 studies providing adequate information to determine the scheduling, 27 (with the exception of 2 and 14) included an element of randomisation. This was achieved in various ways, such as dividing the day's scheduling period to intervals (depending on the number of signals) and setting a signal to occur randomly during each interval (as in Moberly and Watkins, 2008). Alternatively, the signals were sent randomly during set time frames, e.g. every 50 to 80 minutes (as in Gerteis & Schwerdtfeger, 2016). Both Marcusson-Clavertz, Koster and De Raedt (2016)

and Fanning et al. (2016) used fixed scheduling, and within the study by Marcusson-Clavertz et al. (2016) the participants chose their specific signalling times. This rendered them predictable and susceptible to biasing the individual's responses.

In addition to the use of random or fixed scheduling, restricting the time a participant has to respond to the signal also impacts on the validity of the sampling method. Imposing strict response criteria, such as within 30 seconds of the response is likely to result in large amounts of data being excluded from analysis. However, including responses provided significantly after the signal has a detrimental impact on the validity of that response. Specifically, by allowing participants to delay their response they can effectively choose when to respond. When considering thought sampling this is problematic as the nature of the current experience may influence whether the individual delays the signal. For example, if focused on a task they may delay the signal. Thus, the sample has the potential to be biased towards representing the experience as they occur at times when they are freely available, as opposed to the experience generally.

Delespaul (1995) found there to be a qualitative difference in responses completed more than 15 minutes after a signal in their ESM research. Many of the studies therefore cite this as being an appropriate cut off for inclusion. Eighteen of the papers provided information regarding whether a time restriction on responses was imposed. Of these 11 (5,6,7,8,9,10,11,15,23,34,35) restricted the response time to 15 minutes or less, ensuring the validity of the responses. The most restrictive were Hare, Gracey and Wood (2016), Gerteis and Schwerdtfeger. (2016) and Walsh, Brown, Barrantes-Vidal and Kwapil (2013), limiting response times to 1, 2 and 3 minutes respectively. Five of the studies limited response times to 30 minutes (24,30,31,32,33). The study of Selby, Ribeiro and Joiner (2013a) was the least restrictive, including responses up to an hour following the response.

1.3.4 Response rates.

Missing data due to non-responses is a problem with ESM research (Verhagen, Hasmi, Drukker, Os & Delespaul, 2016). Attempts are typically made to maximise response rates, including designing the sampling procedure to reduce the burden on participants. In addition to this Moberly and Watkins (2008a) suggested that it is standard practice to excluded participants who respond to less than one third of the signals sent. Of the studies providing information regarding exclusion criteria in relation to response rate (n=9) five used the cut-off of one third (6,7,8,15,18). Fanning et al. (2016) and Thompson,

Kircanski and Gotlib (2016) used more relaxed criteria of 25% and 9% respectively.

Takano and Tanno (2011) and Takano, Sakamoto and Tanno (2014) used a more stringent exclusion criterion of 60%.

Six of the studies did not state the response rate or provide adequate information for its calculation (6,18,28,29,32,34). Of the remaining 25, the response rates were generally good, with all above the recommended 33%. Only two had response rates of less than 50% (Huffziger, Ebner-Priemer, Koudela, Reinhard & Kuehner, 2013; Real, Dickhaus, Ludolph, Hautzinger & Kubler, 2014). The highest response rates were above 90% (Hare, Wood, Wastell & Skirrow, 2015; Huffziger, Ebner-Priemer, Koudela, Reinhard & Kuehner, 2012; Mor et al., 2010 and Selby et al., 2013a). However caution must be taken when considering the value of high response rates, as attempts to improve responding can compromise the quality of data. For example, whilst Selby et al. (2013a) had the highest response rate (94.7%), participants had 1 hour to respond to each signal, questioning the validity of those responses. As another example Mor et al. (2010) had a high response rate of 91%, however participants each only supplied up to nine responses in total. This is far below the recommended number considered for capturing an adequate representation of an experience.

1.3.5 A note on data analysis.

Due to the multi-level nature of the data acquired during ESM (for example, typically each of the responses (level 1) are nested in days (level 2), which in turn are nested within individuals (level 3)), it is not typically appropriate to use normal statistical methods, such as linear regression or analysis of variance (Verhagen et al., 2016). Instead, appropriate methods include multi-level regression or aggregating of the data (Verhagen et al., 2016). Aggregation refers to combining responses to provide an overall score, for a given day for example. This method removes the multi-level structure of the data, leaving it open to analyses via normal statistical approaches (such as linear regression) (Verhagen et al., 2016). This however limits the potential to explore variability of the level aggregated (for example within-day variability). It is not within the scope of this paper to provide a thorough review of complex data analysis strategies conducted within the studies. Instead, the focus will be on whether the studies adhered to the recommendations of using hierarchical linear modelling or aggregation to analyse their data.

Of the 31 studies reviewed, 26 used hierarchical linear modelling when exploring the relationship between mind wandering and mood, thus adhering to the widely accepted recommendation highlighted by Verhagen et al. (2016). As for the exceptions, Floridou & Mullensiefen (2015) used bayesian networks, a strategy also appropriate for experience sampling data (Larson & Csikszentmihalyi, 2014). Both Poerio, Totterdell and Miles (2016a) and Hare et al. (2016) appropriately used aggregation of the data, primarily due to the small sample sizes. For example, Poerio et al. (2016a) aggregated samples collected during each day to give a mean score for each ESM item for that day. This simplified the data for use with a regression analysis by removing the first level of data (i.e. response level). The limitation of this method was the inability to assess intra-day variability.

It was not clear within their description of the data analysis how Real et al. (2014), Hare et al. (2015) and Moore et al. (2016) managed the multi-level nature of their data. Instead Real et al. (2014) merely outlined the use of mediational analysis to explore the relationship between rumination and well-being. Hare et al. (2015) cited the use of Chi-squared to explore the association between thought type and anxiety. Moore et al. (2016) used a mixed model ANOVA to compare scores on standardised assessments with ESM measures of anxiety, low mood and mindfulness.

1.4 The Relationship between Mind Wandering and Mood

This section provides a narrative synthesis of the key findings within the identified studies. The heterogeneous focus of the studies renders it difficult to conduct a more direct comparison of the results within a meta-analysis. Instead the findings will be discussed in terms of the particular aims of the studies that related to features of mind wandering. The 27 studies included within this section broadly divide into their focus on either mind wandering generally or rumination specifically, and will be discussed accordingly.

1.4.1 Mind wandering generally.

Thirteen out of the 27 studies explored the relationship between mind wandering generally and mood (2,4,6,7,8,9,12,14,18,20,21,22,29), this included studies using the broad term of mind wandering as well as those assessing both worry and rumination. The study consisting of the largest sample of the general population ($n=2250$) was conducted by Killingsworth and Gilbert (2010). They reported that individuals were less happy when mind wandering, regardless of the activity they were engaged in. In addition, minds were more likely to wander to pleasant topics than neutral or unpleasant ones. Furthermore, similar ratings of happiness were identified when thinking about a pleasant topic compared to being focused on the current activity. Also, individuals were significantly less happy when thinking about a neutral or unpleasant topic. A key limitation of this study was the significant differences in the number of responses provided by participants. Participants were able to choose how many times they were signalled and thus able to stop responding when desired, if experiencing a drop in mood for example.

Four studies (Fanning et al., 2016; Franklin et al., 2013; Poerio, Totterdell, Emerson & Miles, 2016b; Song & Wang, 2012) used a non-clinical, predominantly student sample, the key being limitation the difficulty to generalise findings to those with clinical levels of negative affect. Despite this, they provide insight into the relationship between mind wandering and mood. Franklin et al. (2013) found mind wandering generally to be associated with increased negative mood. However, when the mind wandered to a topic of interest more positive mood was reported. Similarly, in a sample of Chinese undergraduates Song and Wang (2012) found mind wandering occurred less when in a positive emotion, when concentrating, when attending to their surroundings and when doing something they are good at. Minds wandered more when in a negative mood and when doing something important. Furthermore, the affective states prior to the mind wandering predicted the affective content of the mind wandering in the same direction.

Others focussed more on the potential adaptive functions of mind wandering. Fanning et al. (2013) reported that momentary mind wandering in conjunction with positive affect, predicted engagement in physical activity in the following hour. The opposite was found for negative affect. A limitation of this study however was the possible influence that wearing activity-monitoring equipment could have on the participant's behaviour. Poerio et al. (2016b) reported that during the transition to university, social daydreaming was associated with increased feelings of connectedness to others and less loneliness. It was not associated, however, with feeling positive. In the later weeks of the transition participants reported less negative affect. However, change in incidence of daydreaming over time was not assessed; therefore, it is possible that the reduction in negative affect is associated with a reduction in daydreaming, as opposed to an adaptive effect of social daydreaming as suggested by the authors.

Eight of the studies exploring mind wandering generally consisted of samples made up at least in part by clinical populations (6,7,8,9,14,18,20,22). Hare et al. (2016) reported that worrying thoughts were associated with heightened anxiety in nine individuals with high functioning autism. The small sample size of the study does limit the generalisability of this finding. Similar findings were however, reported by Hare et al. (2015). Specifically, they identified periods of rumination lasting longer than 10 minutes, worries about everyday events and a high level of self-focus to be associated with increased anxiety in 20 individual's with Asperger's syndrome, compared to 20 neuro-typical individuals. However, assessment of whether mind wandering occurred depended on the researchers' coding of participant's written descriptions of thoughts. Furthermore, there may have been a discrepancy between those with and without Asperger's syndrome in ability to access and record specific details of thoughts.

Marcusson-Clavertz et al. (2016) explored the everyday mentation of 45 adults who had unresolved or disorganised representations of childhood trauma. They found that those reporting greater negative affect also reported higher levels of mind wandering. However, unresolved/disorganised attachment did not predict frequency of mind wandering as hypothesised. A limitation of this study was the lack of healthy control sample with which to compare frequency of mind wandering. Based on the findings of Hartley, Haddock, Vasconcelos, Emsley and Barrowclough (2014) worry and rumination were found to predict psychotic experiences of auditory hallucinations and persecutory delusions, and the distress that result from such experiences. Poerio et al. (2016a) presented their findings of a case study with and individual diagnosed with dissociative

disorder (and also previously diagnosed with GAD). Mind wandering (referred to as daydreaming within this study) predicted dissociative symptoms, particularly when the content of the mind wandering was negative and repetitive. Furthermore, the occurrence of mind wandering predicted feelings of anxiety and depression. Finally, the relationship between mind wandering and dissociation was mediated by anxiety and depression. Specifically, the individual was more likely to experience symptoms of dissociation following mind wandering when experiencing heightened anxiety and depression. Naturally it would not be appropriate to generalise these findings beyond the case study, particularly due to the complex nature of their presentation. Real et al. (2014) found that thinking about the future, as well as ruminating on the past were associated with reduce wellbeing in 10 individuals with amyotrophic lateral sclerosis.

Two of the studies (6,18) explored the effects of mindfulness-based intervention on mind wandering or mindfulness. Moore et al. (2016) compared the benefits of an MBSR course, compared to a health education control in 67 older adults with a cognitive impairment experiencing anxiety. Those who engaged in a MBSR course experienced an increase in momentary mindfulness and decrease in momentary depressive symptoms. However, the relationship between mindfulness and mood was not assessed directly. The sample within the study by Gotink et al. (2016) consisted of 29 completers of MBSR or MBCT course (those in the MBCT course were predominantly diagnosed with recurrent depressive disorder). Following completion of the respective courses, engagement in a mindfulness walking intervention increased state mindfulness and positive affect. Furthermore, state mindfulness and positive affect enhanced each other prospectively. However, due to the intervention being compared to a control period of up to one week immediately following the MBSR or MBCT course, it is difficult to determine the extent to which the results are independent of the effects of practicing the skills developed within the previous course.

1.4.2 Rumination.

Fifteen studies focused on the construct of rumination specifically (1,10,13,15,16,17,19,23,24,25,26,27,30,31,33), with nine of the studies using a student or non-clinical sample (1,10,15,16,17,19,30,31,33) and six including at least a partly clinical sample (13,23,24,25,26,27). In their large student sample (n=171) Borders and Lu (2016) found that concurrent state anger and state rumination predicted each other. Cross-lagged analyses revealed that previous rumination predicted current anger; however, previous

anger did not predict rumination. A key limitation was the lack of identification of whether an angry event occurred between prompts, therefore within the cross lagged analyses it is not possible to determine whether the anger was predicted by previous rumination or whether an anger inducing event occurred between assessments.

Moberly and Watkins (2008a; 2008b; 2010) reported their findings from a single dataset from 93 students across three separate reports. Moberly and Watkins (2008a) identified ruminative self-focus to be positively associated with concurrent negative affect. Based on time lag analysis rumination predicted negative affect at the subsequent assessment, and negative affect predicted rumination, suggesting a reciprocal relationship. Moberly and Watkins (2008b) added that negative events were associated with negative affect during the next assessment. Finally, Moberly and Watkins (2010) further added that the pursuit of goals rated as important combined with low goal success was positively associated with negative affect. This relationship was marginally mediated by self-focus rumination. A limitation of this study was the order of questions within the momentary assessment. In contrast with other studies, affect was assessed prior to rumination. This has the potential for contamination of responses. Specifically, becoming aware of ones affect (by answering the question) could influence responses to the rumination items.

In their community sample of 40 individuals Huffziger et al. (2012) reported that ruminative self-focus increased immediately following rumination inductions, and a concurrent decrease in affect was experienced. Depressive symptom levels did not moderate the immediate induction effects, however levels of depression were sub-clinical. Furthermore the assessment period only took place over two days (a weekend), providing limited opportunity to determine variability over the course of a week.

When exploring ruminative self-focus in 31 students Takano and Tanno (2010) distinguished between abstract (overgeneralised) and concrete (contextually specific) thinking. A positive relationship between concurrent ruminative self-focus and negative affect was identified when concrete thinking was low, not when concrete thinking was high. However, the small sample size questions the appropriateness of using HLM. Within their larger sample of 68 undergraduate students, Takano and Tanno (2011) explored the relationship between characteristics of self-focused thought and negative affect. Self-focused thoughts were associated with negative affect when the content was highly unpleasant and the thoughts were deemed uncontrollable. Furthermore, those with higher levels of depression were more likely to ruminate during the evening than the morning. Takano and Tanno (2014) reported that repetitive thought in the evening delayed

sleep onset. Reduced sleep efficiency was associated with reduced positive mood in the morning. Reduced positive affect in the morning was concurrently associated with increased repetitive thinking. However, whilst positive affect decreased, negative affect did not increase, questioning the value of using a non-clinical sample.

Finally, Mor et al. (2010) used a sample of 278 Adolescent students, and oversampled those who were at high risk of developing emotional difficulties. They reported that negative affect was related to self-focus, this relationship was stronger in those with a recent depression compared to those without an emotional disorder as well as other conditions (including anxiety, comorbid anxiety and depression). In addition to the methodological flaws regarding the study discussed in the previous section the sample was predominantly female, limiting generalisability.

In terms of clinical samples, the relationship between mood and rumination has been explored with a range of presentations including obesity, dysregulated behaviour, GAD, depression and eating disorders. In their sample of 37 individual's with anorexia nervosa (AN) and 30 healthy controls (ranging from aged 12 to 28 years) Seidel et al. (2016) found that those with AN spent more time thinking about food and weight than healthy controls. Furthermore, ruminations focusing on food and weight were associated with negative affect, this relationship was stronger for those with AN. This study neglected to consider rumination beyond that specific to food and weight. Kubiak, Vogeley, Siering, Schiel and Weber (2008) also focused on difficulties with weight management. With their sample of 16 obese adolescents taking part in a weight management course, they reported that daily hassles and concurrent negative affect predicted emotional eating. Furthermore, rumination added to the predictive power. Caution should however be taken when interpreting findings from this study, which used HLM with such a small sample size. This has the potential to increase bias in the findings, potentially rendering them untrustworthy (McNeish & Stapleton, 2016).

Ruscio et al. (2015) explored the experience of rumination in those with anxiety and mood disorders. Specifically their sample consisted of 145 individuals with either GAD, MDD, comorbid GAD and MDD or no diagnosed condition. Generally, diagnosed individuals experienced more event related rumination than healthy controls following a stressful event. Those with co-morbid GAD and MDD experienced greatest level of rumination. More rumination following a stressful event predicted increased negative affect. Furthermore, rumination mediated the relationship between stress and affect. When assessing the relationship between affect and rumination in relation to a stressful

event, participants were asked to consider any negative event occurring in the past 90 minutes, introducing retrospective bias.

Selby et al. (2013a; 2013b; 2016) published three papers from a single study of 47 individuals who reported experiencing dysregulated behaviour, 16 of whom had received a diagnosis of borderline personality disorder. They reported that daily experiences of emotional cascades (the experience of upsetting emotions, potentiated by rumination fuelling further rumination and negative affect) predicted the occurrence of nightmares. Higher levels of negative affect were experienced in the day following the nightmare in those diagnosed with BPD (Selby et al., 2013a). Selby et al. (2013b) contributed further findings reporting that during the study 25 incidents of non-suicidal self-injury (NSSI) were reported. They explored the relationship between rumination and NSSI and reported that rather than rumination generally it was instability of rumination that predicted NSSI. Furthermore, a significant relationship between instability of rumination and instability of negative affect was identified. However only 25 incidents were reported within the 3118 responses, making it difficult to draw meaningful conclusions. Finally Selby et al. (2016) reported that rumination and negative affect predicted increased levels of each other at subsequent assessments, and this synergistic effect predicted impulsive behaviours. A limitation of the study generally was the difference in sample size of the BPD and non-BPD groups, suggesting caution must be taken when interpreting findings related to group differences.

1.5 Discussion

This review aimed to evaluate the methodology used to capture the momentary experiences of mind wandering, and determine the nature of the relationship between present moment mind wandering and concurrent mood, based on the available literature. General guidance based on previous ESM research has been developed in order to improve consistency of the methodology and validity of data collected through ESM (such as Palmier-Claus et al., 2011). This has included recommendations on the method for delivering and responding to signals, the frequency and scheduling approach of signals and time restrictions on responses to signals. The extent to which the methodology used within the studies adhered to such guidance varied extensively. This is understandable to a degree, given the necessity to adapt the methodology to answer the different specific research questions. However, deviating too much from the guidance is likely to have a detrimental impact on the validity of the findings.

Generally speaking the methodological quality of the studies within the review was good, based on level of adherence to the guidance of Palmier-Claus et al. (2011). Only a few deviated from the guidance to an extent that it was deemed to compromise the quality. Specifically, three of the studies were rated as fair (Kubiak et al., 2008; Marcusson-Clavertz et al., 2016; Mor et al., 2010) and four as weak (Moore et al., 2016; Real et al., 2016; Slatcher et al., 2010; Song & Wang, 2016). A key motivator to deviate from the guidance is likely to be in the interest of improved response rates. However even those studies who adhered most closely to the guidance (such as Gerteis & Schwerdtfeger, 2016; Moberly & Watkins, 2008a; Ruscio et al., 2015) achieved good response rates (81%, 77% and 72%, respectively), whilst maintaining high validity of data collected. Within the review, it has been evident that reporting of the aspects of methodology discussed was inconsistent. Sixteen of the studies neglected to provide information regarding at least one of the methodological aspects, with response time restrictions being the most widely unreported detail. Such neglect of reporting compromises the replicability of the research, as well as the ability to adequately assess the validity of the findings.

In terms of findings, the studies were fairly consistent in suggesting that mind wandering is associated with negative affect. This appeared to vary depending on the nature of the mind wandering, with unpleasant and neutral topics being associated with reduced affect (Killingsworth & Gilbert, 2010). For positive affect the opposite was observed. Furthermore, mind wandering was identified as having a detrimental impact on

other daily activities including sleep. This relationship was also reported within clinical populations, with both those with long term physical health conditions such as amyotrophic lateral sclerosis (Real et al., 2014), mental health problems such as psychosis (Hartley et al., 2014) and developmental disorders such as Asperger's Syndrome (Hare et al., 2016). Beneficial effects of mind wandering, when in a positive mood, such as predicting engagement in physical activity have also been observed (Fanning et al., 2013). The investigation of the positive effects has however been neglected within the literature.

Similar findings were generally found within the literature focusing primarily on rumination. Again, the relationship was consistent with both healthy controls and those experiencing mental health difficulties, including GAD, depression, Anorexia Nervosa and borderline personality disorder. However, those with a diagnosis of GAD or depression reported higher levels of rumination than healthy controls. This provides support for the transdiagnostic nature of mind wandering. Rumination was by far the most investigated component of mind wandering, with only one study focussing solely on worry (Slatcher et al., 2010). This study was excluded from the review of findings due to a lack of exploring the relationship between concurrent worry and affect directly. Arguably, worry and rumination are two components of the same construct, and thus it would be reasonable to expect the same relationship with concurrent affect to be observed, it is however imperative to support this empirically.

Furthermore, only two studies explored the potential benefits of interventions on momentary mind wandering and negative affect (Moore et al., 2016; Gotink et al., 2016). Both were mindfulness based and found a reduction in mind wandering and improvements in mood. However, the methodology of Moore et al. (2016) was rated as weak in terms of adherence to the ESM guidance and Gotink et al. (2016) assessed state mindfulness generally, rather than specific momentary mind wandering.

Based on this review further studies would usefully broaden the literature to be more inclusive of the relationship between momentary worry and affect. This should include a range of clinical presentations, with the aim of supporting the transdiagnostic understanding of worry. Furthermore, using ESM to evaluate interventions targeting the process of mind wandering specifically would be beneficial for developing an understanding of the efficacy for specific components of psychological interventions that can be utilised transdiagnostically. Such research should adhere closely to the methodological recommendations of Palmier-Claus et al. (2011), and consistently report the methodology in order to improve replicability.

1.6 Conclusion

This review systematically explored the methodological quality of ESM research investigating the relationship between mind wandering and mood. Thirty-five papers met the criteria for inclusion and were evaluated in terms of their adherence to guidance developed for ESM research in psychopathology. The studies were generally of good quality, in terms of accordance with previous guidance. There is a need however for greater consistency in reporting of methodological details to improve replicability. It is evident that ESM is an effective way for the use of capturing momentary thoughts and future research should capitalise on the benefits of this methodology.

Mind wandering, as well as specific components, namely rumination, were generally found to be associated with negative affect. This was consistent across a range of healthy and clinical populations, supporting the view that mind wandering is a transdiagnostic process. Whilst research has consistently explored the relationship between mind wandering and mood, little attention has been given to the use of ESM within interventions studies. Specifically, within this review limited research exploring the impact of psychological interventions (such as mindfulness) on the detrimental effects of mind wandering, and in particular on the process of worry, was available. Further research could usefully address this, with potential clinical value.

Chapter 2: Comparing the Effects of Attention and Acceptance-Based Psychological Interventions on Thought Intrusions in Chronic Worriers

2.1 Introduction

Mind wandering refers to the experience of having a thought that is decoupled from stimuli present in the current environment and unrelated to the activity being carried out (Stawarczyk et al., 2011). The experience of mind wandering is a typical component of the human condition, and is experienced by all individual's on a daily basis (Song & Wang, 2012). The cognitive experiences of worry and rumination can be classified as types of mind wandering, and are seen as transdiagnostic symptoms featuring in a range of mental health conditions (Watkins, 2015), see section 1.1.2. For example, whilst a key component of generalised anxiety disorder worry is cited as a feature within a range of mental health conditions (Arditte, Shaw & Timpano, 2016). Therefore, mind wandering could be considered as playing a key role in the maintenance of a range of mental health difficulties.

Evidence for the relationship between mind wandering and negative mood states has come from studies utilising experience sampling methodology (ESM). ESM is used to capture momentary experiences within daily life - for an in depth account of the use of ESM for psychopathology refer to Myin Germeys et al. (2009) and Verhagen, et al. (2016) (also see section 1.3). The key benefits of ESM are the high ecological validity resulting from capturing experiences within the naturalistic setting. Furthermore, the momentary assessment of experiences improves both accuracy of recall and thus reduces recall bias compared to retrospective measures (Palmier-Claus et al., 2011). When comparing retrospective and ESM measures of symptoms of individuals with psychosis Ben-Zeev et al. (2012) found that negative affect was overestimated within retrospective measure, suggesting a negative memory/recall bias. Furthermore, Moore et al. (2016) found ESM assessment of mindfulness and depression to be more sensitive at detecting change than traditional retrospective measures in individuals participating in a mindfulness-based stress reduction course.

In terms of the relationship between mind wandering and mood, as assessed by ESM, Killingsworth and Gilbert (2010) found that individuals were less happy when mind

wandering, regardless of the activity they were engaged in. Within this non-clinical sample, individual's minds were more likely to wander to pleasant topics than neutral or unpleasant ones. Similar ratings of happiness were identified when thinking about a pleasant topic compared to being focused on the current activity. However, individuals were significantly less happy when thinking about a neutral or unpleasant topic. Furthermore, momentary ruminative self-focus has been positively associated with concurrent negative affect (Moberly & Watkins, 2008a). Rumination appears to have a greater detrimental effect on those diagnosed with either generalised anxiety disorder (GAD), major depressive disorder (MDD) or comorbid GAD and MDD than those without such diagnoses (Ruscio et al., 2015). Rumination following a stressful event was associated with negative affect, and was more persistent in those with a diagnosis (Ruscio et al., 2015). Concurrent rumination and state anger have also been found to predict each other (Borders & Lu, 2016) when explored using ESM. Poerio, Totterdell and Miles (2013) however, argue that mind wandering is not in itself maladaptive. As such, they found that mind wandering did not predict subsequent feelings of anxiety or sadness, when assessed 15 minutes later. Instead, the affective content of the mind wandering had an effect on later mood. Specifically content of mind wandering rated as sad predicted sadness 15 minutes later, and content rated as anxious predicted anxiety 15 minutes later. The literature therefore indicates that mind wandering, or at least the affective content of mind wandering, is potentially a useful target for intervention when aiming to reduce its detrimental impact on levels of anxiety and low mood. In terms of clinical aspects of mind wandering the ESM literature has focused largely on rumination with less attention given to the process of worry.

There is a growing interest in the use of mindfulness-based interventions for managing problematic symptoms of mental health, including worry. Evaluations of such interventions have found them to be effective at alleviating distress in those diagnosed with conditions such anxiety disorders, for a review see Vollestad, Nielsen and Nielsen (2012). Furthermore, ESM research has found mindfulness based interventions to increase state mindfulness and positive affect (Gotink et al., 2016). Understanding the active ingredients of mindfulness-based interventions would enable clinicians to optimise the effectiveness of treatment protocols. One way to determine this is to identify the processes operating within mindfulness exercises and their differential effect on the problematic process of mind wandering. Bishop (2004) proposed a two-component model of mindfulness, suggesting that mindfulness practice typically aims to target and develop the self-

regulation of attention (referred to here as focused attention) and orientation to the experience (referred to here as acceptance). Self-regulation of attention refers to the process of paying deliberate, focused and sustained attention on present moment and thus increasing awareness of the private experiences occurring (including cognitions, physical sensations and urges) (Bishop, 2004). Orientation to the experience refers to observing private experiences with curiosity and acceptance, abandoning the agenda to change or get rid of the unwanted private experiences (Bishop, 2004). Within therapeutic approaches such as Acceptance and Commitment Therapy, this agenda is referred to as experiential avoidance; a process deemed a key maintaining factor for psychological difficulties (Eilenberg, Hoffmann, Jensen & Frostholtm, 2017).

Experimental research has explored the differential effects of the components of mindfulness on anxiety and worry in non-clinical populations. Ainsworth et al. (2015) found that an acceptance based exercise in particular, and focused attention to a modest extent, reduced CO₂ induced self-reported anxiety compared to a relaxation control. In terms of the underlying mechanism Ainsworth et al. (2017) suggest that the attention and acceptance based mindfulness exercises may reduce anxiety by reducing the frequency of negative thought intrusions that characterise worry. Their sample of non-clinical participants practiced a 10 minute exercise (either acceptance based, attention based or a progressive muscle relaxation (PMR) control exercise), before engaging in a worry induction task. They found that an increase in self-reported anxiety following the worry induction was associated with an increase in negative thoughts. Furthermore, those in the acceptance group experienced less induced worry than the attention and PMR, and those in the attention group experienced less induced worry than those in the PMR condition.

PMR is a form of psychological intervention involving the voluntary tensing and relaxing of various muscles throughout the body (Jain et al. 2007). PMR has frequently been used as an active control condition when exploring the effects of mindfulness, due to the distinct hypothesised mechanisms. Specifically, PMR is hypothesised to reduce distress by increasing physiological relaxation, rather than by increasing mindfulness. Jain et al. (2007) explored the differential effects of PMR and mindfulness on aspects of stress. They found that whilst there was no significant difference between PMR and mindfulness for reducing levels of distress, a mindfulness-based intervention had a greater effect on the reduction of cognitive aspects of stress, specifically rumination.

Differential effects of particular components of mindfulness on worry have been identified within high worriers. Delgado et al. (2015) compared the effects of exercises

focussing on awareness of internal sensations (metainteroceptive), attention to cognitive (metacognitive) and a non-intervention control, over the course of three weeks. Both mindfulness groups experienced an increase in levels of mindfulness following the intervention and reduction in negative affect, however only the interoceptive group reported a significant reduction in worry (Delgado et al., 2015).

To summarise, mind wandering has been associated with negative affect including anxiety. Some have proposed that rather than mind wandering specifically, it is the affective content of the mind wandering that influences mood (Poerio et al., 2013). Based on this relationship, targeting negative thought intrusions (a component of mind wandering) has been proposed as a mechanism of change within mindfulness exercises, and this effect appears to differ depending on the type of exercise (acceptance or attention based) practiced. Research has predominantly focused on non-clinical populations. However, understanding the differential effects of components of mindfulness on mind wandering, in a high trait worry population, is potentially beneficial to clinicians, as it offers the opportunity to tailor intervention protocols accordingly. Furthermore, the limited research focusing on the effects of mindfulness components on worry (e.g. Delgado et al., 2015) has relied on retrospective measures, providing limited accurate information on the frequency of distressing mind wandering.

Previous research has validated the use of ESM to assess momentary thoughts over an extended period of time (see chapter 1 section 1.3). Furthermore, the differential effects of specific mindfulness exercises on worry has been explored within the laboratory setting (Ainsworth et al., 2017). The current study is the first to use experience sampling of momentary thoughts to test the differential effects of two mindfulness exercises in a sample of high worriers over the course of three weeks. The aim of the current study was therefore twofold. Firstly, to determine whether there is a differential effect of two distinct components of mindfulness (focused attention and acceptance) on the levels of worry in high trait worriers. Secondly, to explore the nature of mind wandering (including valence and temporal orientation) within a high trait worry population with the use of experience sampling. Based on these aims, and the available literature, four hypotheses were tested. The first two hypotheses reflect data collected from standardised retrospective measures, whereas hypotheses 3 and 4 reflect data collected using the novel experience-sampling component of the study and are thus exploratory in nature. Based on the current available literature (e.g. Delgado et al., 2015) it is appropriate to predict that the two mindfulness exercises will have a differential effect on worry (or future orientated negative intrusions)

and affect. However, it would not be appropriate at this stage to predict a differential effect on levels of overall mindfulness. The four hypotheses tested are as followed:

H1: Trait worry and negative affect (anxiety and low mood) will reduce over the course of the intervention; this reduction will be greater for those practicing an acceptance-based mindfulness exercise, compared to a focused attention-based mindfulness exercise or PMR.

H2: Mindfulness will increase over the course of the intervention for those in the mindfulness conditions.

H3: The proportion of future orientated negative thought intrusions will reduce over the course of the intervention, particularly for those in the acceptance condition.

H4: Momentary affect (anxiety and sadness) associated with future orientated negative thought intrusion will reduce over time for those in the mindfulness conditions, but not for those practicing PMR.

2.2 Method

2.2.1 Participants.

The sample was 75 participants (69 female/6 male; $M_{age} = 24.81$, $SD_{age} = 9.76$) with a high score on the Penn State Worry Questionnaire (PSWQ) (Meyer et al., 1990), and currently residing in the UK. The final sample was selected from an initial pool of 225 individuals recruited through advertising on a university campus as well as relevant online websites, including anxiety charity organisations (e.g. Anxiety UK). Of this pool, 39 participants were excluded because they did not meet the criteria of high worry (scored less than 56 on the PSWQ) and 77 participants dropped out during the course of the study. One hundred and nine participants completed the study, and received either course credit (if a university student) or payment of £10 plus entry into a prize draw. Of those who completed the study, seven were excluded from the final analysis due to providing less than 33% of responses to the ESM surveys, as recommended by Delespaul (1995). A further 17 who identified themselves as current practitioners of mindfulness, were excluded from the final analyses, consistent with previous research, (Ainsworth et al., 2017). Finally, participants who practiced their psychological exercise fewer than five occasions during the course of the intervention were excluded ($n = 10$; PMR, $n = 7$; FA, $n = 3$; Acc, $n = 0$). Ethnic backgrounds of the participants: White British (81.3%), Bangladeshi (1.3%), Chinese (2.7%), Black African (2.7%), Black Caribbean (2.7%), Indian (4.0%) and other (5.3%).

A Power calculation was performed using G*Power version 3 (Faul, Erdfelder, Lang & Buchner, 2007). Based on achieving an effect at least as great as those of Delgado et al. (2015) ($\eta_p^2 = 1.5$) a target sample of 37 participants per group to test a two tailed hypothesis, with 80% power and 5% significance level was suggested.

2.2.2 Design and procedure.

The study was completed online, hosted on Lifeguide (a web based intervention platform) and participation lasted for a period of 21 days. Prior to accessing the baseline measures informed consent was obtained on the website. Participants then completed the PSWQ to determine eligibility. Eligible participants continued to complete the remaining baseline questionnaires (GAD-7, PHQ-9, PHLMS, MEWS— see section 2.3). Non-eligible participants were thanked for their time and were unable to continue with the study. Upon

completion of the baseline questionnaires participants were randomly allocated to one of the three groups: acceptance-based mindfulness, focussed attention-based mindfulness and progressive muscle relaxation (active control group). Randomisation was performed within the Lifeguide software. Specifically pure minimisation with 0.8 certainty was used, meaning that there was 80% certainty that each new participant was allocated to the group with the lowest participant number. Participants were unaware of the group to which they were assigned. Groups did not differ on age, gender, current use of medication for anxiety or low mood, nor baseline measures of anxiety, depression, mindfulness or mind wandering. For group characteristics, see Table 3. During days two and three participants did not have access to their psychological exercise, instead they simply completed the ESM measure, to obtain a baseline measure of mind wandering as assessed via ESM. Following the baseline assessment period, on day four participants were able to access their respective intervention exercise for the remainder of the study. Standardised self-report measures of anxiety, mindfulness and mind wandering were administered at set intervals throughout the intervention phase, in addition to the ESM measures, see Figure 3 and Figure 4 for the assessment schedule. The study received appropriate ethics and governance approval from the University of Southampton (Study ID: 24636), see appendix A.1.

Table 3.

Group characteristics

	PMR	FA	OE
<i>N</i>	27	26	22
Mean age (<i>SD</i>)	24.15 (8.35)	26.12 (11.82)	24.09 (8.95)
Female	26	23	20
Current medication for anxiety or low mood	5	5	4
Currently engaging in therapy	3	1	3
Current physical health problem	6	4	2
Previously practiced mindfulness	12	11	11

Note. *N* = number of participants; *SD* = Standard Deviation; PMR = progressive muscle relaxation; FA = focussed attention; OE = open experience

2.2.3 Measures.

2.2.3.1 Questionnaire measures.

2.2.3.1.1 Trait worry.

The PSWQ (Meyer et al., 1990) was completed at baseline and post intervention (T6). The PSWQ is a measure of trait worry, consisting of 16 items scored on a 5-point scale (from 1 (not at all typical of me) to 5 (very typical of me)), yielding a possible total score range of 16 to 80. Consistent with previous research a score of 56 or higher at baseline was considered to reflect high trait worry (Hirsch, Mathews, Lequertier, Perman & Hayes, 2013). The PSWQ was chosen for its good psychometric properties, including high internal consistency, test re-test reliability and validity with student, community and clinical populations (Hirsch et al., 2013).

2.2.3.1.2 Depression.

The Patient health Questionnaire (PHQ-9) (Kroenke, Spitzer & Williams, 2001) was used to assess self-reported levels of depression. The PHQ-9 is a nine-item questionnaire measuring symptoms of depression. Based on the construct and criterion validity Kroenke et al. (2001) cite the PHQ-9 as being a reliable and valid assessment of depression severity. The PHQ-9 was administered at baseline and T6.

2.2.3.1.3 Anxiety.

Anxiety was assessed using the Generalised Anxiety Disorder -7 (GAD-7) (Spitzer, Kroenke, Williams & Lowe, 2006) questionnaire. The GAD-7 is a 7-item questionnaire designed as a brief measure of generalised anxiety disorder symptoms. It has been validated for use with clinical populations as well as for research (Spitzer et al., 2006). The seven items are scored on a 4-point scale giving a score range of 0-28, higher scores indicating a higher severity of symptoms. The GAD-7 was administered at set intervals, throughout the intervention (Baseline, day 9 (T2), day 15 (T4) and day 21 (T6)), to monitor change.

2.2.3.1.4 *Trait mindfulness.*

The Philadelphia Mindfulness Scale (PHLMS) (Cardaciotto, Forman, Farrow, Herbert & Moitra, 2008) was designed to assess two key components of mindfulness, namely awareness and acceptance. The self-report questionnaire consists of 20 items, 10 for each subscale, scored on 5-point (scores of 1-5) likert scale. The total scores therefore range from 20 to 100. The measure has been validated for use with both clinical and non-clinical samples. The PHLMS was chosen as it measures aspects closely related to the mindfulness exercises used within the intervention (focussed attention and acceptance). The PHLMS was administered at baseline, T2, T4 and T6.

2.2.3.1.5 *Trait mind wandering.*

In order to assess self-reported levels of mind wandering using a standardised measure the Mind Excessively Wandering Scale (MEWS) (Mowlem et al., 2016) was administered at set intervals throughout the intervention (baseline, T2, T4 and T6). The MEWS, developed as a measure of excessive mind wandering, was initially validated with a population of adults with ADHD as well as healthy controls. The measure consists of 15 items (such as “I have difficulty controlling my thoughts” and “I find it hard to switch off from my thoughts”) that are scored on a 5 point Likert scale, resulting in a possible score range of 0 to 45. Higher scores indicated greater levels of mind wandering.

2.2.3.2 *Experience sampling protocol.*

Experience sampling methodology was used to assess momentary mind wandering and mood six times per day for a period of 19 days (from day 2 up to and including day 20). Prompts were delivered via SMS to the participant’s personal mobile phone according to a fixed schedule during typical waking hours. Specifically, prompts were sent at 8.00, 11.00, 13.30, 16.30, 18.30 and 20.30. Within the SMS was a link to the website and instructions to complete the 3 question survey (referred to here as the Momentary Mind Wandering Survey (MMWS)) “as soon as possible, ideally within the next five minutes”. The survey was open and available for completion for up to 30 minutes following each prompt.

2.2.3.2.1 *MMWS Q1. Momentary mind wandering.*

Consistent with previous research (Killingsworth & Gilbert, 2010), momentary mind wandering was assessed using the question “Are you thinking about anything other than what you are doing?”. To obtain a rating of the pleasantness of the thought content (valence) the available responses to this item, presented in a drop down response list, included “Yes, pleasant”, “Yes, neutral”, “Yes, unpleasant” and “No, I’m thinking about what I’m doing”.

2.2.3.2.2 *MMWS Q2. Temporal orientation.*

The second item of the survey, answered only if the initial item indicated the presence of mind wandering, assessed the temporal orientation of mind wandering. The question “was the thought related to the past or the future” was answered with the available response of “past” or “future” from a drop down response list.

2.2.3.2.3 *MMWS Q3. Momentary affect.*

Following on from previous research (Poerio et al., 2013) momentary affect was assessed using two dimensions, anxiety and sadness. The item “how were you feeling when having the thought” was answered on two five-point scales, one with the anchors of calm/anxious and the other of happy/sad at either end.

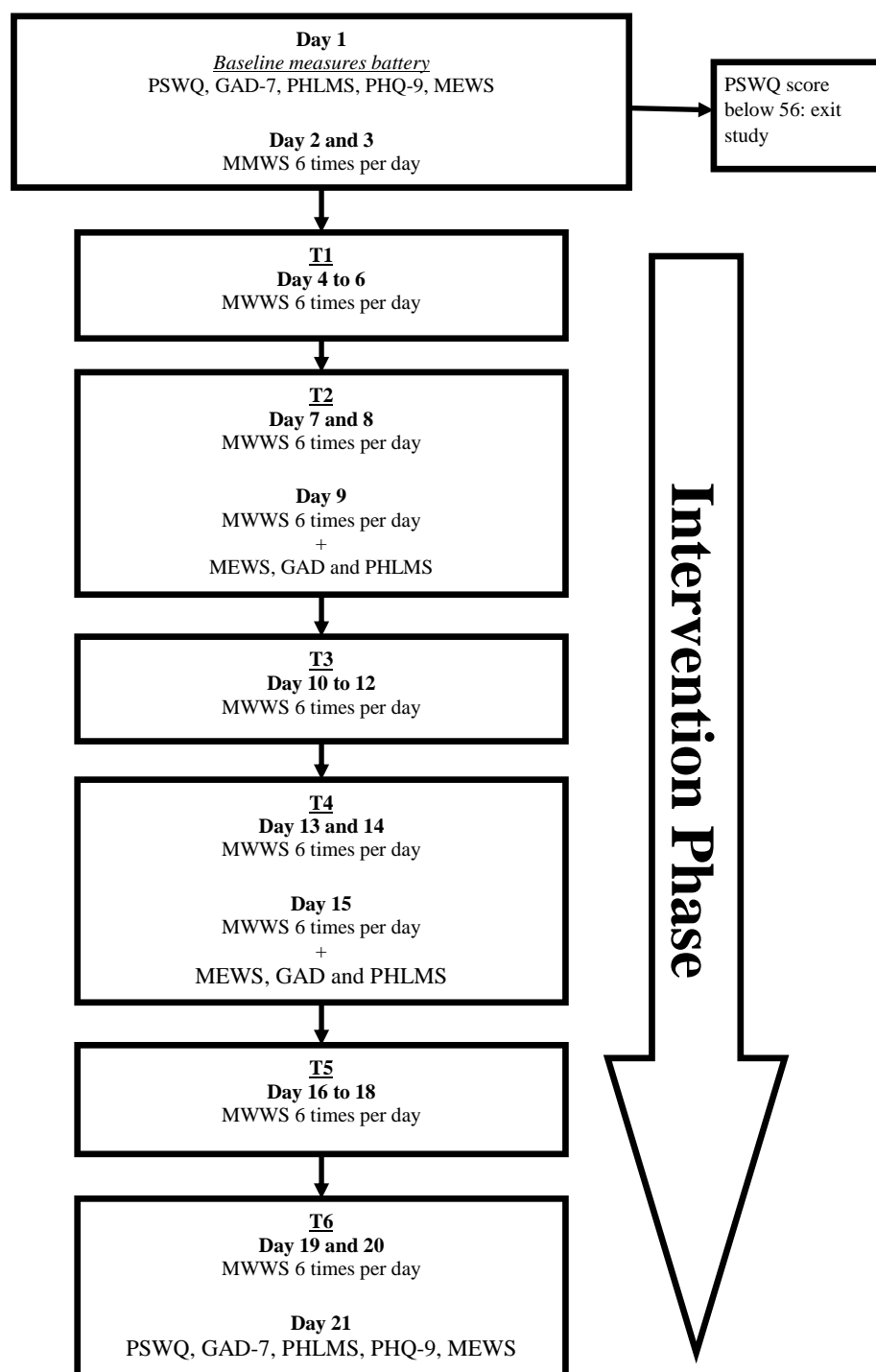


Figure 3. Flowchart demonstrating data collection during each of the seven time phases of the intervention.

Day	PSWQ	PHQ-9	GAD-7	PHLMS	MEWS	MMWS
1	X	X	X	X	X	
2						X
3						X
4	<i>Intervention commenced</i>					X
5						X
6						X
7						X
8						X
9			X	X	X	X
10						X
11						X
12						X
13						X
14						X
15			X	X	X	X
16						X
17						X
18						X
19						X
20						X
21	X	X	X	X	X	

Figure 4. Matrix outlining day of participation and measures completed. X=assessment was conducted on respective day; PSWQ= Penn State Worry Questionnaire; PHQ-9 = Psychological Health Questionnaire -9; GAD-7 = Generalised Anxiety Disorder Questionnaire -7; PHLMS = Philadelphia Mindfulness Scale; MEWS = Mind Excessively Wandering Scale; MMWS = Momentary Mind Wandering Scale.

2.2.4 Intervention conditions.

Each condition consisted of a different 10 minute audio exercise. The exercises, initially used by Ainsworth et al. (2017), were developed by a clinical psychologist with over 19 years of experience in delivering mindfulness based interventions. On day four of the study participants were sent an email informing them of their access to access their psychological exercise and were advised to listen to the guided practice daily until the end of the study. The audio exercises were hosted on a well-known video sharing website. The exercises were private and only those with the link, embedded in the study website on a page accessible to the participants in the respective groups, could access the exercise.

2.2.4.1 *Mindfulness-based interventions.*

2.2.4.1.1 *Attention based mindfulness exercise.*

During the focussed attention mindfulness exercise the participants were guided to focus their attention solely towards their breath. Therefore this physical sensation was used as an anchor for their attention, and they were reminded to return their attention to their breath when they noticed their mind wandering. Specifically participants were given guidance during the exercise such as “become aware of the sensation of breathing... noticing where in the body the physical sensations of breathing are vivid for you, right now... choosing one place to follow the breath... making a decision to stay with this place... bringing your attention and your curiosity to each breath... Feeling the moment-by-moment physical sensations as you breathe in and breathe out.” (As cited by Ainsworth et al., 2017, p.74).

2.2.4.1.2 *Acceptance based mindfulness exercise.*

During acceptance based mindfulness exercise, participants were guided to notice whatever private experiences were present, such as thoughts, feelings and physical sensations and to accept them. The instructions include asking the participants to “Direct your attention inwardly... notice thoughts, emotions, physical sensations... any other kinds of experiences as they show up in the field of your awareness... sitting and noticing what’s here, right now, for you.... Each time you become aware of a private experience, such as a thought, or a feeling... turning your attention towards it, acknowledging it, maybe labelling it... and as best you can, letting things be as they are ... making space for your experiences.” (As cited by Ainsworth et al., 2017, p.74).

2.2.4.2 *Progressive muscle relaxation exercise.*

As in previous research (Ainsworth et al. 2017) progressive muscle relaxation (PMR) was used as an active control condition, against which the two mindfulness exercises could be evaluated. The PMR exercise involved developing the participants’ skills in relaxing groups of muscles identified by the person as holding tension. The practice started by asking the participant to take a couple of slow deep breaths. They were then guided to “feel the tension in your toes, feet and lower legs’... ‘breathe deeply, in and out, and let the muscles relax’... ‘notice the difference between when they were tense, and now they are relaxed” (As cited by Ainsworth et al., 2017, p.74). The practice focused on

encouraging relaxation in a range of areas throughout the body, such as the lower back and stomach.

2.2.5 Data analysis.

All data analysis was conducted using IBM SPSS version 24 (IBM corp., 2016). Data from the standardized measures (including the PSWQ, PHQ-9, GAD-7, PHLMS and MEWS) were analysed using one-way and mixed ANOVAs. Thus, relevant assumptions were explored; normality of distribution was inspected visually using histograms and *p-p* plots, homogeneity of variance was explored statistically for between subject's factors via the Levene's test, the assumption of sphericity was tested statistically for within subject factors using the Mauchly's test of sphericity. Any violation, along with the method for correction, is outlined within the relevant results. Covariates were considered, however excluded from the analyses.¹

Data collected from the ESM measure (the MMWS) was prepared for analysis with the use of aggregation. For question 1 (the presence and valence of mind wandering), responses were aggregated into proportions for each day, thus presenting the proportion of responses (out of six possible responses) from each participant for each day that reflected unpleasant mind wandering, pleasant mind wandering, neutral mind wandering, on task thinking and missed responses. These data were aggregated further into set intervals to explore change over time. Specifically, responses from day two and day three of the study were aggregated to form the baseline ESM measure (proportion out of 12). Data from days four through 17 were aggregated into five sets of 3 days (T1 to T5, proportions out of 18) and days 18 and 19 were aggregated into the T6 (proportion out of 12). In order to explore the temporal orientation variable (question 2) data were aggregated into proportion of responses that reflected each valence type and temporal orientation of mind wandering (e.g. pleasant mind wandering about the past, pleasant mind wandering about the future, etc.). Finally, the continuous variable of momentary anxiety (question 3) was aggregated

¹ The use of relevant covariates was considered for each analysis including; the use of baseline scores from the standardised measures, current use of medication, frequency of practice, previous mindfulness practice and current psychological therapy. Appropriate assumptions of potential covariates were explored (e.g. linear relationship between the covariate and dependent variable for each group and independence of the covariate and treatment effect (Field, 2009)). The use of covariates were excluded from all analyses due to either a lack for relationship between the change score of the dependent variable and the covariate, or due to the lack of significant change when including the covariate within the model.

into days and set intervals (baseline to T6) using the mean of responses provided. Ratings of sadness were aggregated in the same manner. Aggregated data were then explored using relevant mixed ANOVAs.

The findings of the statistical tests are reported with a focus on the respective effect sizes. This was deemed appropriate due to the inclusion of multiple conditions and thus the benefits of exploring the magnitude or strength of difference between the groups, rather than statistical significance alone (Sullivan and Feinn, 2012). The exploration of the hypotheses requires multiple testing of the data. Whilst values of statistical significance (p values) are susceptible to type-1 errors when multiple measures are used (Feise, 2002), effect sizes are not. Therefore, it was not necessary to make p -value adjustments.

2.3 Results

2.3.1 Effect of exercise on trait worry.

A 3 (Group) x 2 (Time) Mixed ANOVA was performed to assess the effect of the intervention on reported levels of trait worry, measured using the PSWQ (between baseline and T6). All relevant assumptions were met, with the exception of the assumption of sphericity, which indicated the use of corrections based on Greenhouse-Geisser estimates. The mean and standard deviations for each time point by group are provided in Table 4.

A main effect of time on level of worry ($F(1, 72) = 69.12, p < .001, \eta_p^2 = .49$) and small effect of group ($F(2, 72) = 2.71, p = .074, \eta_p^2 = .07$) were subsumed within a strong interaction between group and time ($F(2, 72) = 3.27, p = .044, \eta_p^2 = .08$) (see Figure 5). Inspection of Figure 2 suggests that whilst levels of self-reported worry reduced over the period of the intervention for all groups, the level of reduction was greatest in the Acc group. This was explored with separate one-way ANOVAs at each time point. There was no evidence of a group difference in worry at baseline ($F(2, 72) = .268, p = .766, \omega^2 = .02$). However, at T6 worry was substantially lower in the Acc compared to PMR group ($F(1, 48) = 7.38, p = .009, d = .80$), and there was some evidence that worry following Acc was lower than following FA ($F(1, 47) = 3.51, p = .067, d = .55$). There was no evidence that worry differed following PMR and FA ($F(1, 52) = .91, p = .346, d = .03$). This therefore suggests that the reduction in worry was greatest for those in the acceptance (Acc) group, particularly compared to those in the PMR group.

Table 4.

Descriptive statistics for standardised questionnaire data at each time point for each group

	Progressive Muscle Relaxation (n=27)	Focused Attention (n=26)	Acceptance (n=22)
	Mean (SD)	Mean (SD)	Mean (SD)
PSWQ			
Baseline (day 1)	68.26 (5.69)	67.08 (6.14)	67.45 (6.20)
T6 (day 21)	61.41 (10.46)	58.77 (9.70)	53.50 (9.71)
PHQ-9			
Baseline	21.11 (6.76)	20.35 (5.24)	21.36 (6.17)
T6	19.85 (7.17)	17.62 (5.49)	17.77 (5.17)
GAD-7			
Baseline	19.22 (4.64)	19.69 (4.55)	19.36 (4.22)
T2	17.85 (4.75)	16.96 (4.65)	18.23 (5.44)
T4	17.44 (4.85)	15.04 (4.80)	17.00 (5.35)
T6	16.70 (5.30)	14.88 (5.16)	15.45 (4.98)
PHLMS			
Baseline	57.74 (8.23)	59.31 (6.16)	56.86 (6.28)
T2	58.93 (6.87)	59.15 (7.40)	57.00 (9.80)
T4	59.52 (7.59)	59.04 (9.13)	59.27 (10.78)
T6	60.37 (7.96)	59.35 (7.80)	60.86 (12.32)
MEWS			
Baseline	24.04 (7.45)	25.23 (7.86)	26.18 (7.06)
T2	22.61 (9.83)	23.42 (8.42)	23.27 (8.86)
T4	21.85 (11.33)	20.58 (9.54)	19.50 (9.23)
T6	19.37 (11.30)	19.10 (10.83)	18.23 (9.04)

Note. SD = standard deviation

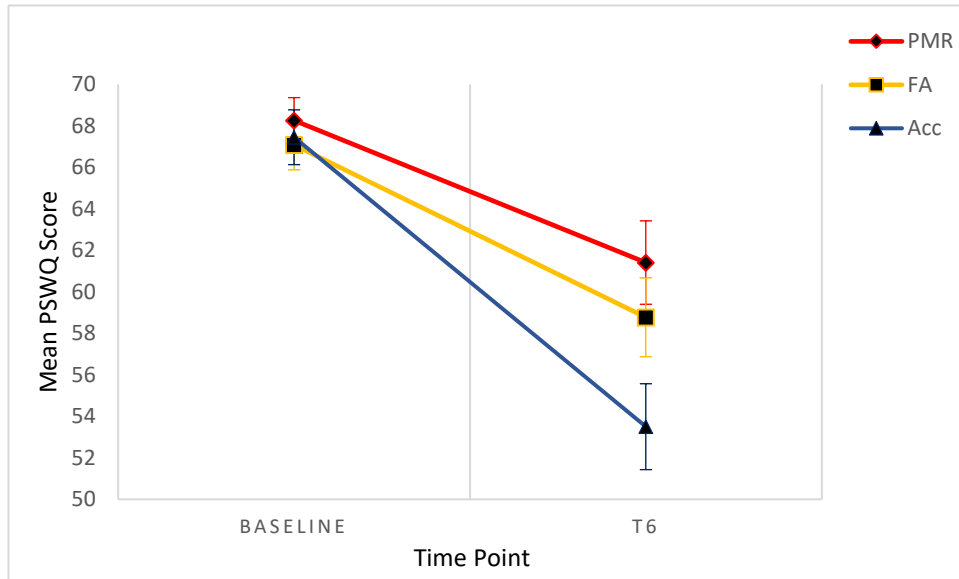


Figure 5. Mean worry at baseline and T6 (day21) in each group. Error bars = +/-1SEM

2.3.2 Effect of exercise on mood.

2.3.2.1 Anxiety.

For the within subject measure of time, the Mauchly's test indicated that the assumption of sphericity had been violated ($\chi^2(5) = 37.65, p < .001$). As such, the degrees of freedom were corrected using Greenhouse–Geisser estimates of sphericity ($\epsilon = .72$).

A 3 (Group) x 4 (Time) mixed ANOVA tested the effect of the interventions on levels of self-reported trait anxiety (measured using the GAD-7) across four time points (Baseline, T2, T4, T6). The results indicated a strong main effect of time ($F(2.16, 155.62) = 29.43, p < .001, \eta_p^2 = .29$) – contrasts for the main effect revealed that across participants the GAD-7 was substantially lower at T2 vs, baseline ($F(1,72) = 16.56, p < .001, \eta_p^2 = .19$), with a linear reduction throughout the intervention. However, there was no indication of a main of group ($F(2, 72) = .502, p = .607, \eta_p^2 = .01$), nor was an interaction effect observed ($F(4.32, 155.62) = 1.96, p = .098, \eta_p^2 = .05$). This suggests that whilst

anxiety reduced over the course of the intervention, the reduction comparable for each condition.

2.3.2.2 Depression.

Exploration of the assumptions revealed that the assumption of sphericity had been violated, and therefore corrections were made using Greenhouse-Geisser estimates.

A 3 (Group) x 2 (Time) mixed ANOVA, exploring the effect of the intervention on depression (between baseline and T6) was performed. A main effect of time ($F(1,72) = 21.49, p < .001, \eta_p^2 = .23$) was identified, however no main effect of group ($F(2,72) = .482, p = .620, \eta_p^2 = .01$) nor an interaction effect ($F(2,72) = 1.56, p = .217, \eta_p^2 = .04$) was observed. Thus, whilst a reduction in depressive symptoms was indicated over the course of the intervention, as measured by the PHQ-9, this did not differ between groups.

2.3.3 Effect of exercise on trait mindfulness and mind wandering.

2.3.3.1 Mindfulness.

Due to the violation of the assumption of sphericity the appropriate corrections were made based on the Greenhouse-Geisser estimates.

A 3 (Group) x 4 (Time) mixed ANOVA was performed to assess the effect of the interventions on levels of self-reported mindfulness across four time points (Baseline, T2, T4 and T6), measured using the PHLMS. The results indicated a strong main effect of time ($F(1.91, 137.27) = 3.45, p = .037, \eta_p^2 = .05$), characterised by greater mindfulness at T6 vs. baseline ($F(1, 71) = 4.65, p = .034, \eta_p^2 = .06$). There was no indication of a main effect of group on self-reported levels of mindfulness ($F(2, 72) = .07, p = .937, \eta_p^2 = .002$), or an interaction effect between group and time ($F(3.81, 137.27) = 1.12, p = .347, \eta_p^2 = .03$). This suggests that the overall increase in self-reported levels of mindfulness occurred independent of group, as shown in Figure 6.

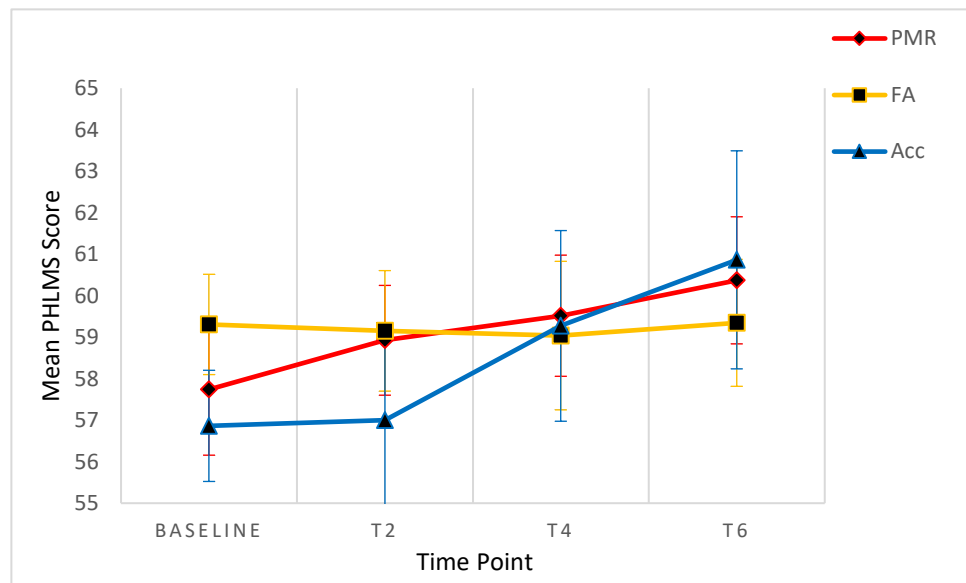


Figure 6. Mean mindfulness at baseline and T6 (day21) in each group. Error bars = +/-1SEM

2.3.3.2 Trait mind wandering.

Due to the violation of the assumption sphericity the appropriate corrections were made based on the Greenhouse-Geisser estimates.

A 3 (Group) x 4 (Time) mixed ANOVA was performed to assess the effect of the interventions on levels of self-reported trait mind wandering, measured using the MEWS, across four time points (baseline, T2, T4 and T6). There was evidence of a main effect of time ($F(1.97, 142.00) = 24.80, p < .001, \eta_p^2 = .26$) characterised by lower mind wandering at T2 vs baseline ($F(1,72) = 6.85, p = .011, \eta_p^2 = .09$), and a linear reduction through to T6. However there was no main effect of group ($F(2, 72) = .01, p = .993, \eta_p^2 < .001$), nor Group x Time interaction effect ($F(3.94, 142.00) = 37.33, p = .365, \eta_p^2 = .03$). This suggests that the self-reported level of mind wandering reduced over time; however, this decrease did not differ by group.

2.3.4 Momentary mind wandering.

In total, participants responded to 5184 of the possible 8550 experience sampling signals, resulting in an overall response rate of 60.63%. Mind wandering was reported to have occurred within 58.82% of the responses. An analysis of response rate (missing data) with a 3 (Group) x 7 (Time) ANOVA provided evidence that the frequency of responses provided by participants reduced over time ($F(5.10, 365.88)=59.31, p<.001, \eta_p^2 = .45$), particularly between Baseline and T4 ($F(1,72) = 134.96, p < .001, \eta_p^2 = .65$), however this was unaffected by Group (Group x Time: $F(2, 72)=.37, p=.692, \eta_p^2 = .03$), see appendix A.2.

2.3.4.1 *Change in mind wandering over time.*

In order to determine whether the proportion of thought intrusions (mind wandering) changed over time a 3(Group, Acc, FA, PMR) x 7(Time: 1-7) x 3(Valence: neg, neut, pos) x 2 (Temporal direction: Future vs. Past) mixed ANOVA was conducted. Hypothesis 3 (that Acc would be particularly effective at reducing negative future-oriented intrusions) would be supported by evidence of a Group x Time x Valence x Orientation interaction.

A main effect of Time ($F(4.28, 308.33)=26.941, p<.001, \eta_p^2 = .27$) was characterised by mind wandering reducing over the course of the study. There was no evidence that mind wandering was affected by group ($F(2, 72)=.48, p=.620, \eta_p^2 = .01$), valence (mean shown in Table 3) ($F(1.99, 143.31)= 2.92, p=.057, \eta_p^2 = .04$), nor Group x Time ($F(8.57, 308.33)=.63, p=.762, \eta_p^2 = .02$). A main effect of temporal direction ($F(1, 72)=1.59, p<.001, \eta_p^2 = .52$) was characterised by greater future oriented thought intrusions vs. past oriented intrusions (means are presented in Table 5). Furthermore this effect changed over time (Orientation x Time: $F(4.91, 353.38)=6.43, p<.001, \eta_p^2 = .08$) and was

characterised by a greater reduction in future oriented relative to past-oriented intrusions across participants.

Table 5.

Mean overall frequency for each type of thought valence and orientation

	Mean (SD)
Valence	
Pleasant	13.39 (8.90)
Neutral	15.61 (9.40)
Unpleasant	11.65 (8.79)
Orientation	
Past	9.95 (9.03)
Future	25.24 (12.56)

Note. SD = standard deviation

A valence x time interaction ($F(9.21, 663.42)=3.13, p=.001, \eta_p^2 = .04$) was characterised by a greater reduction in pleasant and neutral intrusions over time ($F(4.08, 346.27) = 23.26, p < .001, \eta_p^2 = .24$ and $F(4.51, 324.42) = 6.30, p < .001, \eta_p^2 = .08$ respectively) with limited change in unpleasant intrusions ($F(4.91, 353.24) = 2.15, p = .060, \eta_p^2 = .03$).

Interestingly, a valence by temporal direction interaction effect ($F(2, 144)=5.42, p=.005, \eta_p^2 = .07$) suggested that whilst the proportion of thoughts about the future was typically greater than thoughts about the past, this difference was more pronounced for unpleasant and neutral thoughts than for pleasant thoughts (see Figure 7).

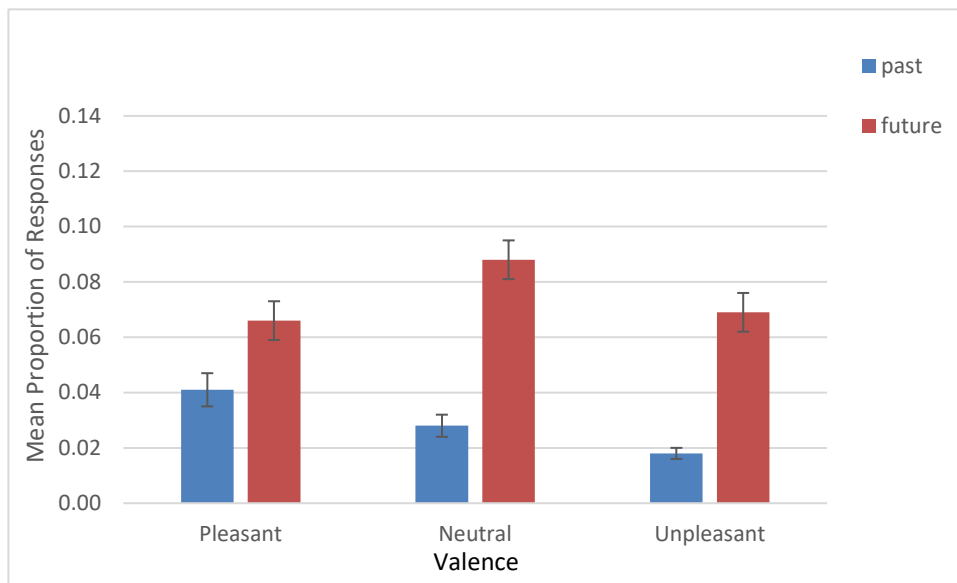


Figure 7. Means for the Proportions of Mind Wandering Type (Valence) by Temporal Direction.

2.3.4.2 *Effect of group on affect associated with future orientated unpleasant mind wandering.*

A 3 (Group) x 7 (Time: 1-7) mixed ANOVA was performed to test whether anxiety following future orientated unpleasant thoughts changed over time x group (Hypothesis 4). There was evidence of a main effect of time ($F(5.17, 372.13)=4.13, p=.001, \eta_p^2 = .05$), characterised by a reduction in anxiety at T4 vs. Baseline ($F(1,72)= 4.54, p=.036, \eta_p^2 = .06$) onwards. However, there was no main effect of group ($F(2,72)= 1.94, p=.152, \eta_p^2 = .05$), or time by group interaction ($F(10.34, 372.13)= .860, p= .574, \eta_p^2 = .02$). This suggests that the anxiety associated with future orientated negative intrusions reduced over the course of the intervention, particularly from T4 onwards. However, this change did not differ between groups.

A 3 (Group) x 7 (Time: 1-7) mixed ANOVA for ratings of sadness associated with future orientated unpleasant mind wandering revealed a main effect of time ($F(6, 432)= 2.37, p=.029, \eta_p^2 = .03$). This was characterised by a reduction at T6 vs. baseline ($F(1,$

72)= 3.11, $p=.082$, $\eta_p^2 = .04$). No main effect of group ($F(2,72)= 1.13$, $p= .329$, $\eta_p^2 = .03$) or an interaction effect ($F(12, 432)=.379$ $p=.971$, $\eta_p^2 = .01$) was identified, see appendix A.3. This suggests that the level of sadness associated with future orientated negative intrusions reduced for all groups, particularly at T6 compared to baseline. The level of sadness did not differ by group at any time point.²

² Mean levels of momentary anxiety for all thought intrusions was explored using a 3 (Group) x 7 (Time: baseline-T6) mixed ANOVA. A main effect of time ($F(4.91, 353.46) = 6.32$, $p < .001$, $\eta_p^2 = .08$) was characterised by a reduction in anxiety, particularly from T5 vs. baseline ($F(1, 72) = 4.29$, $p = .042$, $\eta_p^2 = .06$) onwards. No main effect of group ($F(2, 72) = .70$, $p = .499$, $\eta_p^2 = .02$) or group by time interaction was observed ($F(9.82, 353.46) = .67$, $p = .750$, $\eta_p^2 = .02$). Furthermore, a 3 (Group) x 7 (Time: baseline-T6) mixed ANOVA testing changing in momentary sadness also revealed a main effect of time ($F(4.77, 343.29) = 6.84$, $p < .001$, $\eta_p^2 = .09$). This was characterised by a reduction in sadness over time, particularly at T3 vs. Baseline ($F(1, 72) = 10.44$, $p = .002$, $\eta_p^2 = .13$) onwards. No main effect of group ($F(1, 72) = .28$, $p = .759$, $\eta_p^2 = .01$) or group x time interaction ($F(12, 343.29) = 1.77$, $p < .069$, $\eta_p^2 = .05$) was identified, indicating the reduction in sadness did not differ by group. See appendix A.4.

2.4 Discussion

The findings from this study support the prediction that acceptance and attention components of mindfulness practices have differential effects on levels of worry, in high worriers. Trait worry was found to reduce for those practicing a mindfulness exercise, as well as those practicing progressive muscle relaxation, during the intervention phase of the study. However, as expected, the acceptance-based intervention was found to reduce levels of worry more than the focused-attention and PMR exercises, thus supporting the primary hypothesis. This finding builds on experimental studies (e.g. Ainsworth et al., 2017), demonstrating that the beneficial acute effect of acceptance based mindfulness exercises on worry is sustained over the course of an 18-day intervention, within a naturalistic setting.

Both levels of self-reported anxiety and depression reduced over the course of the intervention, this reduction was similar across groups. This similarity was not expected and it suggests that whilst the acceptance-based exercises may be superior for reducing worry, all interventions had similar positive effects on reducing anxiety and low mood.

It should be highlighted that the current intervention included the practice of one particular exercise. The use of one exercise alone is unlikely to be sufficient in eliciting change in all features of an individual's experience of a difficulty such as anxiety. Instead, usefully, this finding supports the argument for tailoring interventions to target each transdiagnostic processes maintaining one's difficulties. Thus, this finding provides evidence for the use of an acceptance based exercise to support the reduction of the transdiagnostic process of worry, where such a difficulty is indicated. Such an exercise would be a typical component of the acceptance-based, transdiagnostic approach of ACT (Harris, 2009).

It was predicted (hypothesis 2) that a differential effect on mindfulness would be observed over the course of the intervention. Whilst levels of mindfulness increased for all conditions during the course of the intervention, there was no particular benefit of one group over any other. It is possible that this is due to the active control used. The progressive muscle relaxation exercise required participants to bring awareness to different parts of the body and notice changes in sensations when tensing and relaxing. Thus, it is reasonable to expect an increase in mindful awareness to bodily sensations as a result of this practice. An alternative explanation is that the act of frequently completing the mind wandering survey, which required bringing attention to one's thoughts and feelings, developed participants ability to bring awareness to such sensations. It is important to note however, that previous research has also found no such difference between mindfulness based exercises and PMR for increasing trait levels of mindfulness (Agee, Danoff-Burg & Grant, 2009).

It is important to acknowledge the constraints of the study, and thus view the findings in light of these. Firstly, whilst the study took place over a sustained period of 21 days there was no follow up assessment. It is therefore not possible to determine whether any changes were maintained beyond the period of participation. Also, it is important to note that for those in the mindfulness conditions only one component of mindfulness was tested, namely the practice of a discrete exercise. The therapeutic process of developing mindfulness skills is not limited to the practice of such exercises. Instead, individuals are also typically encouraged to reflect on their practice, utilising guided discovery. Thus, it is not possible within the current study to identify the value of guided discovery in developing one's skills in mindfulness. This could usefully be explored in further research.

The results from the ESM measure revealed that for this sample of high worriers' minds wandered frequently, on 58.82% of occasions. This is a higher rate than reported by previous studies with non-clinical populations such as Killingsworth and Gilbert (2010), Song and Wang (2012) and Poerio et al. (2013), who reported rates of 46.9%, 24.4% and 36.14% respectively.

As expected, the frequency of momentary mind wandering reduced over the course of the intervention, and in particular thoughts about the future. However, contrary to hypotheses 3 this reduction was not greater for those in the mindfulness conditions. This is also contrary to the finding regarding trait worry. It is possible that whilst capturing the frequency of worry, the momentary assessment of mind wandering was not sufficient for capturing other aspects of the construct considered within the trait worry measure, such as having a sense of control over worrisome thoughts. Thus, whilst the frequency of momentary worry may not have differed between groups other aspects, such as a sense of control, may have. Despite this, the findings do provide support for the use of attention and mindfulness based interventions in reducing the frequency of thought intrusions.

Levels of momentary anxiety and sadness associated with future orientated unpleasant were found to reduce over the course of the intervention, providing support for hypothesis 4. This reduction in anxiety and sadness did not, however, differ between the groups, suggesting that each condition was similarly effective at reducing momentary levels of anxiety and sadness. This finding is consistent with the standardised retrospective measures of anxiety and low mood, further validating the use of standardised measures for capturing change over time.

Caution should be taken when interpreting the findings in relation to a reduction in momentary mind wandering. As is typical with ESM research, a natural reduction in response rate occurred over the course of the study. Whilst no reduction of on task

thinking was observed over time, it nonetheless remains difficult to determine the extent to which the reduction in momentary mind wandering is independent of a reduction in overall response rate. This limitation could be overcome within future research by offering an incentive for providing a more consistent response rate across the study. For example by offering a higher monetary payment for providing a particular number of responses. A second limitation of the ESM element of the methodology was the use of fixed scheduling of the signals. This could have led to predictability of the signals, allowing for the potential of influencing participants' behaviour. This has been overcome in previous research with the use of randomised scheduling (Verhagen et al. 2016). Another limitation of the study was the method for monitoring frequency of practice. Participants' practice was monitored by their access to the web link via the study website. However, following the initial use of the link the exercise could be accessed directly (through their web history for example), bypassing the study website and making it difficult to quantify the amount of practice. This uncertainty on the frequency of practice could account for the absence of many group effects explored. Therefore, it would be beneficial for future research to overcome this limitation, for example by using a more integrated format, hosting the exercise directly on the study website. In addition to addressing the above limitations, future research could further explore the transdiagnostic effects of attention and acceptance-based mindfulness exercises on negative thought intrusions. Such as exploring whether the exercises have a differential effect on rumination where high levels are indicated.

2.5 Conclusion

In conclusion, this study explored the differential effects of acceptance-based and attention-based mindfulness exercises on worry in high worriers, utilising both standardised measures and experience sampling methodology. The findings provide evidence that acceptance-based, and to a lesser extent focussed attention-based mindfulness exercises can reduce trait worry and momentary mind wandering about the future events in high worriers. As such, the regular practice of the short exercises could usefully act as a component of an intervention targeting the transdiagnostic process of worry. Furthermore, both mindfulness exercises were found to reduce levels of anxiety and low mood, and increase levels of mindfulness, during the course of the intervention. However, the magnitude of change was similar to that of practicing progressive muscle relaxation. As no follow up assessment was conducted it was not possible to generalise these findings beyond the period of participation. It would be beneficial to determine the long-term effects of such exercise on worry within further research. Also, it would be clinically beneficial to explore the benefits of such exercises on related features of mind wandering, including rumination.

Appendices

Appendix A Additional Information for Chapter 2

A.1 Confirmation of ethics approval

[View all my research](#)

Evaluating the effects of mindfulness on daytime thoughts and worries (Amendment 1)

Submission ID: 24636

Submission Overview | IRGA Form | Attachments | History | Adverse Incident

Amendment History

[Latest Version](#)
[Version 2](#)
[Original Submission](#)

Current Status

✓ Approved
 Category B Research.
[Click here for more information on research categories](#)

Submission Checklist

IRGA Form ✓ Complete
 Ethics Form ✓ Attached
 Risk Form ✓ Attached

Comments

Amendments: Adding a recruitment poster (attached). This poster has the same content as the approved advert with the addition of a picture and rip off tabs containing the study web address. The poster will be placed around campus, including the library, and in the local community.

Co-ordinators

Matthew Garner
 Liam Williams

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Figure A1. Confirmation of ethics approval

A.2 Mean Response Rates for the MMWS

Table A1.

Mean frequency of responses at each time point, by group

	PMR (n=27)		FA (n=26)		Acc (n=22)	
	Mean	SD	Mean	SD	Mean	SD
Baseline	15.57	2.98	16.60	3.51	15.84	3.34
T1	12.19	2.70	13.00	2.97	12.68	3.30
T2	10.81	3.28	11.27	3.00	11.64	3.06
T3	9.70	3.34	10.27	4.90	10.86	3.81
T4	8.41	3.95	10.19	3.94	9.86	3.08
T5	10.67	3.15	9.77	4.30	9.91	3.29
T6	10.81	3.40	11.23	3.59	10.55	3.50

Note. SD = standard deviation

A.3 Mean Proportions of Future Orientated Unpleasant Mind Wandering

Table A2.

Mean anxiety and sadness ratings associated with future orientated unpleasant mind wandering, over time, by group.

		PMR (n=27)		FA (n=26)		Acc (n=22)	
		Mean	SD	Mean	SD	Mean	SD
Anxiety	Baseline	1.34	1.50	1.10	1.10	1.70	1.44
	T1	1.18	1.35	1.77	1.73	2.09	1.45
	T2	1.58	1.46	1.34	1.28	1.58	1.59
	T3	1.58	1.40	1.05	1.41	1.62	1.51
	T4	0.93	1.18	0.78	1.29	1.22	1.37
	T5	1.22	1.42	0.74	1.08	1.51	1.41
	T6	1.04	1.41	0.66	0.98	1.20	1.49
Sadness	Baseline	1.05	1.21	0.96	0.93	1.12	0.95
	T1	0.91	1.05	1.15	1.04	1.36	0.93
	T2	1.11	0.94	1.11	1.02	1.25	1.18
	T3	1.13	1.03	0.84	1.01	1.14	1.09
	T4	0.76	0.92	0.67	1.10	1.05	1.06
	T5	0.89	1.03	0.63	0.90	1.04	0.98
	T6	0.82	1.09	0.61	0.90	0.92	1.12

A.4 Mean Anxiety and Sadness Ratings for the MWWS

Table A3. Mean anxiety and sadness ratings associated with mind wandering, over time, by group.

		PMR (n=27)		FA (n=26)		Acc (n=22)	
		Mean	SD	Mean	SD	Mean	SD
Anxiety	Baseline	2.99	0.52	2.80	0.70	3.01	0.67
	T1	3.01	0.68	3.00	0.69	3.07	0.55
	T2	2.88	0.51	2.70	0.91	3.10	0.56
	T3	2.88	0.62	2.71	0.94	3.00	0.69
	T4	2.81	0.83	2.71	0.87	2.91	0.75
	T5	2.82	0.76	2.60	0.94	2.79	0.79
	T6	2.73	0.82	2.53	0.87	2.53	0.83
Sadness	Baseline	2.96	0.42	2.62	0.46	2.75	0.49
	T1	2.81	0.49	2.81	0.48	2.77	0.48
	T2	2.67	0.46	2.67	0.61	2.96	0.46
	T3	2.62	0.58	2.31	0.88	2.50	0.83
	T4	2.49	0.79	2.58	0.64	2.62	0.42
	T5	2.58	0.83	2.53	0.73	2.38	0.54
	T6	2.54	0.95	2.55	0.72	2.24	0.86

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