Content-free cueing as a technique to inhibit mind wandering and treat anhedonia in depression

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Thesis declaration form

I confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Signature:

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Date:

Overview

This thesis addresses the relationship between mind wandering and mood. Mind wandering is defined as a state of 'decoupled attention' removed from the immediate contexts towards unrelated thoughts and feelings (Smallwood & Schooler, 2006).

Part one is a literature review that investigates the association between mind wandering and mood. It examines whether mind wandering affects mood and vice versa, and how mind wandering relates to mood disorder. Overall the findings were inconsistent. Gaps in the literature are highlighted and suggestions for future research are discussed.

Part two consists of an empirical paper investigating if content-free cues in the form of auditory tones can reduce mind wandering and enhance mood. It furthermore examines if the beneficial effects of cuing are more pronounced in individuals with increasing depression severity. While cues led to a reduction in mind wandering in two laboratory tasks, this did not translate into pleasant every-day activities carried out at home. There was furthermore only weak support for the effects of cues on mood and contrary to predictions depression severity did not moderate the effects of cues. Limitations of the design and suggestion for further research are discussed along with clinical implications.

Part three is a critical appraisal which discusses the research designs, methods and testing and makes suggestions for future research. It closes with personal reflections on completing the thesis.

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Tables and Figures

Table of Abbreviations

CES-D = Centre for Epidemiological Studies Depression Inventory (Randolff, 1977)

DDFS = Daydreaming Frequency Scale (Giambra, 1993)

CBT = Cognitive Behavioural Therapy

CES-D = Centre for Epidemiological Studies Depression Inventory (Randolff, 1977)

DDFS = Daydreaming Frequency Scale (Giambra, 1993)

DSSQ = Dundee Stress State Questionnaire (Matthews et al., 1999)

IPI = Imaginal Processes Inventory (Singer, & Antrobus, 1972)

NART= National Adult Reading Test (Nelson, 1982)

PANAS = Positive Affect and Negative Affect Scale (Tellegen, Watson, & Clark,1988)

PHQ-4 = Patient Health Questionnaire 4 (Kroenke, Spitzer, Williams, & Löwe, 2009)

RT CV = reaction time variability

RT = reaction time

SART = Sustained Attention to Response Task (Robertson, Manly, Andrade, Baddeley, & Yiend, 1997)

SART errors = errors of commission during Sustained Attention to Response Task (Robertson et al., 1997); failure to withhold a response to rare targets used as a behavioural index of mind wandering

TRI = Task Related Inference (measured via Dundee Stress State Questionnaire, Matthews et al., 1999)

TUTs = Task Unrelated Thoughts (measured via Dundee Stress State Questionnaire, Matthews et al., 1999) used as an self-report measure of mind wandering

IQ = Intelligence Quotient

VAS = Visual Analogue Scale

SCID = Structured Clinical Interview for DSM-IV Axis I and II disorders (First, Spitzer, Gibbon & Williams, 2002)

Acknowledgements

Part 1: Literature Review

Is mood associated with mind wandering?

Abstract

Aims: Given the high prevalence of mind wandering in daily life and the notion that thought processes and emotions are related, this review aims to examine the relationship between mind wandering and mood. It posed the questions whether mind wandering affects mood and vice versa and if mind wandering is related to mood disorders.

Method: A systematic review of the PsychInfo, MedLine, Embase and Web of Science databases was completed to identify peer-reviewed studies measuring mood and mind wandering published up to March 2013. This led to 19 studies being included in the review.

Results: The papers employed heterogeneous methods and designs. With the majority of studies being correlational in nature, the causal nature and direction of the relationship between mood and mind wandering could not be established on the basis of the current literature. There was weak support showing that induced sad and anxious moods affects the frequency with which the mind wanders and that mind wandering might cause people to feel less happy. There was some evidence that low mood might be associated with more frequent mind wandering. However, none of the studies included a comparison between individuals with mood disorders and controls.

Conclusions: Further research is needed to confirm the findings above and establish the role of mind wandering in mood disorders.

Introduction

We have all experienced times when our minds have wandered. For example, we may have been reading a book only to notice that when we got to the end of a page, we do not remember anything of what we have just read. Indeed, research suggests that mind wandering forms a large part of our mental experience, with estimates that we spend as much as 50% of our waking hours engaged in thoughts that are removed from the here and now and unrelated to current external events (Killingsworth & Gilbert, 2010; Klinger, 1999).

Definition of mind wandering

Mind wandering refers to a thought process, in which attention is removed from the here and now. It is defined as a state of 'decoupled attention' away from an immediate context towards unrelated, internal processing (Smallwood & Schooler, 2006) and is often studied in relation to task engagement and performance. Mind wandering can involve both an undirected flow of thought that comes to mind uninvited and without any conscious effort, as well as deliberate thoughts about something other than the current sensory input or current task demands. A variety of terms have been used in the literature to describe mind wandering, such as 'stimulus independent thought' (Mason et al., 2007), 'task unrelated thought' (Smallwood & Schooler, 2006), 'spontaneous thought' (Christoff, 2012) and 'day dreaming' (Mar, Mason, & Litvack, 2012; Singer, 1966).

Though mind wandering is a complex human ability and research into its benefits suggests that it plays a beneficial role in future planning and creativity (Schooler et al. 2011; Smallwood & Schooler, 2006), the majority of research to date has focused on the costs of mind wandering, particularly its disruption of task performance. The detrimental effect of mind wandering has been found in a variety of contexts, including reading (Franklin, Smallwood, & Schooler, 2011; Reichle, Reineberg, & Schooler, 2010; Schooler, Reichle, & Halpern, 2005; Smallwood,

McSpadden, & Schooler, 2008; Smallwood, 2011; Smilek, Carriere, & Cheyne, 2010) and driving (He, Becic, Lee, & McCarley, 2011).

Link between different cognitive processes and mood

The notion that cognitions and emotions are linked has fascinated psychologists for a long time and after research initially focused on studying them separately, a huge amount of investigations and theories have been devoted to studying and explaining their interplay in the last 30 years (De Hower, & Hermans, 2010). Several constructs relating to mind wandering have been examined in this context.

Initial research focused on thought content, thus contrasting from mind wandering representing a thought process which does not specify thought content. Different types of repetitive thoughts, such as worry and negative thoughts have been found to have a detrimental effect on mood (for a review see Watkins, 2008). Rumination has been most frequently studied in relation to its impact on mood disorders. It is defined as repetitively thinking about the symptoms, causes and consequences of one's negative affect (Nolen-Hoeksema, 1991) and has been linked both to the onset and maintenance of anxiety and depression (Smith & Alloy, 2009). It is possible to think of mind wandering as a precursor to rumination, i.e. that when a depressed individuals' mind wanders for a moment, it might be more likely to get stuck in a specific, ruminative way of thinking, which in turn may contribute to low mood.

More recently, thought processes have received increased attention within third wave cognitive behavioural therapy (CBT), which extended their aims towards understanding and changing thought processes (Brown, Gaudiano, & Miller, 2011). Within third wave CBT, mindfulness can be seen as a construct most closely related to mind wandering. With its origin in Buddhism, there is currently no agreement upon how mindfulness is best operationalized (Grossman, & Van Dam, 2011). It is most commonly conceptualised as a multifactorial construct. For example, Kabat-Zinn

(1994) described mindfulness as awareness arising through "paying attention in a particular way: on purpose, in the present moment, and non-judgementally" and Bishop and colleagues (2004) defined it as consisting of self-regulation of attention and cultivating a specific orientation towards one's experience in the form of curiosity, experiential openness and acceptance. Self-regulation of attention involves both sustaining and switching attention as well as inhibiting elaborative processing.

In contrast to these multifactorial operationalization, other researchers focus almost exclusively on attentional aspects of mindfulness, defining it as sustained non-distraction (Brown, & Ryan, 2003; Dreyfus, 2011; Wallace, & Shapiro, 2006). Following this definition it has been suggested that mindfulness and mind wandering can be seen as opposing constructs (Mrazek, Smallwood, & Schooler, 2012). However, this can be criticised as mindfulness also includes awareness of one's emotional states.

Hypothesising on the mechanisms of action of mindfulness, Williams (2010) suggested that helping people to fully attend to the present moment adds vividness to experience and may enhance happiness and well-being directly. This implies that mind wandering may lead individuals to experience less positive emotions. In contrast to this, disengaging from the here and now and operating on 'auto-pilot', i.e. mind wandering, is considered a vulnerability and maintaining factor in depression (Williams, 2010).

A multitude of clinical interventions based on mindfulness have been linked to a reduction of psychological distress and emotional reactivity, improved behavioural regulation as well as increased subjective well-being (for a recent review, see Keng, Smoski, & Robins, 2011). Despite the variable ways of defining mindfulness, it is conceivable that preventing the mind from wandering is one of the mechanisms of action of mindfulness-based interventions (Baer, 2003) and could thus have positive effect on well-being.

Review questions

Considering the high prevalence of mind wandering and the relationship between related constructs, in the form of rumination and mindfulness with emotions, this paper aims to systematically review the link between mind wandering and mood. When referring to mood, this review focuses on both background mood (e.g. tides) as well as more transient mood states (e.g. waves). Both are constructed from subjective feelings, appraisals, action tendencies as well as bodily responses, which are all inter-dependent on each other (Kaiser & Scherer, 1997) and are measured via self-report.

Specifically, this paper aims to answer the following three questions:

(1) Does mood influence the frequency of mind wandering?

(2) Does mind wandering affect mood?

(3) Is mind wandering related to mood disorders?

Method

Inclusion criteria

Articles published in peer-reviewed journals in the English language up until and including March 2013 were selected if they included adult participants, aged 18 and above, as age has been suggested to impact on the frequency of mind wandering (McVay, Meier, Touron, & Kane, 2013). Studies further needed to measure mood states, traits or mood disorders and mind wandering either in daily life via (1) experience sampling or (2) questionnaires (the Daydreaming Frequency and the Mindwandering subscales of the Imaginal Process Inventory; Singer, & Antrobus, 1972) or in the laboratory via (3) behavioural indices (using the Sustained Attention to Response Task; Robertson, Manly, Andrade, Baddeley, & Yiend, 1997) or (4) self-reports of subjective experience (thought probes, self-caught mind wandering or the 'Thinking Content component' of the Dundee Stress State Questionnaire; Matthews et al. 1999). Both correlational and experimental designs were included.

Exclusion criteria

Mindfulness measures were excluded as it is a complicated construct, capturing multiple, diverse elements such as one's orientation towards thoughts, as well as awareness of physical sensations and emotions. Measures which mainly focus on sustained attention were excluded as these also include awareness of emotional states, and thus do not represent a pure measure of mind wandering. The Attention-Related Cognitive Errors Scale (Carriere, Cheyne, & Smilek, 2008) was also not included. While it captures frequency of mind wandering it only focus on cognitive errors resulting from mind wandering and not more subtle instances of mind wandering that do not lead to cognitive errors.

Search strategy

Studies were identified through a combination of database searches (PsychInfo, MedLine) and searches of reference lists of relevant papers. In order to identify synonyms and terms used for mind wandering, initial scoping searches were conducted using Google Scholar.

As a first step, a systematic search of PsychInfo database was conducted. As initial search strategies resulted in a vast amount of studies, the search was eventually limited to combined keyword searches for mind wandering and related terms (mind wandering OR wandering mind OR stimulus-independent thought OR task-unrelated thought OR daydreaming OR spontaneous thought) and mood (mood* OR emotion OR feeling OR affect* OR depression OR anxiety). Asterisks were used to indicate a wildcard. Both constructs were then combined using AND. In PsychInfo the above strategy resulted in 265 studies. The above searches were repeated using MedLine, Embase and Web of Science databases resulting in 67 additional papers. All search results were scanned by title in the first instance to identify only those papers that included mind wandering and mood. A full article search was performed on the remaining 36 papers. From this 11 studies were identified which met full inclusion

criteria. A further eight papers were identified through searching reference lists of included papers. Thus, overall 19 papers are included in this review. A summary of this process is illustrated in Figure 1.

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│    Full-text articles   │        │  Full-text articles excluded as │
│  assessed for eligibility│──────▶│   they focused exclusively on   │
│        (n =36)          │        │    thought content only or      │
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Figure 1: Flow chart illustrating study selection process

Results

Measures of mind wandering

Three studies used experience sampling, which involved prompting volunteers at random times of day to record if their minds were focused on their current activity or not (Kane et al., 2007; Killingsworth, & Gilbert, 2010; McVay, Kane, & Kwapil, 2009). Where mind wandering was identified, participants were typically required to indicate what types of thoughts their mind wandered to, possibly indicating the valence (pleasant, neutral or unpleasant) and content of their thoughts. The environmental and emotional context was recorded simultaneously. An advantage of this method is that it enables the experimenter to obtain multiple measurements during the daily routine and an assessment of contextual influences on experience, leading to good reliability and ecological validity (Kane et al., 2007). By measuring immediate experience retrospective bias is minimised. Employing a time lag analysis it is furthermore possible to investigate causal relationships. However, this analysis was only applied in one study (Killingsworth, & Gilbert, 2010). The limitation of this method is that mind wandering is only assessed over a limited, specified time period.

A further three studies used self-report questionnaire in daily life in the form of the Daydreaming Frequency Scale (DDFS), a subscales of the Imaginal Process Inventory (IPS; Singer, & Antrobus, 1972) (Cundiff, & Gold, 1979; Giambra, & Traynor, 1978; Stawarczyk, Majerus, Van der Linden, & D'Argembeau., 2012). Two of these also reported scores on the Mindwandering subscale of the IPS (Cundiff, & Gold, 1979; Giambra, & Traynor, 1978). In both questionnaires, items are rated on a five point Likert scale, varying in wording depending on the question. The DDFS contains 12 items. For example the item: "When I am at a meeting or show that is not very interesting, I daydream rather than pay attention" is rated from 1="never" to 5="always". The Mindwandering subscale has six items. An example item is: "Even when I am listening to an interesting speaker, my mind wanders". Other subscales

assessing thought content, e.g. guilt daydreams, and attitude towards them, e.g. acceptance of daydreams, were not included as they do not represent a measure of mind wandering.

An advantage of questionnaire measures is that they capture larger time periods and can be seen as an indicator of mind wandering generally. However, they are limited in that they rely on accurate memory of thought processes and due to limited meta-conciousness, instances of mind wandering may be missed (Schooler, 2002). While both questionnaires have face validity, their construct validity and reliability has not been examined systematically.

In the laboratory, the experimental Sustained Attention to Response Task (SART; Robertson et al., 1997) was used to obtain a behavioural index of mind wandering in nine studies (Deng, Li, & Tang., 2012, Farrin, Hull, Unwin, Wykes, & David, 2003; McVay et al., 2009; Marchetti, Koster, & De Raedt, 2012; Mrazek et al. 2012; Robinson, Krimsky., & Grillon, 2013; Smallwood et al., 2004a; Smallwood, Fitzgerald, Miles, & Phillips, 2009; Stawarczyk, Majerus, Van der Linden, & D'Argembeau, 2012). The SART is a Go/No-go task in which a sequence of stimuli (e.g. numbers 1-9) are presented on a computer screen and participants are instructed to respond by key press as quickly as possible to frequent non-targets, and to refrain from responding to rare targets (e.g. number 3). Due to the boring nature of the task, it is easy to get into a mindless state of responding, leading to frequent SART errors, even with short task duration.

In the literature four different performance measures of the SART have been used to measure mind wandering: SART errors (failure to withhold a response to rare targets), SART omissions (failure to respond to a non-target), SART anticipation (automatic, rapid responses to non-targets that occur too rapidly to be indicative of focused task performance) and reaction time variability (RT CV, i.e. standard deviation of RT for all correct responses divided by the mean RT for all correct responses). All four performance measures during the SART have been found to

correlate with each other, as well as with self-reported measures of mind wandering (Allan Cheyne, Solman, Carriere, & Smilek, 2009). However, there are conflicting views as to which measure constitutes the best indicator. Some researchers have focused on SART errors (e.g. Smallwood, O'Connor, Sudbery, & Obonsawin, 2007), whereas others argue that RT CV is the more accurate indicator, as it reflects subtle differences in RTs that are produced by lapsing attention (Seli, Cheyne, & Smilek, 2012).

Apart from the fast administration time, not having to rely on self-report constitutes a strength of this method. It has also been suggested that it is a more sensitive test of sustained attention than more traditional measures (Robertson et al., 1997). However, Helton and colleagues (Helton, 2009; Helton, Kern, & Walker, 2009; Helton, Weil, Middlemiss, & Sawers, 2010) argue that the SART does not represent a measure of sustained attention and therefore cannot be used to assess mind wandering. Instead they suggest it is a measure of impulsivity and response strategy, i.e. balancing the benefits of speed of responding as opposed to accuracy.

Another way mind wandering is measured in the laboratory either on its own or in conjunction with the behavioural measure is via self-report. Thought probes involved disrupting participant's while performing a task to report if their minds were wandering. This method was employed in nine studies (Burg & Michalak, 2011; Deng et al., 2012; Marchetti et al., 2012; Mrazek et al., 2011; Mrazek et al., 2012; Seibert, & Ellis, 1991; Smallwood et al., 2007; Stawarczk, 2012; Watts & Sharrock, 1985). An advantage of thought probes are that they do not rely on memory and that both mind wandering with and without awareness is captured and can be differentiated. Its limitations are that performance is disrupted and cannot be studied over time.

Five studies furthermore used the 'Thinking Content' component of the Dundee Stress State Questionnaire (DSSQ; Matthews, et al. 1999) after a laboratory task to measure the frequency of mind wandering (Mrazek et al. 2011; Smallwood et al., 2004a; Smallwood et al. 2005; Smallwood, et al., 2009; Stawarczyk et al., 2012).

However, due to unsatisfactory psychometric properties Stawarczyk et al. (2012) did not include this measure in further analyses. The DSSQ differentiates between task engagement and task disengagement. Task engagement is referred to as Task Related Interference (TRI), consisting of attention directed towards task completion or appraisal of one's performance. Task disengagement, operationalized as Task Unrelated Thought (TUT) refers to attention that is drawn away from what one is doing and thus represents a measure of mind wandering (Smallwood et al., 2009). There are eight items measuring TUTs, e.g. "I thought about something that happened earlier today.", which are rated on a five-point Likert scale with 1 = "never" and 5 = "very often". Once more limitations of the DSSQ is that it relies on accurate memory of thought processes and does not capture instances of mind wandering occurring without conscious awareness (Schooler, 2002). One could also argue that some TRI also represents instances of mind wandering, e.g. thoughts appraising one's performance.

Lastly, three studies used thought catching procedures, asking participants to indicate when they notice that their minds were wandering, e.g. by pushing a button (Burg, & Michalak, 2011; Mrazek et al., 2012; Watts, & Sharrock, 1985). While an advantage of this method is that it does not rely on memory, in common with questionnaires, this method is not able to measure mind wandering without awareness. It furthermore relies on peoples abilities to monitor their thinking processes online (Schooler et al., 2005).

In summary, studies identified in this review used a diverse range of methods to capture mind wandering in daily live and in a controlled laboratory context. While each method has both advantages and disadvantages, it is of note that different instances of mind wandering are recorded. Thought probes used in experience sampling and in the laboratory measure both mind wandering with and without awareness, while thought catching procedures and questionnaire measure only capture instances individuals are aware of.

Associations between mind wandering and mood

The majority of studies identified were correlational, i.e. measuring mind wandering and mood at the same time and hence causality cannot be established. However, as they indicate whether the constructs might be related they were reported here. Overall 11 studies looked at a correlation between mind wandering and mood. They are summarised in Table 1.

Firstly, Giambra and Traynor (1978) employed questionnaire measures to look at the relationship between mind wandering and low mood in a mixed sample of students and inmates. They assessed mind wandering via the DDFS and Mindwandering subscales of the IPI (Singer, & Antrobus, 1972) and found a positive correlation between more frequent mind wandering and higher scores on three depression scales: the Beck Depression Inventory (BDI; Beck & Beamesderfer, 1974), the Zung Self-Rating Depression Scale (Zung, 1973) and the Depression Adjective Check Lists (Lubin, 1967). However, Cundiff and Gold (1979) using the same questionnaires to assess mind wandering in a student sample did not find a positive correlation with the BDI. A weakness of their study is that they do not specify the distribution of the depressive symptoms in their sample, which might account for the lack of association. As discussed above a limitation of using retrospective questionnaires of mind wandering is that due to memory difficulties as well as difficulties in noticing mind wandering in the first place, instances might be missed.

Two studies by Smallwood and colleagues (Smallwood et al. 2004a; Smallwood et al., 2005) assessed mind wandering via retrospective self-report (TUTs from DSSQ) after completing the SART or a word fragment completion task in a student sample. Mood was measured using the Centre for Epidemiological Studies Depression Inventory (CES-D, Radloff, 1977), which is a 20-item self-report scale designed to measure depressive symptoms over the past week in a non-clinical population. Both studies found a positive correlation between more frequent self-reported mind wandering and higher scores on the CES-D, suggesting that there is a

link between the subjectively experienced frequency of mind wandering in laboratory task and low mood in a student sample. A limitation of the studies is that while SART errors and reaction time were measured during the SART, relationships between these behavioural indices of mind wandering and CES-D was not discussed. Again, retrospective reports might be biased due to limited meta-consciousness.

Another four studies, which also used the SART, assessed mind wandering via online thought probes as opposed to a retrospective questionnaire. A strength of the first study (Deng et al., 2012) was that it differentiated between mind wandering with and without awareness. The researchers used thought probes asking participants to indicate if their thoughts were off task and whether they had been aware that they had not paid attention to the task. They also reported SART errors as a behavioural measure of mind wandering. While BDI scores (Beck, & Beamesderfer, 1974) were not correlated with either SART errors or mind wandering with awareness, a positive correlation between higher BDI scores and more frequent mind wandering without awareness was identified. This suggests that the relationship between low mood and mind wandering might be due to a lack of consciousness that one is not focusing on the present moment as opposed to a conscious drift towards other thoughts. Limitations of the study include the small number of participants (N=23) and that the occurrence of mind wandering without awareness was low and might not be sufficiently sensitive.

Employing a similar procedure in their second experiment, Stawarczyk et al. (2012) used the SART with thought probes containing four options to indicate thought processes: on-task reports, task-related interference (e.g. thoughts about task duration), external distractions and mind wandering (thoughts unrelated to the task). In their population sample, they did not find a correlation between probe-caught mind wandering during the SART and either depression (CES-D) or anxiety (BAI; Beck Anxiety Inventory, Beck, Steer, & Carbin, 1988) symptoms over the past week. The researchers also assessed mind wandering in daily life with the Daydreaming

Frequency Scale (DDFS, Singer, & Antrobus, 1972) and found a correlation of this scale with self-reported mind wandering during the SART. In contrast to their findings in the laboratory, mind wandering in daily life (measured via DDFS) correlated with negative mood over the past week, assessed in various ways in all three experiments of this study (the PANAS trait negative affect in the first, the CES-D and BAI in the second and PHQ-4 in their third experiment). However, the researchers argued that the association between negative mood and mind wandering might not be due to mind wandering *per se*, but due to being less mindful and attentive to the present-moment.

The final study (Marchetti et al., 2012) using thought probes during the SART measured mind wandering by asking participants to rate to what extend their minds were wandering on a 7-point Likert scale ranging from 1= "on task" to 7="off task" and which valence their thoughts were, rated on the same scale, with 1= "extremely negative" and 7= "extremely positive". Here no correlation between either SART errors or thought probes and BDI-II scores was found. Limitations of the study include that overall scores on the BDI-II were low (mean=8.91 and SD=5.95) and the usefulness of assessing mind wandering on a continuous scale is questionable.

In contrast to trait measures of mood discussed above, Mrazek and colleagues (2012) looked at the association between mind wandering and mood state using two tasks. In the SART, behavioural indices of mind wandering in terms of SART errors and reaction time variability (RT CV) were measured, while in a 10-minute mindful breathing task, either thought probes or a self-catching version was used. Both tasks were administered in a counterbalanced order and mood state was assessed after the tasks with the Positive and Negative Affect Schedule (PANAS; Tellegen, Watson, & Clark, 1988). The PANAS consists of words describing different feelings such as "upset" and "nervous" for negative affect and "interested" and "strong" for positive affect, which are rated on a 5-point Likert scale from 1="very slightly or not at all" to 5="extremely". Instructions were given to indicate how they felt 'now'. Negative affect was found to correlate with errors on the SART, but not with RT CV or any of the mind

wandering measures during the breathing exercise. A limitation of the study is that the PANAS does not differentiate between sad and anxious mood. As mood state was measured after the tasks, and as participants completing the SART are commonly aware of how many errors they made during the task, the relationship between negative affect and SART errors might be due to appraisal of their task performance as opposed to mind wandering.

Another laboratory study explored the link between mind wandering and mood during an 18-minute mindful breathing exercise within a student sample without prior experience in this practice (Burg & Michalak, 2011). After the meaning of mindfulness and meditation was explained, participants initially practiced staying in contact with their breathing. Mind wandering was assessed both via thought probes, by asking if their minds were focused on their breathing or if their minds had been wandering, and thought catching. The latter required participants to press a button whenever they noticed that were lost in thoughts and no longer attended to their breathing. Using probes, the researchers found a correlation between mind wandering and higher symptoms of depressed mood in the previous week, measured by CES-D. No such correlation was found with the thought catching method. It is possible that participants who are more aware of their thought processes are more able to catch their own off task thoughts and individuals with low mood might lack this ability.

Further bridging the gap between laboratory studies and every-day occurrences of mind wandering, McVay and colleagues (2009) employed experience sampling to measure mind wandering in daily life, which involved asking participants to record on personal digital assistant (PDA) eight times a day during a 90 minutes block over a seven-day period whether their minds were wandering and how they were feeling at the time. The researchers found that higher rates of mind wandering in the laboratory during the SART measured via thought probes correlated with the frequency of mind wandering in daily life measured by the experience sampling methodology. However, SART errors did not show any relationship with day-to-day

mind wandering. This suggests that thought probes might represent a more accurate measure of mind wandering. Exploring the link between mood state and mind wandering in daily life they identified a positive association between greater levels of mind wandering and feeling more tired, stressed or bored and a negative association between mind wandering and feeling happy. Thus participants felt happier if their minds were not wandering. This finding represented a replication of an earlier study by the same research group using the same experience sampling procedure (Kane et al., 2007). A criticism of both studies is that they did not employ time lagged analysis to test hypothesis regarding a causal relationship between mood and mind wandering.

In summary, findings varied depending on which methods were employed to measure mind wandering. Firstly, measuring mind wandering via retrospective questionnaires during a laboratory task and questionnaires of daily life occurrences of mind wandering showed that more frequent mind wandering was associated with lower mood in all but one study. A limitation of this method is that it relies on memory and meta-consciousness and may thus miss instances of mind wandering. Secondly, none of the studies identified a correlation between behavioural indexes of mind wandering (SART errors) and low or anxious mood over the previous week/s. Using thought probes during laboratory tasks mixed results were found. One study identified a correlation between thought probe mind wandering and low mood during a mindful breathing exercise and another between low mood and mind wandering without awareness during the SART, while two studies found no association between the two constructs during the SART. Lastly the two studies examining mind wandering in daily life using experience sampling procedure both found that greater levels of mind wandering were associated with feeling tired, stressed, bored and less happy. It is of note that apart from not being able to indicate a causal relationship between two constructs another weakness of correlational studies is that other confounding variables might be responsible for any association identified.

Table 1: Correlations between mood and mind wandering

Authors	N (N =f)	Design	Task	Mind Wandering Measures	Mood Measures	Main findings
Burg & Michalak (2011)	45 (35) students in Germany, mean age= 24.0	Cor-relation	Mindful-Breathing Exercise	Thought probes if attending to breath or mind wandering Thought catching	CES-D	Thought probe mind wandering correlated with CES-D. Self-caught mind wandering did not correlate with CES-D.
Cundiff, & Gold (1979)	100 (100) students in USA, mean age nk	Cor-relation	None	DDFS and Mindwandering subscale of IPI	BDI	Positive, but no significant correlation between mind wandering and BDI.
Deng et al. (2012)	23 (11) students in China; mean age= 21.9	Cor-relation	SART	Thought probes: on task, mind wandering with and without awareness SART errors	BDI	SART errors and mind wandering with awareness did not correlate with BDI. Mind wandering without awareness correlated with BDI
Giambra, & Traynor (1978)	91 (37) students 29 (0) inmates in correctional institution in USA; mean age nk	Cor-relation	None	DDFS and Mindwandering subscale of IPI	BDI, Self-Rating Depression Scale, Depression Adjective Check Lists	Mind wandering, measured via both scales correlated with all three measures of depression.
Kane et al. (2007)	124 (88) students in USA; mean age=19.34	Cor-relation	Daily activities	Experience sampling over 7 days using probes to complete questionnaires measuring mind wandering, thought content and mental and environmental context	Self-report ratings: I feel happy (anxious, bored) right now. What I am doing right now is boring (stressful).	More self-reported mind wandering in daily life associated with feeling more tired, stressed and bored and less happy.
Marchetti, et al. (2012)	80 (61) students in Holland; mean age = 20.3	Cor-relation and repeated measure design	SART	Thought probes: on and off task in continuous way and valence of thoughts SART errors	BDI-II	BDI-II did not correlate with either SART errors, mind wandering assessed via thought probes or valence of cognitions during thought probes.
Mrazek et al. (2012)	Study 1: 117 (84) students in USA, mean age= 19	Cor-relation	SART and mindful breathing exercise	SART errors, RT CV Thought probes, or thought catching during mindful breathing;	PANAS	SART errors correlated with PANAS negative affect measured after task

nk=not known; RT CV = reaction time variability, BDI= Beck Depression Inventory (Beck & Beamesderfer, 1974); BDI-II = Beck Depression Inventory – 2nd edition (Beck, Steer, & Brown, 1996); CES-D= Centre for Epidemiological Studies Depression Inventory (Randolff, 1977); DDFS = Daydreaming Frequency Scale (Giambra, 1993); IPI= Imaginal Processes Inventory (Singer, & Antrobus, 1972); PANAS = Positive Affect and Negative Affect Scale (Tellegen et al.1988) ; SART= Sustained Attention to Response Task (Robertson et al., 1997)

Table 1 (continued): Correlations between mood and mind wandering

Authors	N (N =f)	Design	Task	Mind Wandering Measures	Mood Measures	Main findings
McVay et al. (2009)	244 (nk) for SART 72 (nk) experience sample, students in USA, mean age nk	Cor-relation	SART and daily activities	SART errors, SART RT and thought probes Experience sampling over 7 days using probes to complete questionnaires measuring mind wandering, thought content and mental and environmental context	Mood state: Self-report ratings: 'I feel happy right now.' 'I feel anxious right now.' 'What I am doing right now is boring.' 'I feel tired right now.' 'What I am doing right now is stressful.'	Neither SART errors nor SART RT variability correlated with daily-life mind wandering Higher laboratory thought probe mind wandering during SART correlated with higher mind wandering frequency in daily life. More self-reported mind wandering in daily life when feeling tired, stressed or bored and less mind wandering when feeling happy.
Smallwood, et al. (2004a)	75 (50); students in UK mean age nk	Cor-relation	SART	Retrospective self- report: TUTs	CES-D	TUTs correlated with CES-D
Smallwood et al. (2005)	98 (86) students in UK, mean age=20	Cor-relation	Word fragment completion task	Retrospective self- report: TUTs	CES-D	TUTs correlated with CES-D
Stawarczyk et al. (2012)	Study 1a: 100 (48) 1b: 164 (110) 2: 100 (77) general population in Belgium, mean age approx. 28	Cor-relation	1a: none 1b: SART 2: none	1a: French version of DDFS 1b: DDFS and thought probes during SART: on task, task-related inferences external distractions, mind wandering 2: DDFS	1a: PANAS positive and negative affect trait questionnaire 1b: CES-D, Beck Anxiety inventory (BAI) 2: PHQ-4	1a: DDFS correlated with PANAS negative affect but not positive affect 1b: Mind wandering during the SART did not correlate with CES-D or BAI SART probes mind wandering correlated with everyday mind wandering (DDFS), DDFS correlated with both CES-D and BAI 2: DDFS correlated with PHQ-4

nk=not known; RT= reaction time, BAI= Beck Anxiety Inventory (Beck et al., 1988); CES-D= Centre for Epidemiological Studies Depression Inventory (Randolff, 1977); DDFS = Daydreaming Frequency Scale (Giambra, 1993); IPI= Imaginal Processes Inventory (Singer, & Antrobus, 1972); PANAS = Positive Affect and Negative Affect Scale (Tellegen et al.,1988); PHQ-4 = Patient Health Questionnaire 4 (Kroenke et al., 2009); SART= Sustained Attention to Response Task (Robertson et al., 1997); TUTs= Task Unrelated Thoughts (measured via Dundee Stress State Questionnaire, Matthews et al., 1999)

Does mood influence the frequency of mind wandering?

The studies reviewed above suggest a correlation between mind wandering and mood. The second step was to identify research suggesting a directional relationship between the two constructs. Four studies were identified that manipulated participant's mood, testing if mood states affect the frequency with which the mind wanders. They are summarised in Table 2. The studies used a variety of mood induction procedures to compare the effects of neutral, positive and negative (sad and anxious) mood states on mind wandering.

The first study by Smallwood and colleagues (2009) employed a between groups design. Videos were presented to induce neutral, negative and positive mood and the PANAS (Tellegen et al., 1988) was used to confirm that the mood induction was successful. The video clip for the negative mood induction consisted of showing a seriously ill dog, suggesting that the induction had induced sad as opposed to anxious mood. Immediately following the mood induction, participants completed the SART. No differences in SART errors in either the negative compared to the neutral condition or in the positive compared to the neutral condition were identified. However, an increase in mind wandering assessed via SART errors was found in the negative condition as opposed to the positive condition. This difference was also identified using retrospective self-report of mind wandering. Participants reported more frequent mind wandering in the negative compared to the positive condition. As there was only an increase in mind wandering in the negative condition compared to the positive and not to the neutral condition it is possible that there was only a small increase in mind wandering due to negative mood while positive mood potentially decreased mind wandering.

Another study employing between groups design compared the effect of induced mood on mind wandering during a memory task involving recalling a random string of letters (Seibert, & Ellis, 1991). Happy, neutral and sad mood states were

induced by presenting 25 self-referent statements and mind wandering was measured either retrospectively by asking participants to write down their thoughts or online by asking participants to say out loud what they were thinking, regardless of whether thoughts related to the task or not. Thoughts were then rated by participants to indicate if they were task-related or irrelevant, i.e. represented mind wandering. That the mood induction was successful was confirmed as more sad adjectives were endorsed in the sad condition and more happy ones in the happy condition using the Depressive Adjective Checklist (Lubin, 1967). The study found that participants reported more frequent mind wandering in the happy and sad condition compared to the neutral condition using both online and retrospective reports of mind wandering. Recall was furthermore superior in the neutral as opposed to the sad and happy condition. A limitation of this study was the small number of participants per condition (n=15).

Two additional studies looked at the impact of induced anxiety on performance and mind wandering. The first study (Mrazek et al., 2011) looked at the effect of stereotype threat in female volunteers using a between group design. Anxiety was induced by telling women that the research was conducted into the reasons why men outperform women in maths before taking a maths test (experiment 2). The control condition included the same maths test, which was labelled as a problem solving exercise and gender was not recorded. Mind wandering was assessed using thought probes as well as a retrospective questionnaire (TUTs of DSSQ). Participants in the threat condition reported higher levels of anxiety assessed by rating five adjectives (anxious, agitated, uneasy, nervous and worried) on a 9-point Likert scale ranging from 1="not at all" to 9="very strongly". The study found that higher levels of anxiety were associated with more frequent mind wandering measured via thought probes but not the retrospective questionnaire. However, as anxiety was only measured after the task, it is not clear if increased anxiety caused mind wandering or if the poorer

performance on the math test under the threat condition led to higher anxiety levels reported. It is of note that another study using the same procedure to induce stereotype threat failed to show increased anxiety ratings when employing a more reliable scale, the State-Trait Anxiety Inventory (STAI; Spielberer, Gorsuch, & Lushene, 1970; Beilock, Rydell, & McConnell, 2007).

The second study investigating the impact of induced anxiety was by Robinson and colleagues (2013) and compared performance on the SART under threat of unpredictable electrical shocks versus a safe condition. In contrast to the previous study they employed a repeated measures design, where each participant acted as their own control. The mood induction was successful, as higher levels of anxiety measured retrospectively on a 10-point scale ranging from 1="not at all anxious" to 10="extremely anxious" were found in the threat condition. Both behavioural indices (increased SART errors) and thought probes after each of the eight blocks of the SART showed that mind wandering was less frequent in the threat as opposed to the safe condition. Therefore this study indicated that the threat of shocks decreased mind wandering. The authors propose this might be due increased response inhibition under threat.

Overall it is not possible to draw any clear conclusions, because there were few studies using a range of different mood states and methodologies. One might tentatively conclude that sad mood might lead to more frequent mind wandering. However, this was found once in comparison to happy mood and not neutral mood and once in comparison to neutral but not happy mood. The effect of anxiety was in opposing directions; when anxiety was induced with stereotype threat, mind wandering was increased whereas the threat of an electric shock led to a reduction of mind wandering.

Table 2: Impact of induced mood on mind wandering

Authors	N (N =female)	Task	Design	Mind Wandering Measures	Mood Measures	Main findings
Mrazek, et al. (2011)	Study 2: 72 (72) students in USA, mean age not known	Math test	Between groups design: performance under stereotype threat versus safe condition	Thought probes during maths test degree to which mind wandered and retrospective questionnaire: Thinking Content Component of DSSQ	Retrospective self-rating scale of 5 adjectives related to anxiety	Higher levels of anxiety in stereotype thereat condition led to impaired performance and more frequent mind wandering measured via thought probes No effects of anxiety on retrospectively reported mind wandering
Robinson, et al. (2013)	22 (11) healthy volunteers in USA; mean age 27	SART	Repeated measures: safe versus threat of electric shock condition	SART error SART RT Retrospective self-report: on task, off task thinking	Retrospective rating of anxiety level on VAS with 1="not anxious at all", 10=" extremely anxious"	Higher levels of anxiety in threat condition led to reduced mind wandering in form of less SART errors and less retrospectively self-reported mind wandering, but no effect on SART RT
Seibert, & Ellis (1991)	45 students in USA (15 per condition), mean age not known	Recall of random letter stings	Between groups design: induced happy, neutral and sad mood	Thought recording Study 1: writing down thoughts after recall task Study 2: concurrent think aloud	Depressive Adjective Checklist to gain continuum measurement of mood states	Participants in the happy and sad condition reported higher proportion of mind wandering instances than in the neutral condition and recalled less strings than the neutral group.
Smallwood, et al. (2009)	59 (34) students in UK; mean age=21.7	SART	Between group: induced neutral, negative and positive mood	SART errors, SART RT retrospective questionnaire: Thinking Content Component of DSSQ	PANAS pre and post induction	Negative mood led to more frequent mind wandering as measured via SART errors and retrospective self-report compared to positive mood but not in comparison to neutral mood.

DSSQ= Dundee Stress State Questionnaire (Matthews et al., 1999); PANAS = Positive Affect and Negative Affect Scale (Tellegen et al., 1988); RT= Reaction time; SART= Sustained Attention to Response Task (Robertson et al., 1997); VAS = Visual Analogue Scale

Does mind wandering affect mood?

While there are several ways of inducing different moods, it is considerably more difficult to manipulate mind wandering in order to test if mind wandering affects mood. Indeed for this review only one study was identified investigating the effect of mind wandering on mood states. Killingsworth and Gilbert (2010) employed an experience sampling procedure and used a time-lag analysis to show that mind wandering might lead people to feel less happy. A convenience sample of 2250 adults (58.8% male, 73.9% residing in the United States, mean age of 34 years) participated in the research by answering questions via an iPhone application. Participants reported how they were feeling, whether their mind was wandering and what activity they were engaged in. Mood was assessed by having participants rate how they felt at the moment on a Visual Analogue Scale ranging from 0= "very bad" to 100= "very good". Mind wandering was assessed by asking participants whether they were thinking about what they were currently doing or not. If they reported mind wandering they were asked if their thoughts had wandered to something neutral, pleasant or unpleasant. Lastly, they could choose from 22 activities to best describe what they were doing. The results indicated that the nature of the activity in which people were engaged had only a minor impact on the frequency of mind wandering and no impact on the pleasantness of the topics to which their minds wandered. Multiple regression analysis showed that participants were less happy, irrespective of the activity they were engaged in, when their minds were wandering. Participants were furthermore not any happier when their minds wandered towards pleasant thoughts as opposed to when their thoughts were focusing on the current activity, and they reported feeling unhappier when their minds wandered towards neutral or unhappy thoughts. In other words, mind wandering at time t – 1 predicted lower happiness ratings at time t, while happiness at time t was not related to mind wandering at time t + 1. The authors thus

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concluded that mind wandering caused unhappiness. A weakness of the study is that they did not report a time period of testing, nor how many prompts were presented per day. They furthermore did not examine the link between more enduring low mood, such as depression and the frequency of mind wandering.

Is mind wandering related to mood disorders?

As only one study with participants meeting criteria for mood disorder was identified, it was decided to include sub-clinical reports of depression in this section. Overall three studies looked at the association between mind wandering and depressed/ dysphoric mood. These are summarised in Table 3.

Watts and Sharrock (1985) were interested in concentration problems in depressed individuals, classified via the Levine-Pilowsky Depression Questionnaire (Pilowsky, & Spalding, 1972). Recruiting from psychiatric hospitals they examined mind wandering during a ten-minute reading task. Participants were instructed to indicate when they 'lost it' and were then asked if their minds had been wandering to other thoughts (mind wandering) or not (going blank). While there was a positive correlation between increased depression severity and more frequent mind wandering, it did not reach statistical significance. As discussed above a limitation of assessing mind wandering via self-caught procedures is that instances of mind wandering the person is not aware of are missed. As the study did not include a non-depressed group no comparison between mind wandering in depressed versus non-depressed individuals was made.

Smallwood et al.'s study (2007) investigated whether dysphoria was associated with greater frequency of mind wandering during a word recall task. Dysphoria was measured with the CES-D and after a median split, scores of 31 or below were classified as low dysphoria and scores of 32 or above as high dysphoria. It is of note, that previous research suggested scores of 40 or above was indicative of clinical depression (Field, Diago, & Sanders, 2001). In their task, participants were

instructed to either study and remember or shadow words, not to be recalled later. The words were taken from the ANEW word norms (Bradley, & Lang, 1999) and presented in 20 blocks with 12 +/- 2 words each. Mind wandering was assessed after each block via thought probes, prompting participants to indicate exactly what was going through their minds. Two independent judges, blind as to the dysphonia group, later classified these to be either task-related or off-task, i.e. mind wandering. Retrieval was assessed using word fragment completion. Participants were instructed to complete words presented during the study phase but not new words or words presented during the shadow phase. The study found that mind wandering was more frequent in the high dysphoria group in comparison to the low dysphoria group under the instruction to recall words but not in the shadow condition. While no difference in recall was identified between dysphoric and non-dysphoric participants, mind wandering itself was associated with impaired retrieval under the instruction to remember words. The study also used physiological measures previously associated with mind wandering and found that the dysphoric groups' heart rate was faster when they reported that their minds were wandering while no difference in skin conductance response was observed. Overall this study suggests that a higher frequency in mind wandering when studying words is associated with dysphoric mood. As this study did not involve a manipulation of either mood or mind wandering it is not possible to draw any causal interference.

Farrin et al. (2003) aimed to compare effects of depressed mood on a variety of attention measures in military personnel. They included the SART and reported SART errors and reaction time (RT) representing behavioural indices of mind wandering. Depression was assessed via the BDI (Beck, & Steer, 1993) with a score of 10 as the cut-off point for mild depression. They found that participants in the depressed group made more errors in the SART while no difference in RT was identified. Further examining patters of responding during the SART a general

tendency was observed to speed up RTs leading up to an error as opposed to leading to correctly withholding responses to rare targets. This tendency was only significant in the depressed group. They also found a post errors slowing of RT in the depressed group, leading the researchers to hypothesise that depressed participants interpret their errors in a very negative way leading to more disruption and a heightened sense of subjective effort. Overall, this study suggests that dysphoria might be associated with more frequent mind wandering. However, once again it is not possible to draw any causal conclusions. It has furthermore been suggested that the cut off point for depression in the BDI should be set at 12 (Kendall et al., 1987).

In summary the three studies with depressed/ dysphoric participants all assessed mind wandering in the laboratory context employing heterogeneous methods. Two studies contrasting dysphoric from a control group found an association between more frequent mind wandering during a recall task in dysphoric individuals assessed via thought probes and during the SART measured via SART errors but not RT. Another study that only included depressed individuals found that while depression severity positively correlated with more frequent mind wandering during a reading task using thought catching procedure, this did not reach statistical significance. All studies were correlational and it is therefore possible that other variables account for the relationship between mind wandering and mood disorders and no conclusion can be drawn regarding possible causal relationships.

Table 3: Mind wandering and mood disorders

Authors	N (N =female)	Task(s)	Design	Mind Wandering Measures	Mood Measures	Main findings
Watts, & Sharrock (1985)	31 (7) depressed	Reading	Correlational	Thought catching self-report while reading for 10 minutes Questionnaire about concentration problems while reading and how much due to mind wandering	Levine-Pilowsky depression questionnaire Spielberger Anxiety Questionnaire, State form	Positive correlation between either thought caught mind wandering and depression severity, however this was not statistically significant
Farrin et al. (2003)	102 (0) military personnel; mean age= 35.8	SART	Between groups, mildly depressed (43) versus non depressed (59)	SART errors and reaction times (RT)	BDI (mild depression > 10)	SART errors correlated with BDI . Both groups (depressed and non-depressed) speeded up RT leading up to error but only sign in depressed group.
Smallwood et al. (2007)	37 (26) university students; mean age= 25.6	Retrieval of words in encode or shadow condition	Between group comparison high and low CES-D	Verbal thought probe during task later coded as on or off task, Skin conductance response and average heart beats	CES-D (high dysphoria mean = 39.8; low dysphoria mean = 25.8)	Dysphoria associated with more accessible mind wandering when encoding verbal items but not when shadowing dysphoria associated with greater heart rate when mind wandering in the encoding condition

BDI = Beck Depression Inventory (Beck, & Steer, 1993); CES-D = Centre for Epidemiological Studies Depression Inventory (Randolff, 1977); SART = Sustained Attention to Response Task (Robertson et al., 1997)

Discussion

As mind wandering is very frequent and related to concepts which have been linked to mood, such as rumination and mindfulness, this review aimed to establish whether there is a relationship between mind wandering and mood. It examined (1) if mood influences the frequency with which the mind wanders; (2) if mind wandering affects mood; and (3) whether mind wandering is related to mood disorders.

Overall, the standard of the literature was poor and mainly correlational in design, thus only tentative conclusions can be drawn. The 19 studies identified employed heterogeneous designs, which capture slightly different aspects of mind wandering. While thought probes measure both mind wandering with and without awareness, self-catching methods and questionnaires assess only mind wandering with awareness and rely both on meta-awareness and memory. Correlational studies indicated that low mood and mind wandering might be related. There was furthermore weak support that current mood states such as sadness and anxiety can influence the frequency of mind wandering in the laboratory. Due to challenges of manipulating mind wandering experimentally only one study examined if mind wandering affects mood using experience sampling procedures and conducting a time lag analysis (Killingsworth & Gilbert, 2010). While findings suggested that mind wandering might lead people to feel less happy this needs to be replicated in other studies before drawing any clear conclusions. There is furthermore some initial evidence that mind wandering might be related to dysphoria. However, none of the studies compared a clinical sample of depressed people with a healthy control group.

Limitation of studies

Limitations of the studies included that participants were mainly students, who might not be representative of the general population. For example, there have been suggestions that working memory capacities and age are associated with mind

wandering (Mrazek et al., 2012; McVay et al., 2013). The samples furthermore consisted mostly of healthy volunteers with a limited range of mood difficulties. The reliability of several brief screening instruments of depressed mood, such as the CES-D, as well as that of mind wandering questionnaires is a further limitation (Zich, Attkisson, & Greenfield, 1990). Additionally, most studies were conducted in the laboratory. While this has the potential to give greater experimental control, the ecological validity of such approaches can be questioned. While two studies found that mind wandering measured via thought probes correlated with mind wandering in daily life using experience sampling (McVay, et al., 2009) and a questionnaire measure of mind wandering (Stawarcyk, 2012) further research is necessary to establish how mind wandering in the laboratory generalises to other contexts.

Future research directions

To gain a better understanding of whether there is indeed a reciprocal role of mood and mind wandering and how mind wandering relates to mood disorders further research is needed. Studies should compare samples who meet diagnostic criteria of mood disorders with healthy controls, ideally without a history of the disorder, as residual symptoms are common in individuals who experienced depression in the past (Kennedy, & Paykel, 2004). Alternatively, studies could compare participants with long experience in mindfulness mediation versus those without, or use a repeated measures design testing pre and post mindfulness based therapy to establish if mind wandering is reduced though mindfulness interventions. Here one needs to take into account that increased self-reports of mind wandering might represent an increase in awareness as opposed to an actual increase in occurrence (Stawarczyk et al., 2012).

Secondly, mind wandering should be measured via thought probes and mind wandering with and without awareness should be differentiated, as mindfulness interventions aim to both increase meta-awareness (ability to notice mind wandering) and returning attention to the present moment (Bishop et al., 2004). Establishing

whether the relationship between mind wandering with or without awareness and mood differs will help to determine if more attention should be paid to increase meta-awareness or to help people return their attention to the present moment. It is furthermore possible that with increased awareness of mind wandering, individuals might learn to respond in a more helpful way, which might in turn reduce the negative impact of mind wandering (Stawarczyk et al., 2012).

Thirdly, there is a need for controlled laboratory studies manipulating both mood and mind wandering to establish a directional relationship. While there are several reliable ways to induce different mood states, further research is needed on the effectiveness of different strategies of manipulating mind wandering. As vigilance tasks are associated with more frequent mind wandering when presentation of stimuli is slow, with infrequent targets (Giambra, 1995), one way to manipulate mind wandering could be to change the speed or target presentation during the SART.

In addition to measureing self-reported mind wandering, laboratory studies could validate and employ additional behavioural and physiological indices as well as brain imaging procedures. For example, when using SART errors as a behavioural index of mind wandering, Seli and colleagues (Seli, Jonker, Cheyne, & Smilek, 2013) recently proposed a statistical analysis to control for the speed-accuracy trade-off, which might improve validity. Temporal increases in heart rate have also been suggested to be associated with mind wandering (Smallwood et al., 2004a, 2004b) and studies using functional magnetic resonance imaging (fMRI) identified an association between default activation of the mode network (DMN) of cortical regions and mind wandering (Mason et al., 2007; Hasenkamp, Wilson-Mendenhall, Duncan, & Barsalou, 2012).

To bridge the gap between laboratory and day-to-day experiences of mind wandering, laboratory measures of mind wandering should be compared to experience sampling measures during daily life. The latter should include a time lag

analysis to establish a directional relationship between mind wandering and mood. It might furthermore be possible to target mind wandering more directly during every-day life, by giving people reminders to stay in the present moment.

Limitations of this review

The search strategy was limited to keyword searches and therefore might have missed relevant studies. It might have furthermore been helpful to include related constructs in the review. In hindsight, mindfulness measures should have been examined more systematically, testing their overlap with measures of mind wandering. For example, the Mindful Attention Awareness Scale (Brown & Ryan, 2003), which conceptualises mindfulness in relation to sustained non-distraction by mainly measuring mindlessness, should have been included.

It is also of note that the relationship between mood and mind wandering might depend on several other variables, including whether one voluntarily directs one's thoughts away from the here and now, or involuntarily drifts away from the current activities or as suggested by mindfulness interventions, their attitudes towards the experience of mind wandering or the lengths in which the mind is removed from the here and now. Thought content, rigidity of thought processes, repetitiveness, and the level of construal (abstract versus concrete) might also be moderating factors (Watkins, 2008).

A further limitation of this review was that no critical appraisal tool was employed. The advantages of using an established quality checklist are that it highlights limitations in the study design and method and documents missing information, e.g. on randomisation and thus provides an overview comparing the quality of the reviewed studies on which the conclusions are based (Oxman, & GRADE Working Group, 2004).

Conclusions

      This review provides some preliminary evidence that mood and mind wandering are related, though the precise nature of this relationship as well as how this manifests in mood disorders is as yet unclear. With mindfulness interventions emphasising the importance of focusing one's attention towards the present moment, more research is needed to determine whether preventing the mind from wandering could be a mechanism of action of mindfulness interventions. A better understanding of the underlying mechanisms might lead to new developments in improving the effectiveness in existing interventions.

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Part 2: Empirical Paper

Content-free cueing as a technique to inhibit

mind wandering and treat anhedonia in

depression

Abstract

Aims: This thesis examined whether content-free cues in the form of auditory tones can reduce mind wandering and enhance mood in various contexts. It furthermore tested if the beneficial effect was particularly pronounced with increasing levels of dysphoric symptoms.

Method: Fifty-eight participants varying in depression severity completed a range of tasks assessing mind wandering and positive reactivity, under two conditions: once with and once without auditory tones. They were instructed to use the tones to focus on the present moment, intended as a manipulation to reduce mind wandering. Firstly, participants completed a standardised sustained attention task on the computer. Secondly, a standardised laboratory-based pleasant event was presented on the computer in the form of SenseCam footage. Thirdly, participants were asked to carry out pleasant every-day activities at home. Subjective mind wandering while completing the tasks and mood were assessed via self-report.

Results: Content-free cues led to a reduction in mind wandering in the two laboratory tasks, but not when completing pleasant every-day activities outside the laboratory. Cues did not enhance positive mood in the laboratory-based pleasant event. While cues were also not associated with increased happiness ratings in response to pleasant activities at home, there was some evidence that cues led to a higher reduction of sadness. Contrary to the prediction, however, the effects of cues were not more pronounced in participants with higher depression severity for any of the tasks.

Conclusions: Only weak support was found for the beneficial effects of content-free cues. Suggestions are made for refining the design and delivery of cues in order to enhance their impact. Limitations of the design are discussed.

Introduction

In recognition of the devastating impact depression can have on individuals, as well as society at large (e.g. in terms of loss of productivity) substantial effort has gone into developing effective interventions for the condition over the past 60 years. However, a review of the evidence base to date suggests that this has only been partially achieved (Butler, Chapman, Forman & Beck, 2006; DeRubeis et al., 2005; Westen & Morrison, 2001). Given the limitations of the existing interventions and high relapse rate in depression there is need to improve existing approaches. One way forward is to target clinically important but neglected features of the disorder more systematically.

DSM-IV lists anhedonia (a loss of interest and pleasure) as one of the key features of depression (APA, 1994). In clinical practice depressed clients frequently report that they do not get the same amount of pleasure out of activities they previously enjoyed. Laboratory findings support the notion that depressed individuals show an altered emotional response to positive material, in terms of diminished reactivity and in some instances elevated levels of sadness (Dunn, Dalgleish, Lawrence, Cusack & Ogilvie, 2004; Rottenberg, Kasch, Gross & Gotlib, 2002; Sloan, Strauss, Quirk & Satajovik, 1997). With the majority of interventions focusing on reducing elevations in negative mood, difficulties resulting from a loss of interest and pleasure are often neglected. It is therefore possible that explicitly targeting anhedonia might lead to an improvement of treatment outcomes.

Anhedonia frequently results in depressed individuals disengaging from activities they previously enjoyed and becoming more withdrawn. Therefore a variety of interventions, such as 'behavioural activation' approaches (Mazzucchelli, Kane, & Rees, 2009) focus on re-engaging individuals in valued activities. They are designed as a stand-alone treatment as well as a component of cognitive behavioral therapy (Jacobson, Martell & Dimidjian, 2001; Martell, Addis & Jacobson, 2001). Research

has recently supported the effectiveness of behavioral activation (BA), identifying an effect size comparable to other psychological interventions (Cuijpers, van Straten & Warmerdam, 2007; Ekers, Richards & Gilbody, 2008). A key component of BA is activity scheduling, usually involving different forms of homework assignments that encourage clients to engage in specific activities with the goal of increasing positive reinforcement (for a review see Kanter et al., 2010).

As with other CBT interventions, the outcomes for BA are not optimal. This may be because it is not sufficient to merely reengage depressed individuals with reinforcing activities. It may also be essential to identify and overcome underlying psychological mechanisms that block pleasure in these situations. In other words, in order to improve mood by increasing momentary feelings of happiness and decreasing sadness, one does not simply need to get depressed people active, but it may also be necessary to help them change their relationship to their activities. One possible mechanism responsible for loss of pleasure could be the frequency with which an individual's mind wanders away from the present moment. Depressed individuals may fail to enjoy positive activities because, whilst they are physically engaged in them they fail to mentally *engage* in them; in other words, their attention wanders from the here and now towards other thoughts or habitual ruminations with negative themes. In line with this the 'attention to experience rationale' for behavioural activation suggests that individuals could benefit from being trained to pay attention to the activities they are engaging in their environment to decrease ruminative thinking (Martell, Dimidjian & Herman-Dunn, 2010, p.142).

The term mind wandering (also referred to as 'task-unrelated' thoughts or images as well as 'stimulus-independent' thought) refers to a drift of attention away from the *here and now* towards private thoughts and feelings (Smallwood, O'Connor, Sudbery & Obosawin, 2007). Research has consistently shown that mind wandering results in deficits in task performance (e.g. McVay & Kane, 2009) and it has been

suggested to draw heavily on executive resources (Smallwood & Schooler, 2006). McVay & Kane (2009) argued that mind wandering is initially an automatic process in response to cues and that executive-control processes are needed to keep these unrelated thoughts out of focus during demanding tasks. Executive functioning has furthermore been found to be impaired in depression (Zakzanis, Leach & Kaplan, 1998).

Evidence for the relationship between mind wandering and low mood comes from both laboratory research and experience sampling methodology. Smallwood and colleagues (Smallwood, Fitzgerald, Miles & Phillips, 2009) induced different mood states in healthy participants before asking them to complete a sustained attention task and measured mind wandering in terms of behavioural lapses (mistakes) and retrospective self-report indices. Results showed that negative mood resulted in more behavioural lapses, a higher number of irrelevant thoughts and less inclination to re-engage attentional resources following a lapse. Mind wandering may also have adverse consequences for an individual's mood. Killingsworth and Gilbert (2010) employed an experience-sampling methodology in a large sample to examine the effects of mind wandering on happiness. They found that people reported being less happy when their minds were wandering, irrespective of whether they engaged in enjoyable activities or not. While thoughts about pleasant topics did not make people happier than thinking about the activities themselves, thinking about neutral and unpleasant topics led to considerably less happiness. The authors concluded that mind wandering might not merely be a consequence of low mood but that it may cause anhedonia. Together, these studies suggest a reciprocal relationship between mood and attending to the present moment / mind wandering.

Mind wandering could potentially be particularly harmful in depressed individuals, as the mind may wander to negative themes. Indeed rumination, defined as 'a mode of responding to distress that involves repetitively and passively focusing

on symptoms of distress and on possible causes and consequences of these symptoms' (Nolen-Hoeksema, Wisco & Lybomirsky, 2008) has been identified as a key process in depression. Rumination has been found to exacerbate depression, e.g. by prolonging depressed mood (Nolen-Hoeksema & Morrow, 1991), interfering with attention and concentration (Ingram & Smith, 1984), leading to overgeneral autobiographical memory (Watkins, Teasdale & Williams, 2000), obstructing active problem-solving and contributing to an exaggerated view of problem severity (Lyubomirsky & Nolen-Hoeksema, 1995). Watkins (2008) furthermore reviewed different types of repetitive thoughts including rumination and mind wandering and concluded that they are related to both the onset and maintenance of depression. One can conceive rumination as a specific instance of mind wandering, as it defines not only the process of absent-mindedness, but also the thought content and repetitive style. Mind wandering might also be thought of as a precursor to rumination. When a depressed individuals' attention drifts away from the here and now it might be more likely to result in depressive rumination.

There is only one (as yet unpublished) study that looked specifically at the impact of mind wandering on positive experiences in depression as far as it is known. (Dunn, Stewart, Edwards, & Barker, in preparation). This study showed that as depression severity increased, participants reported more trait mind wandering. This tendency mediated the relationship between depression severity and increased sadness during routine positive activity scheduling. It is therefore plausible that one way to increase enjoyment of positive activities is to train individuals to stay in the moment.

Indeed, helping people to stay in the present moment may be an active element of a number of existing therapeutic interventions for depression, such as mindfulness-based treatments (Kabat Zinn 1982, 1990; Teasdale, Segal, & Williams, 1995) and Wells's (1990) attention training and general brain training (e.g. Elgamal,

McKinnon, Ramakrishnan, Joffe & MacQueen, 2007). Mindfulness is based in Buddhism and is defined as 'paying attention in a particular way: on purpose, in the present moment, and non-judgementally' (Kabat-Zinn, 1994, p.3), thus placing emphasis on one's relationship to thoughts. It can be seen as the antithesis to rumination (Williams, Teasdale, Segal, Kabat-Zinn, 2007). A recent study showed that four of the five facets of the Five Facet Mindfulness Questionnaire (Baer, Smith, Hopkins, Krietemeyer & Toney, 2006) were significantly correlated with depression (Bohlmeijer, ten Klooster, Fledderus, Veehof & Baer, 2011). Discouraging rumination and focusing on the present have been suggested as potential mechanisms explaining how mindfulness skills can result in a reduction of depressive symptoms and change in behaviour (see review by Baer, 2003). Initial evidence supports the link between trait mindfulness and mind wandering. Mrazek, Smallwood and Schooler (2012) demonstrated that the Mindful Attention and Awareness Scale (MAAS) presents an opposing construct to mind wandering assessed both via self-report and indirect markers and that a brief mindfulness task reduced behavioural indicators of mind wandering on a test of sustained attention.

Another intervention that aims to enhance attentional as well as metacognitive control is Wells' (1990) attention training. It is possible that the mechanism of action of the interventions above might in part be due to reduced mind wandering (i.e. keeping attention in the moment). However, the link between mindfulness, mind wandering (or rumination) and mood has not been further subjected to experimental examination. Neither has there been any investigation regarding the impact of any of the interventions outlined above on the enjoyment of positive experiences and subsequent improvements on mood in depressed individuals.

All interventions discussed so far involve training individuals in a set of new skills, thus requiring considerable commitment and effort. Achieving this might be especially difficult in the midst of depression. A less effortful way to aid people to stay

in the moment is not to train a new ability, but to give people a 'crutch' to support them in the moment. This strategy is regularly used in the brain-injured population, where tools are developed to compensate for impairment of specific domains of cognitive functioning (Armstrong, McPherson, & Nayar, 2012). In relation to difficulties sustaining attention (i.e. reducing mind wandering), content-free cues in the form of auditory tones have been found to lead to improved performance in tasks in the laboratory (Manly, Hawkins, Evans, Woldt, & Robertson, 2002; Manly et al., 2004).

Manly et al. (2004) employed the Sustained Attention to Response Task (SART), in which participants were presented with random digits on a computer screen and asked to press a response key as quickly as possible following each digit, with the exception of an infrequent presentation of a target digit (the digit '3'), where no response should be made. Random presentations of content-free cues (i.e. cues with no predictive value regarding the occurrence of no-go trials in the task) in the form of auditory beeps were found to decrease participants' error rate in this task. It has been suggested that the cues served the function of participants' own central executive system, by encouraging individuals to take a more executive stance to their current goals, instead of drifting into habitual patterns of responding (Manly et al., 2004). As increased mind wandering in this task has been linked to an increased error rate (pressing on a no-go trial) (Smallwood et al., 2009), one might suggest that the tones discourage mind wandering. It is possible that similar cueing approaches could be of value in depression, helping depressed individuals to stay focused during positive activities, rather than allowing their minds to wander.

The present study is the first to translate this type of external scaffolding approach, previously applied in the brain-injured population, to depression. It aimed to investigate firstly whether similar content-free cues have the potential to be useful in depression in terms of reducing the amount of mind wandering indexed behaviorally and via self-report in a laboratory measure of sustained attention (replication of the

study by Manly et al., 2004). Secondly, the study examined whether content-free cues can improve enjoyment and mood in response to pleasant experiences by encouraging individuals to focus their attention on what they are doing in the moment rather than allowing their mind to wander towards other thoughts. This was tested under both tightly controlled laboratory, as well as under more ecologically valid conditions. The first of these was tested by examining the effects of content-free cues on self-reported mind wandering and emotion experience of standardised SenseCam footage (Hodges et al., 2006) of mildly positive activities. The SenseCam takes pictures automatically within defined intervals from a wide-angle lens, which are then put together in a 'video'. The second was tested by examining the effects of content-free cues on self-reported mind wandering and emotion experience during every-day pleasant activities scheduled outside the laboratory. The data were analysed using a continuous design (individuals with varying levels of depression symptoms). Analysis focused on whether content-free cueing reduced mind wandering and improved mood during these tasks. Moreover, it assessed whether the benefit of this cueing approach became more marked with increasing depression severity (where individuals are particularly prone to mind wandering and therefore will gain more from cue delivery).

This study of is potential theoretical as well as clinical importance, since it hopes to increase the understanding of the role of mind wandering in depression specifically in relation to anhedonia. Clinically, it has potential to enhance the effectiveness of existing intervention.

The hypotheses are as follows:

1. In line with Manly et al.'s (2004) findings in brain-injured populations, it is expected that content-free cues will reduce mind wandering (relative to the control condition) during a computerised task of sustained attention.

2. Further, the reduction of mind wandering will become more marked with increasing depression severity, as individuals with higher levels of depression will have more difficulty inhibiting mind wandering and thus have a greater need for a prosthesis.

3. Content-free cueing will reduce mind wandering and sad mood and increase happy mood (relative to the control condition) when viewing SenseCam videos.

4. Again, this will become more marked as depression severity increases.

5. Content-free cueing will reduce mind wandering, reduce sadness and increase happiness during event scheduling (relative to the control condition).

6. As above this effect is expected to become more marked with increasing depression severity.

Method

Participants

Participants were recruited from the MRC Cambridge general volunteer panel (Appendix A). This led to a community sample of 58 adults (50% women) ranging in age from 18 to 63 years (Mean= 26.38, SD= 9.29) with a wide range of depression severity (BDI-II mean= 21.28, SD= 12.28, range 0 to 58). As there have been suggestions that depression is associated with deficits in cognitive functioning (Porter, Bourke, & Gallagher, 2007) premorbid verbal IQ was estimated using the National Adult Reading Test (NART; Nelson, 1982). However, as 12 participants were not native English speakers this reduces the accuracy of the NART as an IQ estimate,

therefore, years of education is additionally reported as a proxy of IQ. On average participants spent 15.61 years in education (SD=2.89). Table 1 reports correlations of demographic measures with depression severity. It is of note that depression severity significantly correlated with gender, suggesting that female participants scored higher on depression severity. While there was also a significant correlation between NART IQ estimates and depression severity, this was no longer found when years of education was used as an estimate, indicating that non-native English speakers scored higher on depression severity.

A continuous design was adopted as examination of the BDI distribution indicated it was normally distributed and continuous analyses have greater power than between group designs for such variables (Altman, & Royston, 2006). The study was powered to detect between a medium and large effect size (since a small effect is unlikely to be clinically relevant) in an analysis employing continuous methods (as a function of depression severity). According to Cohen (1992), at least 28 participants are needed to find a large magnitude and at least 85 to find a medium magnitude correlation given power = 0.8 and alpha = 0.5. As order effects were additionally analysed, Cohen (1992) suggests that at least 26 participants are needed for a large magnitude effect size. No significant differences on demographic and clinical variables were identified as a function of order of task administration (Appendix B).

Table 1:

Correlations of demographic measures with depression severity measured via BDI-II

	r	p
Gender	.27	.04*
Age	-.19	.15
NART predicted verbal IQ	-.30	.02*
Native English speakers	.18	.17
Years of education	-.02	.87

BDI-II= Beck Depression Inventory – 2nd edition (Beck, Steer, & Brown, 1996); NART= National Adult Reading Test (Nelson, 1982); r = Pearson's correlation coefficient, p= level of significance; * p < 0.05

Procedure

All participants completed three phases of testing (which are described in more detail in a later section) assessing mind wandering and affect once with and once without content-free cues in the form of auditory tones. They were instructed to use the tones to focus on the present moment, intended as a manipulation to reduce mind wandering. Initial testing was carried out in a quiet room with one computer and lasted approximately 90 to 120 minutes. Participants were given an information sheet explaining the study (Appendix C) and had the opportunity to ask questions, before written informed consent was sought (Appendix D). After completing mood questionnaires, including the BDI-II (Beck et al., 1996) to assess depression severity, and other measures not reported in this paper, participants completed Phase 1 of the experiment. This involved a computer-based laboratory task of sustained attention, testing if content-free cues can enhance a depressed individual's performance by discouraging mind wandering. Next participants completed Phase 2, consisting of a laboratory task involving a pleasant event, by presenting participants with SenseCam videos (Hodges et al., 2006) of a walk in pleasant surroundings. This tested whether content-free cues can reduce mind wandering and improve mood. Next Phase 3 was introduced, which represented translation into clinical practice, testing if content-free

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cues can augment activity scheduling. Participants were asked to schedule in pleasant activities to be completed during the following week. Lastly the NART was administered. At the end of the laboratory testing phase participants were given a prepaid return envelope, containing material for phase 3 and a payment form. Upon return of these, participants were reimbursed for their participation via a bank transfer. Ethical approval for this study was obtained from the Psychology Research Ethics Committee of the University of Cambridge (Appendix E).

Measures

Beck Depression Inventory – 2nd edition (BDI-II; Beck, Steer, & Brown, 1996). This 21-item self-report questionnaire is one of the most widely used instruments to assess depression severity. It comprises groups of statements relating to depression symptoms such as hopelessness and irritability, cognitions such as guilt or feelings of being punished, as well as physical symptoms such as fatigue, weight loss, and lack of interest in sex. Each item contains four statements, of which respondents have to select the one which best describes how they have been feeling during the past two weeks. Each statement is rated on a scale ranging from 0 to 3, leading to a maximum score of 63. The sadness item for example contains the following 4 statements: 0= "I do not feel sad." 1= "I feel sad much of the time." 2= "I feel sad all the time." 3= "I am so sad or unhappy that I can't stand it." The BDI-II correlates highly with other recognised depression scales (e.g. the Hamilton Depression Rating Scale; Beck, Steer, & Brown, 1996) and has high test-retest reliability and a high internal consistency (Beck et al., 2006; Beck, Steer, Ball & Ranieri, 2006).

Sustained Attention to Response Task (SART; Robertson, Manly, Andrade, Baddeley & Yiend, 1997): This is a widely used computer task measuring sustained attention, with good ecological validity (Smilek, Carriere & Cheyne, 2010). It has furthermore been validated as a measure of mind wandering (Smallwood et al., 2009). In the SART version used in this study participants were presented with a random

sequence of single digits ranging from 1 to 9 on the computer screen at a regular, rhythmic rate. After each digit appeared for 250ms, a masking pattern (white circle with diagonal white cross) appeared for 900ms. Participants were instructed to press the spacebar on the keyboard as quickly as they could as each digit appeared, with the exception of the number "3", where no response should be made. This task is designed to encourage an automatic, inattentive response set by requiring repetitive responses, as well as by the infrequency of the presentation of the 'no-go' digit (number '3'). Lapsing attention (mind wandering) leads to errors of commission (pressing for 'no-go' trials. Therefore, the accuracy score was used as one index of participant's ability to maintain supervisory attentional control over responses and thus form a behavioural measure of mind wandering. There were 405 trials (including 45 no-go trials).

'Thinking Content' component of the Dundee Stress State Questionnaire (Matthews, Joyner, Gililand, Campbell, & Faulconner, 1999): This 16-item self-report questionnaire retrospectively assesses thoughts during task performance. It was administered immediately after the SART to assess task engagement/disengagement during the task. Task engagement is referred to Task Related Interference (TRI) and consists of attention directed towards task completion or appraisal of one's performance. Task disengagement, operationalized as Task Unrelated Thought (TUT) refers to attention that is drawn away from what one is doing and are thus considered to be a measure of mind wandering (Smallwood et al., 2009). There are 8 items measuring TUTs, e.g. "I thought about something that happened earlier today.", which are rated on a five-point Likert scale with 1 = "never" and 5 = "very often".

Mood measures: To obtain a measure of change of mood during the tasks participants were asked to rate their levels of happiness and sadness on a visual analogue scale ranging from 0 = "Not at all" to 100 = "A great deal" before, after the

SART and before, during and after each video and each activity. They were also asked to rate their level of enjoyment on the same scale.

Mind wandering: After each video in Phase 2 and activity in Phase 3 mind wandering was assessed via retrospective self-report ratings on visual analogue scales ranging from 0 = "Not at all" to 100 = "A great deal".

Phase 1

The first phase aimed to demonstrate that content-free cues in the form of auditory tones can improve sustained attention by decreasing the incidence of mind wandering in people with varying degrees of depressive symptomatology. The procedure was similar to that used by Manly et al. (2004), who found that performance on the SART improved in brain-injured participants when auditory tones without any predictive quality were presented. Participants were informed before each block of the SART that they might hear an auditory tone, which they should use to think about what they were meant to be doing, that is, pressing the spacebar for each number except for the number '3'. In the cued condition, 15 auditory tones with approximately 62dB intensity and a medium pitch were presented at random intervals for 30ms each via computer speakers. Participants initially completed a practice session of the SART to familiarise themselves with the task. Mood states were assessed using visual analogue scales (see above) before and after two 7.5-minute blocks of the SART, which were administered in a counterbalanced order, once cued and once un-cued. After each SART block participants were asked to rate their experience of the task and complete the Thinking Content component of the DSSQ.

Phase 2

While it was anticipated that the inclusion of content-free cues on the SART would be associated with a decrease in mind wandering in depressed individuals, it

was thought unlikely to have a marked effect on mood as the task is neutral. The second phase of this study therefore aimed to examine whether there is an association between mind wandering and emotional experience during more valenced task. A mildly pleasant event in form of SenseCam (see Hodges et al., 2006 for a detailed description of the SenseCam) footage was chosen to examine if cues enhance mood. The SenseCam is a camera that takes pictures automatically within defined intervals from a wide-angle (fish-eye) lens, thus capturing a near complete view of the wearer. The pictures were then put together in a 'video'. Strengths of this method were that it resembles a possible real life experience, giving it ecological validity and as it does not involve any sounds enabled administering tones on a quiet background. A decision was made not to use a strongly pleasant mood induction as it was thought that cues would be unlikely to be beneficial if the task was either too positive or too engaging.

Initially, several videos were piloted to confirm they were experienced as pleasant. Further changes were made to ensure they were similar in content such that they could be presented in a counterbalanced order. As people have different preferences the final testing material consisted of four videos, two of a walk in natural surroundings and two videos of a walk in a city. Participants were asked to choose between watching a walk in natural or urban surroundings on the basis of which they anticipated they would enjoy more.

After assessing baseline mood states a standardised pleasant event followed in the form of two SenseCam 'videos' lasting approximately five minutes, once with and once without cues. Participants were instructed to imagine themselves as the person walking though the landscape and to focus on the present moment, thinking about what they would experience in terms of their physical sensations e.g. sight, smell, and noise, thoughts and feelings. Before the task participants were informed that they might hear auditory tones, which they should use to concentrate on the task

of imagining themselves as the person walking in the landscape. Seven tones (200ms, 400Hz) were then presented at random intervals in the cued condition via a watch. After each video participants completed pen-and-paper self-report measures of mood state and mind wandering, as described above.

Phase 3

Following the laboratory experiments above, the aim of the last phase was to examine whether content-free cues can potentially be useful in clinical practice, by augmenting an intervention that is known to be effective for depression - activity scheduling. At the end of the laboratory session participants constructed personal event timetables for the upcoming week together with the researcher (Appendix F). This involved scheduling each of the following three mildly pleasant every-day activities twice for the next week lasting about 15 minutes each: going for a walk in pleasant surroundings, eating food they enjoy and reading an interesting book or magazine. Analogous to the laboratory task they were asked to complete each task once with and once without the presentation of auditory tones. Tones were presented using a watch provided by the experimenter. Participants received directions (Appendix G) and practiced activating the tones on the watch, which was programmed to present seven auditory tones (tones lasted 200ms and had 400Hz) at random intervals over 15 minutes. Participants were instructed to use the tones as prompts to focus on the present moment and their sensory experiences. Finally participants were given a rating sheet to assess mood state and mind wandering. They were instructed to rate their mood before each activity and after each activity to rate their mood state at the moment, their mood during the activities, as well as their levels of mind wandering while carrying out each activity. They were also asked to write about their experience of the task with and without tones and return the watch and questionnaire in a prepaid envelope.

General analysis strategy

Prior to analysis all variables were assessed to identify if they were normally distributed and if outliers were present. The latter were defined as in excess of 3 standard deviations from the mean. In subsequent sections, only variables which violate these assumptions will be mentioned and attempts will be made to transform data. Results of all participants will be reported in the main text, and if different results were found with outliers excluded these will be reported in the footnotes. In order to test the effect of content-free cues on various dependent variables measuring mind wandering and mood a series of 2x2 ANOVAs were employed, with presence of content-free cues (cues versus no cues) as a within-subjects factor and order of presentation (cues first versus cues last) as a between subjects-factor. Order of presentations was included to control for practice or habituation effects.

To test the depression hypotheses, i.e. the moderating impact of depression on the outcome variables these analyses were each repeated additionally entering depression severity (mean centred BDI score) as a covariate. Alpha was set at .05 and two tailed tests are reported. As all analyses tested a priori hypotheses, no corrections for multiple comparisons were made.

Results

Impact of content-free cues in SART

Fifty-five participants completed the full-length version of the SART and were included in the analysis (the remaining 3 participants were not included as they had completed a shorter pilot version of the task). Mind wandering was indexed in terms of commission errors on the SART (a behavioural measure) and subjective ratings (a self-report measure), which were analysed in turn.

Figure 1 reports errors of commission on the SART as a function of cue condition and order. The prediction that content-free cues would improve sustained attention by reducing SART errors was not supported. There was no significant main effect of either content-free cues, $F<1$, or order of presentation (cues first versus last), $F<1$, in the ANOVA. However, there was a significant interaction between cues and order of presentation, $F(1,53)=4.16$, $p<.05$. In the cued condition individuals who completed this condition first made fewer mistakes than when the cues were presented last, while there was little difference in errors when no cues were presented irrespective if this was the first or last condition.
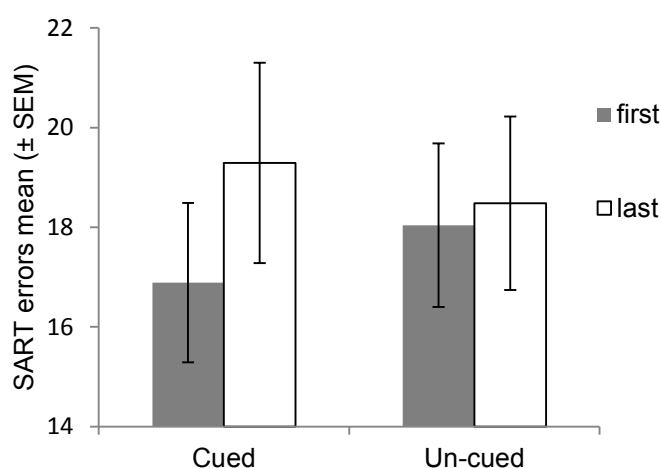
Figure 1: Mean (± SEM) SART errors of commission as a function of cue condition and order

As a second step BDI scores were entered as a covariate in the above ANOVA. The main effect of depression was not significant, $F(1,51)=2.71$, $p=.11$, indicating that depression severity did not have a reliable impact on the number of SART errors overall. Contrary to the prediction, depression did not moderate the relationship between cues and SART errors either, indicated by no significant cue by BDI

interaction, F<1, no significant order by BDI interaction, F<1, and no significant cue by order by BDI interaction, F<1.

Next, the effect of cues on self-reported mind wandering during the SART measured retrospectively in the form of task unrelated thoughts (TUTs) was analysed. TUTs were calculated by summing the eight items of the TUT scale of the DSSQ. Figure 2 shows self-reported mind wandering after the SART as a function of cue condition and order. Supporting predictions, content-free cues were associated with reduced self-reported mind wandering relative to the control condition without cues as demonstrated by a significant main effect of cueing on TUTs: $F_{(1,53)}=9.26$, $p<0.01$. No significant main effect of order, F<1, or cue by order interaction, F<1, was found. Thus, participants reported reduced mind-wandering in the cued condition irrespective of whether this condition was completed first. It is of note that demand characteristics, in particular, expectancy effects may have contributed to this finding as participants were instructed to use the tones to focus on the present moment.
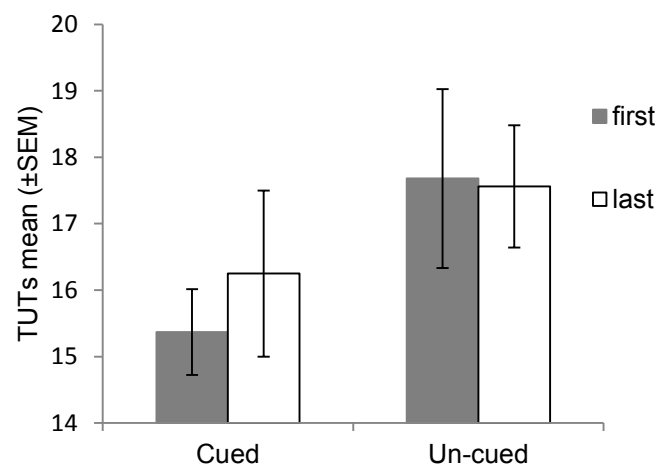

Figure 2: Mean (± SEM) TUTs reported after SART as a function of cue condition and order

Entering BDI as a covariate in the ANOVA, a significant main effect of BDI was found, $F_{(1,51)}= 13.50$, $p<0.001$. Higher BDI scores were associated with increased self-reported mind wandering overall. Contrary to predictions depression severity was

not associated with decreased mind wandering in the cued as opposed to the un-cued condition, indicated by a non-significant cue by BDI interaction, $F<1$. There was also no significant cue by order by BDI interaction, $F<1$. However, the interaction between order of presentation and BDI was unexpectedly significant, $F(1,51)=6.43$, $p=.01$. This interaction was resolved by averaging the cued and un-cued condition and then examining the relationship of these composite ratings with BDI scores. In participants who completed the cued condition first, there was no significant positive correlation between mind wandering and BDI, $r=.24$, $p=.22$. However, when cues were presented last, there was a significant positive correlation between mind wandering and BDI, $r=.54$, $p<.01$, indicating that under this condition participants who scored higher on BDI reported more frequent mind wandering overall.[1]

In summary, Hypothesis One was only partially supported. Content-free cues did not lead to a reduction in errors of commission in the SART, which represents a behavioural measure of mind wandering, but cues lead to a reduction in retrospectively self-reported mind wandering. While higher scores on the BDI were associated with more frequent retrospectively self-reported mind wandering, the second part of Hypothesis One that depression would moderate the effect of content-free cues was not supported.

Impact of content-free cues while watching SenseCam videos

Next self-reported mind wandering and affect ratings during the SenseCam videos were analysed. The videos were intended to be mildly pleasant. However, the mean rating of enjoyment (1="Not at all" and 100="A great deal") of the videos without cues were 45.02 (SD=25.966) and with cues 44.29 (SD=26.286), which suggests that

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[1] Mood was measured but not analysed further due to the neutral nature of the SART task and to avoid increasing type 1 error rates by running multiple comparisons.

the videos overall were experienced as relatively neutral. Forty-five participants chose to watch the two videos of park scenes and 13 participants chose to watch the two videos of the city scene. In the cued condition 20 participants watched the first version of the park scene, and 25 the second version, while 7 watched the first version of the city scene and 6 the second version. Preliminary analyses revealed no significant effects of video, with p>.05, so this factor was excluded from analyses for the sake of brevity.

Figure 3 represents mean self-reported mind wandering while watching the video as a function of cue condition and order. There was some support for the prediction that content-free cues reduce self-reported mind wandering, as there was a trend towards a significant main effect of cueing, $F(1,55)=3.47$, $p=.07$. There was no significant effect of order F<1, and no significant cue by order interaction F<1. This indicates that participants reported reduced mind-wandering in the cued condition irrespective of whether this condition was completed first. Once again, the findings need to be considered cautiously due to possible expectancy effects, i.e. participants might have interpreted the instructions to 'use the tones to focus on the present moment' to reduce mind wandering.
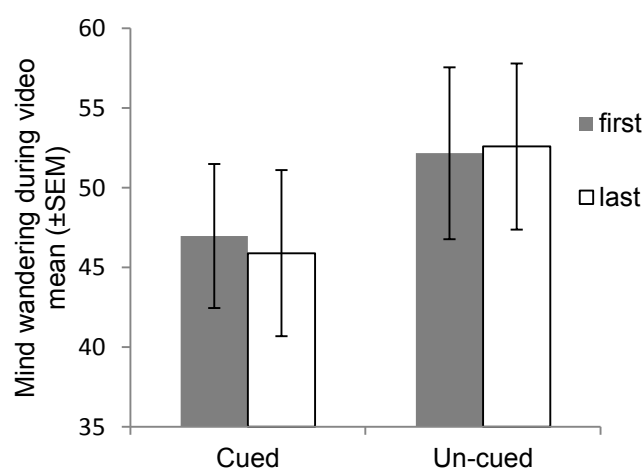
Figure 3: Mean (± SEM) self-reported mind wandering while watching the video as a function of cue condition and order

Next, the analysis was repeated with BDI entered as a covariate. BDI scores were not associated with mind wandering overall while watching the video, indicated by no significant main effect of BDI, $F_{(1,53)}=1.84$, $p=.18$. Nor were there significant BDI by cue, $F<1$, order by BDI, $F<1$, or cue by order by BDI, $F<1$, interactions. The data indicated that BDI did not moderate the impact of cueing on mind wandering while watching the video.

To analyse the impact of content-free cues on mood an initial step was to calculate the changes in mood by subtracting self-reported happiness (or sadness) before watching the video from self-reported happiness (or sadness) while watching the video. Thus, positive scores indicate that happiness (or sadness) increased and negative scores that happiness (or sadness) decreased. While changes in mood were in the expected direction, i.e. watching the video led participants to feeling happier and less sad overall, the changes were very small in magnitude and there was a wide distribution of scores (see Table 3).

Table 2

Changes in mood during the video

	Change in happiness		Change in sadness	
	Cued	Un-cued	Cued	Un-cued
Mean	2.00	1.81	-4.59	-2.83
SD	14.38	19.75	14.89	16.54
Min	-60	-50	-50	-66
Max	27	70	30	30

The distribution for change in happiness ratings violated the assumption of normality. However as there was no straight forward way to correct for kurtosis no transformations were calculated. There were furthermore nine outliers which were left in the analysis to ensure there was sufficient power to test hypotheses. Due to the violation in assumption and the number of outliers the effects need to be interpreted cautiously. Figure 4 shows the effect of cueing on changes in happiness. The hypotheses that content-free cues would be associated with increased self-reported happiness ratings was not supported. There was no significant main effect of cues, $F<1$, and no significant main effect of order of presentation, $F_{(1,56)}=2.26$, $p=.14$. However, a significant cue by order interaction, $F_{(1,56)}=4.70$, $p=.03$ was identified. While there was a small increase in happiness in the cued condition, happiness decreased in the un-cued condition when cues were presented first and increased when cues were presented last.

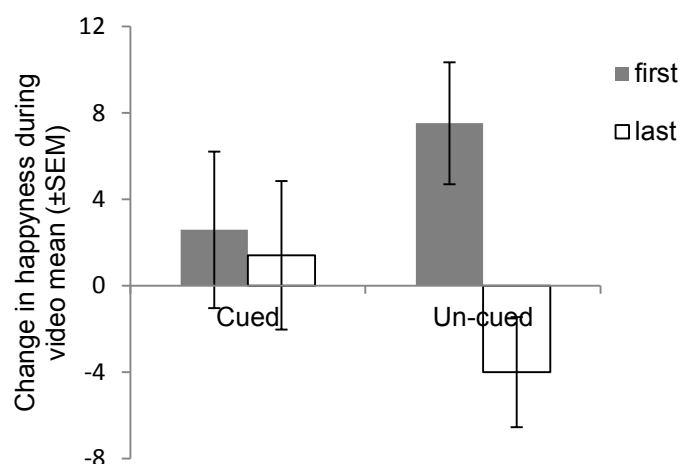*Figure 4:* Mean (± SEM) changes in happiness while watching the video as a function of cue condition and order (positive scores indicate increases in happiness)

Including BDI scores as a covariate in the ANOVA, there was a significant main effect of BDI, $F_{(1,54)}=6.802$, $p=.012$, indicating that higher BDI scores were associated with an increase in happiness when watching the video while lower BDI

scores were associated with a decrease in happiness. Contrary to the prediction, there was no significant cue by BDI interaction, $F(1,54)=1.07$, $p=.31$, no significant order by BDI interaction, $F(1,54)=1.28$, $p=.30$, or cue by order by BDI interaction, $F(1,54)=1.04$, $p=.31$. In other words, depression severity did not moderate the impact of cueing condition on happiness experience.

Sadness data were log transformed prior to analysis to correct for positive skew. There were five outliers in the data, which were once again left in the analysis to ensure there was sufficient power to test hypotheses. The result therefore needs to be interpreted cautiously. Figure 5 represents the effect of cueing and order on changes in sadness. The hypotheses that content-free cues are associated with a reduction in self-reported sadness was not supported, i.e. there was no significant main effect of cues, $F<1$, no significant main effect of order of presentation, $F<1$, but there was a significant cue by order interaction, $F(1,56)=4.38$, $p=.04$[2]. Whichever condition was presented first was associated with greater decreases in sadness ratings.

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[2] Rerunning the analysis with outliers removed resulted in the cue by order interaction no longer reaching significance, $F(1,51)=2.736$, $p=.104$.
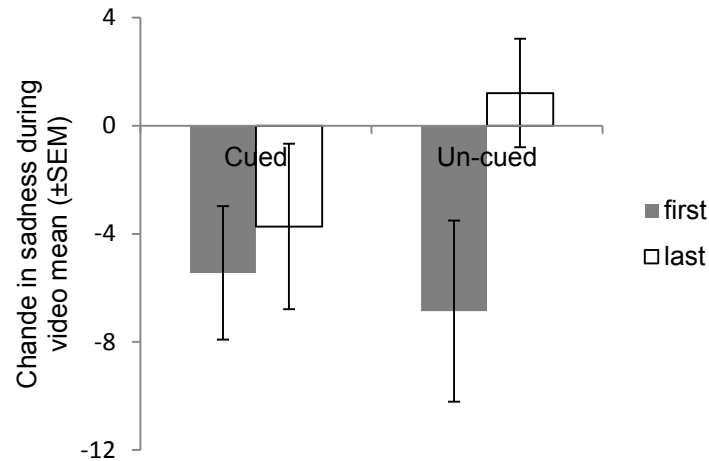
Figure 5: Mean (± SEM) changes in sadness while watching the video as a function of cue condition and order (negative scores indicate decrease in sadness)

Adding BDI scores as a covariate in the ANOVA, no significant main effect of BDI was found, F<1, indicating that BDI was not associated with reported changes in sadness after watching the video. The prediction that BDI scores moderates the effect of cues was also not supported by the data, as no significant cue by BDI interaction, F<1, was found. There was also no significant order by BDI, $F_{(1,54)}=1.31$, p=.26 or cue by order by BDI interaction, F<1.

In summary, there was only weak support for Hypothesis Two. While content-free cues reduced mind wandering, this did not reach statistical significance. However, cues did not bolster happiness or reduce sadness while watching a pleasant video. The second part of Hypothesis Two that depression moderates the impact of the content-free cues by reducing mind wandering and maintaining mood was also not supported.

Impact of content-free cues during every-day pleasant activities

Next, the effects of content-free cues during every-day pleasant activities were analysed. Two participants did not complete the questionnaires, leaving 56 participants in the analysis. Data were averaged across the three events to simplify

the analysis structure. Figure 6 plots the effect of cueing and order on self-reported mind wandering during the activities. The prediction that cues would reduce mind wandering was not supported, indicated by no significant main effect of either cues, $F<1$, or order, $F<1$, and no significant cue by order interaction, $F<1$.
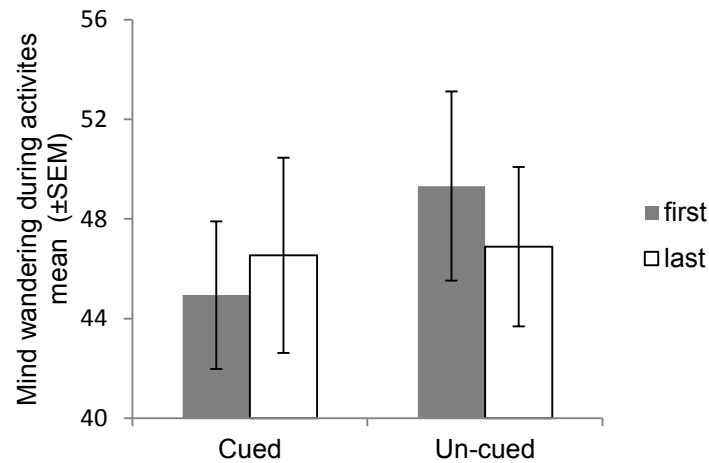
Figure 6: Mean (± SEM) mind wandering during activities as a function of cue condition and order

Adding BDI as a covariate, the main effect of BDI approached significance, $F(1, 51)=3.75$, $p=0.06$, with greater BDI scores being associated with elevated mind wandering during everyday activities. However, the prediction that BDI would moderate the relationships between cues and mind wandering was not supported. There was no significant cue by BDI interaction, $F<1$, and no significant three way interaction between cue, order and BDI, $F<1$. An unexpected significant interaction between presentation order and BDI was revealed, $F(1,51)=4.76$, $p=0.03$. To examine how this affected the relationship between mind wandering and mood, mind wandering ratings in the cued and un-cued condition were averaged for each participant. Then correlations between mind wandering and BDI were calculated. There was no significant correlation between mind wandering and BDI in the group were content-free cues were presented first, $r=-.04$, $p=.82$. However, when

participants completed activities with cues last, there was a significant positive correlation between mind wandering and BDI, r=.43, p=.03.

Next, the hypothesis that content-free cues maintains mood was tested. As with the SenseCam task, change scores were calculated, subtracting self-reported happiness (or sadness) before each activity from self-reported happiness (or sadness) during each activity and combining the three activities by calculating the mean. Thus, as in the previous calculations, positive scores indicate that happiness (or sadness) increased and negative scores that happiness (or sadness) decreased. Overall, activities led to an increase in happiness and decrease in sadness (see Table 4).

Table 3

Changes in mood during activities

	Change in happiness		Change in sadness	
	Cued	Un-cued	Cued	Un-cued
Mean	9.26	8.65	-9.05	-6.26
SD	12.71	11.10	13.01	11.76
Min	-19.00	-30.00	-73.00	-59.00
Max	64.33	39.67	16.67	16.67

There were two outliers in the data indicating the changes in happiness during when carrying out pleasant activities. For consistency they were included in the analysis. Once again the results therefore need to be interpreted cautiously. Figure 7 shows the changes in happiness when carrying out pleasant activities. The prediction that content-free cues led to a higher increase in happiness during every-day pleasant experiences was not supported. There was no significant main effect of cueing, F<1, or order, F<1, and no significant cue by order interaction, F<1.
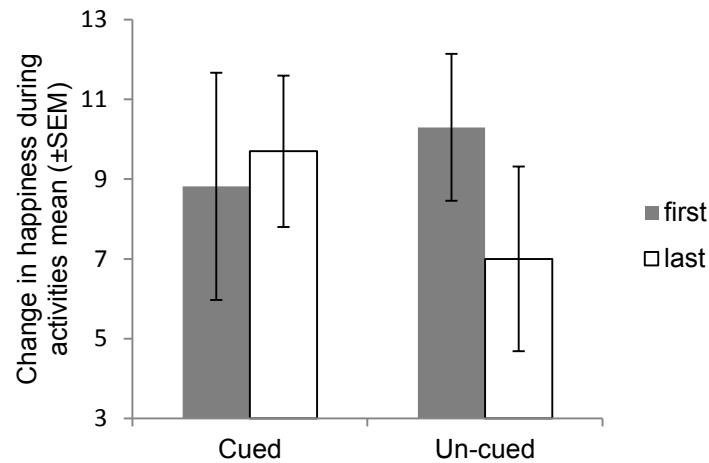
Figure 7: Mean (± SEM) changes in happiness during activities as a function of cue condition and order (higher scores indicate greater increases in happiness)

Adding BDI as a covariate in the ANOVA, the main effect of BDI approached significance, $F(1,52)=3.26$, $p=.08$, indicating that higher depression severity was associated with a higher increase in happiness during activities. There was no significant cue by BDI, $F<1$, or order by BDI interaction, $F(1,52)=1.03$, $p=.32$. However a significant three way interaction between, cue, order and BDI was identified, $F(1,52)=6.53$, $p=0.01$. To resolve this interaction, correlations between BDI and change in happiness were calculated separately depending on which order the cue was presented. In the group that completed activities with cues first there was a significant positive relationship between changes in happiness and BDI in the cued condition, $r=.44$, $p=.02$[3] , suggesting that greater increase in happiness in participants with higher depression scores. There was no significant correlation in the un-cued condition, $r=.15$, $p=.43$. In the group in which tones were presented last there was a non-significant positive correlation between change in happiness and BDI in the un-cued condition, $r=.32$, $p=.10$ and a non-significant negative correlation when cues

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[3] Re-running the analysis with outliers removed, the correlation between changes in happiness and BDI in the cued condition no longer reaches significance, $r=.286$, $p=.157$.

were present, r=-.12, p=.53. This suggests that there is some support for the hypothesis BDI did moderate the relationship between cues and increased happiness. Higher BDI scores were however only associated with more pronounced increases in happiness in the cued relative to the un-cued condition in the group where cues were presented first.

The impact of cues on changes in sadness is presented in Figure 8. The prediction that cues would lead to a higher reduction in sadness was weakly supported, as there was a trend towards a significant main effect of cueing $F(1,54)=2.87$, p=.10 in the ANOVA. There was no significant main effect of order of presentation, $F<1$, nor a significant cue by order interaction, $F<1$. The reduction in sadness was more pronounced in the cued as opposed to the un-cued condition irrespective of which condition was presented first.
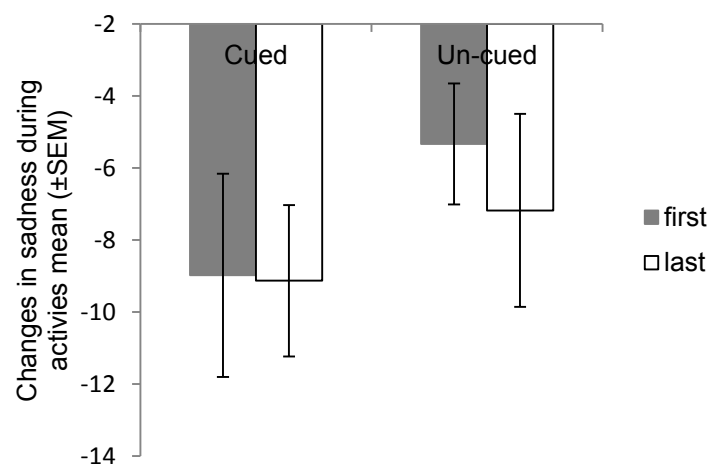
Figure 8: Mean (± SEM) changes in sadness during activities as a function of cue condition and order (negative scores indicate decrease in sadness)

Including BDI as a covariate in the ANOVA, the main effect of BDI was not significant, $F(1,52)=1.10$, p=.30, indicating that BDI scores were not associated with sadness changes overall. The prediction that BDI moderates the effect of cueing was not supported by the data, as there was no significant cue by BDI Interaction, $F<1$.The

cue by order by BDI interaction was not significant, F(1.52)=3.09, p=.09. There was also however a significant order by BDI interaction, F(1,52)=4.02, p=.05. To follow this up, data from the cued and un-cued condition were averaged as a first step and then correlations between changes in sadness and BDI were calculated. In the group where tones were presented first there was a significant negative correlation between change in sadness and BDI, r=-.37, p=.05, while there was no significant correlation in the group where tones were presented last, r=.16, p=.41.

In summary, Hypothesis Three that content-free cues would reduce mind wandering and maintain mood, in terms of more happiness, when carrying out pleasant every day activities was not supported by the data. However there was a trend that cues led to a higher decrease in self-reported sadness. The second part of Hypothesis Three that BDI scores would moderate the effect of cueing was also not supported.

The feedback given by participants about their experiences completing the activities with tones was not analysed systematically due to limited space, however there were certain trends noticeable. There were significant differences between individuals, with some experiencing the tones as distracting and annoying and others reporting finding the tones helpful to stay present in the moment and enjoying the activities more. There were also differences in how individuals experienced the tones during different activities, e.g. finding them helpful during the walk but not while reading. It is therefore possible that the null results above could be due to aggregation effects of combining different activities.

Discussion

This thesis aimed to examine whether content-free cues in the form of auditory tones can reduce mind wandering and enhance mood in various contexts and whether this effect is more marked as depression severity increases.

Phase 1 tested if content-free cues reduce mind wandering during a computer based sustained attention task, attempting to replicate a study by Manly et al. (2004) who found that cues reduced mind wandering in brain-injured participants measured via a behavioural index. In contrast to Manly et al.'s findings, no reduction in the behavioural index of mind wandering was found in the overall sample. However, measuring mind wandering via retrospective questionnaires, content-free cues reduced mind wandering in all participants. Higher depression severity was furthermore associated with more frequent mind wandering. Contrary to the prediction the reduction in mind wandering was not more pronounced with an increase in depression severity.

Phase 2 aimed to test if content-free cues would reduce mind wandering and enhance mood during a mildly pleasant event in the laboratory and if this would be more pronounced as depression severity increased. In line with predictions there was a trend towards reduced mind wandering in the cued condition in comparison to the un-cued condition. Contrary to predictions, cues did not enhance mood and no moderating effect of depression severity was identified. However, it is of note that as the self-rated enjoyment of the videos indicated that they were experienced as neutral, the lack of effect of cues on mood might be due to the videos not leading to sufficient change in mood.

The third phase represented a translation to clinical practice, testing if content-free cues can lead to an augmentation of activity scheduling (a central part of behavioural activation interventions for depression). This was tested by combining ratings over three activities: going for a walk in pleasant surroundings, eating food one enjoys and reading an interesting book or magazine. Contrary to prediction, cues did not reduce mind wandering or boost happiness. However, there was a trend towards a more pronounced reduction in self-reported sadness when cues were

present as compared to the un-cued version. As in the previous task there was no moderating effect of depression severity.

Overall, findings from the study were largely null. This may have been influenced by several overall limitations in the design of the study. Firstly, there were several confounding effects of order of presentation which illustrate significant practice/habituation confounds. In hindsight, it might have been better to employ a between groups design, in which participants are assigned randomly to either a cued or un-cued condition.

In relation to Phase 1, there have been criticisms of using SART errors as a behavioural index of mind wandering. Helton and colleagues (Helton, 2009; Helton Kern, & Walker, 2009; Helton, Weil, Middlemiss, & Sawers, 2010) argue that the SART does not represent a measure of sustained attention and therefore cannot be used to assess mind wandering. Instead they suggest it is a measure of impulsivity and response strategy, i.e. balancing the benefits of speed of responding as opposed to accuracy. Despite the presentation of tones at random times in both this and Manly et al.'s (2004) study, it is furthermore possible that his tones were on average further away from the non-frequent target, and as such might have been less helpful in inhibiting pressing the button.

A limitation in Phase 2 was that the video order was not counterbalanced systematically due to experimenter error. SenseCam videos were additionally not experienced as a pleasant event. Further piloting would have been helpful to identify this limitation allowing attempts to put together more pleasant videos. Alternative video clips could have been used which have been shown to induce positive emotions.

In all tasks, mind wandering was assessed via retrospective self-reports, which are inherently biased due to social desirability, acquiescence and as well as other response styles (Cohen, 2005) and are furthermore problematic as due to memory difficulties and limited meta-consciousness, instances of mind wandering

may be missed (Schooler, Reichle, & Halpern, 2004). Another weakness of the study was that changes in mood were calculated by subtracting a mood state at the start of the task (happiness state before video and activities) from the mood during the task. With the order of the tasks, it is possible that tones might have been experienced as negative as they were first presented during the SART, in which participants are usually aware when they make mistakes.

The sample in this study consisted of participants who were highly educated and the mean age was about 26, which might limit the generalisability of the findings, as there have been suggestions that older age might be associated with less frequent mind wandering (McVay, Meier, Touron, & Kane, 2013). Only a small proportion of the sample (N=13) did not have a history of depression, which made it not possible to carry out a between group comparison of depressed and never-depressed individuals in terms of the effect of cues. As the study was not powered sufficiently to accept the null hypothesis for any of the analyses conducted, it is not possible to conclude that content-free cueing is ineffective.

Considerations for further research

There are several methodological considerations for further research. Firstly, the nature of the tone used as content-free cues might be important. It is possible that a different length or frequency might have been experienced as more helpful. Engagement with activities and tones might have been enhanced if participants selected the tones themselves and/or if they could have been presented via their own phones. Future studies could also explore if it would be beneficial to normalise the experience of mind wandering more explicitly. Participants might have judged themselves negatively when they heard the tones and their minds were wandering and therefore as opposed to helping them be more present, the tones might have led to more mind wandering for some participants. Future research might benefit from including mindfulness based instructions.

Clinical implications

It is possible that mind wandering is particularly harmful for depressed individual as it may represent a precursor to ruminative thinking which has been linked to both the onset and maintenance of anxiety and depression (Smith, & Alloy, 2009). A reduction of mind wandering might furthermore represent a mechanism for change in several effective interventions for treating depression, such as behavioural activation, mindfulness-based and attention training-based interventions. This study tested if it is possible to reduce mind wandering and thus enhance mood by providing people with a crutch to help them focus on the present moment, as opposed to teaching them new skills. While some evidence was found to support the hypothesis that content-free cues can reduce mind wandering in laboratory tasks this was not replicated when participants completed pleasant activities, akin to activity scheduling in behaviour activation approaches. However, there was a trend towards a higher reduction in sadness during activities when content-fee cues were presented. Further research is necessary to establish whether an adaption of this or other procedures targeting mind wandering can be used to increase emotional reactivity in depressed individuals.

Conclusion

This study examined whether content-free cueing cues can reduce mind wandering and enhance mood in various contexts and if cues could be particularly helpful in individuals with higher depression severity. In line with predictions, content-free cues reduced mind wandering in two laboratory tasks. However, this was not replicated when participants carried out pleasant activities at home. Contrary to predictions, cues did not bolster happiness, while there was some evidence that when cues were present sadness reduced more during pleasant everyday experiences as opposed to carrying out the activities without tones. No moderating effect of depression severity on the effects of tones was identified. However, there were

several limitations in this study and further exploratory research would benefit from

making adjustments in design to test if cues can be beneficial.

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Part 3: Critical appraisal

This critical appraisal focuses on the empirical paper, outlining the research process from the development of the research question and material to the testing phase and data analysis. It includes a discussion of the limitations of the study and suggestions for future research. The appraisal concludes with reflections on my personal experience of carrying out this study.

How the research came about

My interest in depression stems from my pre-training experience working in primary care. I was struck by how many people presented with the condition and the challenges in helping individuals on their journey towards living their lives in a more fulfilling way. When my external supervisors Fionnuala Murphy and Barney Dunn made the suggestion for a research project aiming to use content-free cues in the form of auditory tones to enhance performance of depressed individuals, I was excited about the prospect of working with experienced scientists and learning about how basic empirical science can inform clinical practice.

During our initial meetings we developed ideas to make the project more clinically relevant. We decided to use tones as an augmentation to activity scheduling and talked about options to test whether tones could impact on reactivity to positive experiences under more tightly controlled laboratory conditions. This was in order to bridge the gap between using tones in a laboratory task of attention and a practical application in the form of activity scheduling.

Study design and measurement

We initially planned to analyse the data using both a continuous design (with varying depression severity) and a between groups design (currently depressed versus

never depressed). The advantage of the continuous design is that it allows taking depression severity into account and has greater power than between groups designs for continuous variables (Altman, & Royston, 2006). The advantage of using a between groups design is that it enables comparison between two different groups. Given that individuals with a history of depression commonly experience residual symptoms (Judd, 1997; Judd et al., 1999; Paykel et al., 1995), it is possible that their response to cues differs systematically from a population who does not have a history of depression.

To examine the impact of content-free cues a repeated measures design was employed (administering each task once with and once without tones) to control for effects of individual differences, thus reducing random error (Howitt & Cramer, 2011). An additional advantage of this design is that a smaller sample size is needed than in a between groups design. To control for order effects, due to practice, boredom or habituation, the order of presentation was counterbalanced and order effects were calculated (Bergh, & Vrana, 1998; Collie, Maruff, Darby, & McStephen, 2003). Findings showed that there were several significant order effects, suggesting that in this case it would have been better to use a between groups design.

The first phase of the research consisted of a replication of Manly et al.'s (2004) study, which found that content-free cues reduced inattention, or mind wandering, in brain-injured individuals during the sustained attention to response task (SART). I was interested in whether content-free cues could also have beneficial effects in individuals with varying symptoms of depression. In the early stages of testing, however, it became apparent that some participants made very few errors of commission (SART errors), which were used as a behavioural index of mind wandering. In retrospect, it seems logical that there would be a difference between the performance of brain-injured and depressed people. As the literature suggests that mind wandering increases with time spent on the

task (Smallwood, O'Connor, & Heim, 2005), the length of the task was increased in the final design. A more extensive pilot might have alerted me to this.

Phase Two aimed to present a pleasant event to test whether tones could impact on mood. I researched different mood induction procedures and my external supervisor introduced me to the idea of the SenseCam, which takes pictures within defined intervals through a wide-angle lens (Hodges et al., 2006). These are then combined to make a 'video'. A decision was made to use SenseCam videos as I could make the videos myself, thus creating two similar versions used in the repeated measures design and they could mirror the experience of carrying out pleasant activities in real-life. This method also enabled me to present tones on a quiet background (a lot of emotion induction procedures use music to induce mood). After brainstorming many different ideas for video content, a walk in the park, a walk in urban environment and a cycle ride were recorded. I piloted the videos with friends in the first instance, whose ratings confirmed that videos were experienced as pleasant, and then piloted versions with the first five participants in the study. Feedback from pilot participants indicated that they preferred one of the versions over the other and that the cycle ride triggered several different memories, as it depicted an environment they were familiar with. I therefore recorded further park and city scenes and used these as the final test materials.

The two different scenes were chosen to increase enjoyment of the task, reasoning that people might have different preferences in terms of enjoying nature or enjoying being in a busy environment. However, with participants choosing between two different videos, additional confounding variables were included. With a focus on making the videos similar, sufficient attention was not paid to whether these were experienced as enjoyable events. The final analysis indicated that the videos were experienced as neutral, furthermore indicating that additional effort should have gone into piloting the

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mild mood induction procedure. It would have been helpful to additionally pilot a mood induction procedure successfully applied in previous research, e.g. presenting an emotion eliciting film and asking participants to imagine getting involved in the situation (Gross & Levenson, 1995) to establish how strong the mood induction was. The challenge was to have a mild induction of positive mood because if induction was too strong, it was thought that cues would have been unlikely to have any additional effects. Due to difficulties in finding two similar enough films to enable counterbalancing, I could have limited the design to a between participants design.

In Phase Three I decided to include three different mildly pleasant every-day experiences, which could be completed with tones. After programming the watches this task was piloted and the frequency of presenting the tones was reduced from 12 to seven tones over a 15-minute time interval. While instructions were given to use the tones as prompts to focus on the present moment and one's sensory experiences, nothing was said to participants about the potential impact tones might have on mood. I wondered whether participants had any expectations in this regard. Given that expectations of treatment outcomes have been found to play an important role (Greenberg, Constantino, & Bruce, 2006), I wondered if the effect of cues would be increased if more positive expectations were induced.

As the first phase was a performance task in which people noticed the number of mistakes they made, it is possible that this may have led to a negative association with the tones. Depressed individuals might furthermore be more judgemental of their performance and notice negative aspects and therefore might have judged themselves negatively when they heard the tones and their minds had been wandering. It might have therefore been helpful to state more explicitly that mind wandering is a common

experience and encourage them to adopt a non-judgemental attitude towards their experience of mind wandering akin to mindfulness instructions.

I furthermore developed rating sheets to assess mood and mind wandering in Phase Two and Three. I decided to use a visual analogue scale ranging from 0="not at all" to 100="a great deal" to capture a wide range of experiences. In hindsight a smaller scale might have been more beneficial as there have been suggestions that while reliability increases when more scale points are presented (Nunnally & Bernstein, 1994) this diminishes beyond five points (Lissitz & Green, 1975).

Developing the response sheets for participants I aimed to make the wordings as clear as possible and present it in a user-friendly fashion. However, in an earlier version some items were missed and I therefore redesigned it to include boxes in which to enter their scores. The validity of measuring mind wandering via retrospective self-report is also questionable. It relies on accurate memory of thought processes and due to limited meta-consciousness, instances of mind wandering are missed (Schooler, Reichle, & Halpern, 2004). However, it was not possible to use thought probes during the task as they might have interfered with the cueing condition. Participants might also vary in what they perceive as "a great deal" depending on how aware they are of how frequently they think about things removed from the here and now in general.

Several additional measures where included in the study, which were not described in the empirical paper, in order to make it more focused. These were mood questionnaires in order to distinguish between anxiety and depression which commonly present comorbidly (Rapaport, 2001) and a measure of anhedonia only well as questionnaires measuring constructs related to mind wandering (mindfulness, rumination and attention related cognitive errors experienced in daily life questionnaires). This resulted in a big battery of tests.

One of my concerns was volunteers' experience in participating in the research and the demand put on them in terms of time (testing lasted 90-120 min) and concentration in the attention task, especially considering that a further part of the research in terms of activity scheduling was to be completed over the week following the laboratory session. I felt it was important that I ensured that they felt valued, were asked for their views and how they were experiencing the testing session. To my delight, despite expressing some criticisms of the tasks and measures used (e.g. the quality of the video and some questions being repetitive in the questionnaires), when I enquired about these criticisms specifically, the majority of people reported that they enjoyed the testing session overall, while the remaining few were neutral about their experiences. I am aware that this might be a biased picture due to difficulties expressing dissatisfaction. The written qualitative feedback of the rating sheets of the activity scheduling furthermore suggested high compliance with the task.

Overall, a great amount of preparation went into this research. I was struck by how many small decisions needed to be made, which might all have an effect on the final results. I learned that when developing new testing materials, it is important to invest more time in the pilot phase and fully test the new measures. Alternatively, I could have used more paradigms used in previous research. While these also need piloting, it might have been less time intensive.

Recruitment and testing

A great advantage of conducting the study in a research setting was that I could recruit online from an existing general volunteer panel. Initially attendance was very good. However, it dropped to below 50% of the advertised slots towards the end of the study, despite sending email reminders. I therefore called participants prior to testing to confirm if they were able to attend.

As one of my main concerns was not obtaining a large enough sample of depressed individuals, I concentrated on recruiting volunteers who were currently feeling low or depressed in mood from an early stage. My aim was to test at least 28 individuals who at the time of testing met the criteria for depression according to the depression part of the Structured Clinical Interview for DSM - IV Axis I and II disorders (SCID; First, Spitzer, Gibbon & Williams, 2002). However, as depression is a recurrent disorder, several participants who did not currently meet the diagnostic criteria, had a history of depression. Therefore, as I noticed towards the end of testing, I did not have sufficient number of volunteers who had no history of depression to carry out a between groups analysis. Keeping in mind that time would also been needed for the analysis and write up, I decided to stop testing after 63 volunteers (including five pilots) and only conduct an analysis using continuous design.

After the extensive preparation phase I was keen to start testing. I found it very helpful to have a protocol sheet for each participant to make sure that all measures were completed and to ensure the order of the presentation of tones was counterbalanced. In my enthusiasm and as I included different videos, I overlooked the need to counterbalance the order of presentation of the videos. I would recommend preparing a counterbalance order sheet prior to starting testing.

During the testing phase, I was struck by how different the stance of a researcher is to my usual experience working within a therapeutic capacity. Administering the SCID, I had to monitor myself to stick to the protocol and not to ask additional questions. It was also difficult for me to not ask more about people's experiences of seeking treatment for depression and discussing treatment options. All depressed volunteers were given an information sheet on accessing support in their local area, as well as a list of useful resources they could find online.

Data analysis

As I had entered the data into SPSS during the free testing slots, the next major challenge was to make sense of a huge amount of data. I eventually focused on the data that directly addressed the main hypotheses and decided on the most efficient way to analyse the data. With hindsight, it would have been helpful for me to have a clearer idea about data analysis while designing the study.

For brevity I decided to average participants' experience of the three behavioural activation activities to determine whether content-free cueing can be helpful to decrease mind wandering and increase happiness and decrease sadness. However, both the rating sheets and written feedback from participants indicated that there was a variation in whether they experienced the tones as helpful depending on the task they engaged in. In retrospect it would have been useful to analyse activity separately. Moreover, it would have been informative to systematically assess the qualitative written feedback of the behavioural-activation task.

I also decided not to report data on the additional questionnaires as their analysis would have been more exploratory. I wanted to keep the thesis focused and the analysis would have led to more extensive discussion. For example, we found that mind wandering was not consistent across the different tasks. Mind wandering assessed during the tasks also correlated differently with measures related to mind wandering, such as rumination, mindfulness and attention related cognitive errors in daily life. I found it a difficult decision to not include all measures, due to the effort put in by participants and myself to collect the data. However, we are intending to write up the results at a later stage, which will include more measures.

I noticed that only small effect sizes were identified and these had large standard deviations, which suggest that there was a lot of variability across participants and led

me to wonder if there were any specific characteristics of people who experienced tones as helpful. Calculating the statistics, I decided to report all data in the results including outliers as some data included a high number of outliers and the power would have been reduced if they had all been removed. As it is important to adopt a consistent approach across all analyses it was not possible to vary the strategy of dealing with outliers depending on how many were identified. An alternative procedure would have been to change all outliers to the closest data point below. The advantage of this procedure is that while the trend of the data is still included, outliers do not have such a significant impact.

Balancing research and clinical work

During the time of the research my clinical work involved treating refugees and asylum seekers with post-traumatic stress disorder. While I found it challenging at times to combine research and clinical work and noticed that it was more difficult to be the therapist I aspire to be, overall, I found it helpful to have clinical work as a balance. Delivering therapy and building a relationship with my clients has always been very rewarding to me and I felt inspired by how brave and strong my clients were in talking about the most horrendous experiences they have had to face. My colleagues were also very kind and supportive both in regard to my clinical work and in giving me emotional support.

Conclusions

Overall the empirical study was an ambitious project. A lot of material was developed specifically for this study and further piloting might have improved the quality of the design. More detailed planning of the analysis strategy might have led to a reduction in mistakes, such as not counterbalancing in Phase Three.

While the findings of the study did not indicate that content-free cues should be used as an intervention approach as employed in the study, I think it is premature to dismiss the potential of using cues as a crutch to reduce mind wandering and enhance the enjoyment of mildly pleasant activities. Further research could investigate whether cues can be experienced as more helpful using variations in study design, e.g. by normalising how common mind wandering is and introducing ideas of mindfulness, helping individuals to adopt a non-judgemental, accepting orientation towards their thoughts and allowing clients to choose the type of content-fee cues used. Alternatively, cues could be piloted as part of a mindfulness intervention, involving clients to practice mindfulness exercises with cues first.

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Appendixes

Appendix A: Recruitment information

Study Name	# Content-free cueing in depression (Nina Brauner 2012/3112)
Abstract	This project aims to find out whether presentation of auditory tones can influence engagement in and experience of both laboratory-based and real-world everyday activities for people with and without depression.
Description	We are interested in recruiting people who are currently feeling depressed in mood. You will be asked to attend one session at the CBU and to complete a number of pleasant everyday activities in the following week. During the session at the CBU, you will be asked to fill in a series of mood questionnaires and answer some questions about current and past symptoms of anxiety and depression. We will also ask you to complete a simple computer task while listening to auditory tones. Following the computer task we'll ask you to watch two short videos and answer some questions about your experience. Next, we will then ask you to schedule three everyday pleasant activities to carry out twice in the following week; going for a walk in a pleasant surrounding, eating food you enjoy and reading an interesting book or magazine. We will give you a watch to take home, which you can activate to play auditory tones during one of the activities. Before and after each activity we will ask you to rate how you are thinking and feeling in various ways. We will ask you to return the watch and your ratings to us in a prepaid envelope. Each activity will take approximately 15 minutes to complete. To take part in the experiment you will need to have enough free time in the following week to complete the activities. We estimate the session at the CBU will last up to one hour and 45 minutes and the activities will talk a further 1 hour 45 minutes, so we will reimburse you for around 3.5 hours in total.

Please note that if volunteers cancel or fail to arrive this makes our research more difficult and costly. We therefore rely on the goodwill of our volunteers to arrive on time. Volunteers who are unreliable are unlikely to be selected for future studies.

PAYMENT: Payment will be made by bank transfer and will take at least 30 days from the date that you return the test material after the home testing part of the study. Please provide the researcher with your bank accounts details (Bank, Sort Code, Account Number) on the day of testing. |
Eligibility Requirements	Age 18 -65, not currently receiving treatment for depression
Prescreen Restrictions	YES -[**View/Modify Restrictions**]
Duration	105 minutes
Preparation	If you wear glasses or hearing aids please remember to bring them with you.

Pay	23.5 Pounds
Researcher	Nina Brauner Email: **nina.brauner@mrc-cbu.cam.ac.uk**
Principal Investigator	**Principal Investigator**
Participant Cancellation Deadline	24 hours before the study is to occur
Study Status	Visible to participants (approved) Active study (appears on list of available studies)
Automatic Credit Granting	Credit will be automatically granted for timeslots where no action was taken, that are more than 48 hours old. Automatic credit grant is done once per day.
Ethics Approval Code Approval Code	CPREC 2012.26

Appendix B: Differences in demographic and clinical variables depending

on SART order

Table 4:

Demographic and clinical variables for the overall sample and different conditions

Group	All participants (N=58)	SART cued first (N=29)	SART un-cued first (N=29)	Difference SART order
N gender female (%)	29 (50%)	16 (55.2%)	13 (44.8%)	*χ2(1)=1.68, p=.20*
Mean age (SD)	26.38 (9.29)	27.28 (9.76)	25.48 (8.88)	*t(56)=.73, p=.47*
Mean BDI-II (SD)	21.28 (12.94)	22.69 (14.40)	19.86 (11.38)	*t(56)=.83, p=.41*
Mean NART pred verbal IQ (SD)	114.59 (7.49)	114.34 (7.55)	114.83 (7.56)	*t(56)=-.24, p=.81*
Native English speakers	42 (79.3%)	25 (86.2%)	21 (72.4%)	*χ2(1)= .62, p=.43*
Mean Years of education (SD)	15.61 (2.89)	15.45 (2.63)	15.78 (3.17)	*t(56)=-.43, p=.67*

BDI-II= Beck Depression Inventory – 2nd edition (Beck, Steer, & Brown, 1996); NART= National Adult Reading Test (Nelson, 1982)

Appendix C: Information sheet

LOGO

Information Sheet for Volunteers Considering Participating in the Study Entitled:

Content-free cueing in dysphoria

Please read the information below to decide if you would like to take part in the project and ask a member of the team if you have any questions.

What is the purpose of the study? We are interested in finding out whether presentation of auditory tones can influence engagement in and experience of both laboratory-based tasks and real-world, everyday activities. We are interested on the influence on auditory tones on individuals with varying degree of dysphoria, which is a state of feeling unwell or unhappy. This study is important as it may help us to better understand the link between depression and reductions in positivity and possibly lead to improvements of existing treatments for depression.

Why have I been asked to take part? You are being asked to participate because we are interested in dysphoria and so are recruiting people with varied levels of depressed mood.

What will happen to me if I take part? If you decide to take part, you will be asked to attend the Cognition and Brain Sciences Unit, 15 Chaucer Road, Cambridge for a single testing session lasting approximately 90 - 120 minutes. You will additionally be asked to complete six pleasant activities lasting approximately 15 minutes each on your own time during the following week. We will give you a payment of £6 an hour for your time after you have returned all information in a prepaid, addressed envelope. You will also receive an email from the researcher after the study to tell us about your experience.

What do I have to do? You will be asked to fill in questionnaires, including questions about symptoms of depression and anxiety you have recently experienced. Next, you will be asked to complete a simple computer task while listening to auditory tones. The task will be explained to you first and you will have an opportunity to practice. Following the computer task we will show you two short videos. Finally you will be asked to arrange six pleasant activities during the coming week. You will receive a watch to take home, which you can activate to play auditory tones. We will ask you to return the watch and rating sheets via a prepaid envelope.

Are there any risks in taking part? We do not anticipate any specific risks associated with your involvement in this study. All of the tasks we will ask you to complete have been used safely in previous research.

Other information: This study has received ethical approval from the Psychology Research Ethics Committee of the University of Cambridge. The data we collect will be used in confidence, and no identifying information will be stored with the data, to safeguard your confidentiality. The data will be stored in a locked filing cabinet, which only the investigators will have access to, and on secure CBU computer systems for a minimum of 10 years in accordance with good research practice. Results from the study will be presented at conferences and written up in journals. Results will always be presented in such a way that data from individual volunteers cannot be identified.

You are free to decide not to take part in the study and can withdraw from the study at any time and for whatever reason. If you do decide not to take part or to withdraw you do not need to explain your reasons to us if you do not want to.

Who is funding the research: This research is funded by the MRC Cognition and Brain Sciences Unit (CBU), 15 Chaucer Road, Cambridge, CB2 7EF and University College London, Gower Street, London, WC1E 6BT.

Thank you for reading this information sheet and for considering taking part in the project.

For further information please contact

Nina Brauner, Trainee Clinical Psychologist
Research Department of Clinical, Educational and Health Psychology
University College London
Gower Street
London
WC1E 6BT

or

Fionnuala Murphy, Investigator Scientist
MRC Cognition and Brain Sciences Unit
15 Chaucer Road
Cambridge UK
CB2 7EF

Appendix D: Consent form

logo

Consent form for Volunteers Considering Participating in the Study Entitled:

Content-free cueing in dysphoria

	Please tick
I confirm that I have read and understood the information sheet for the above study.	
I have had the opportunity to ask questions and had them answered.	
I understand that my personal information will remain confidential and that all efforts will be made to ensure I cannot be identified (except as might be required by law)	
I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason.	
I agree that the data gathered in this study may be stored anonymously and securely, and may be used for future reearch.	
I hereby fully consent to take part in the above study.	

Name of researcher: …………………………..

Signature of researcher: …………………………..

Name of participant: …………………………..

Signature of participant: …………………………..

Date of birth: …………………………..

Ethnicity: …………………………..

Years in education: …………………………..

Date: …………………………..

Appendix E: Ethical approval letter

Karen Douglas
Secretary

Dr F Murphy
MRC Cognition and Brain Sciences Unit
15 Chaucer Road
Cambridge
CB2 2EF

UNIVERSITY OF CAMBRIDGE

CAMBRIDGE
PSYCHOLOGY RESEARCH
ETHICS COMMITTEE

10 April 2012

Application No: 2012.26

Dear Dr Murphy

'Content-free' cueing in dysphoria

The Cambridge Psychology Research Ethics Committee has given ethical approval to your research project: 'Content-free' cueing in dysphoria, as set out in your application dated 21 March 2012.

The Committee attaches certain standard conditions to all ethical approvals. These are:

(a)   that if the staff conducting the research should change, any new staff should read the application submitted to the Committee for ethical approval and this letter (and any subsequent letter concerning this application for ethical approval);

(b)   that if the procedures used in the research project should change or the project itself should be changed you should consider whether it is necessary to submit a further application for any modified or additional procedures to be approved;

(c)   that if the employment or departmental affiliation of the staff should change you should notify us of that fact.

Members of the Committee also ask that you inform them should you encounter any unexpected ethical issues.

If you would let us know that you that you are able to accept these conditions, I will record that you have been given ethical approval.

Yours sincerely

K S Douglas

cc: Dr B Dunn

17 Mill Lane
Cambridge CB2 1RX
Telephone: 01223 766894
Fax: 01223 332355
E-mail: mb422@admin.cam.ac.uk

Appendix F: Activity scheduling form

Planning Activities

Please schedule each of the following three activities <u>lasting about 15 minutes</u> twice for the next week, once with and once without tones from the watch (see back for instructions how to activate the watch):

- Going for a walk in a pleasant surrounding **(Walk)**
- Eating food that you enjoy **(Food)**
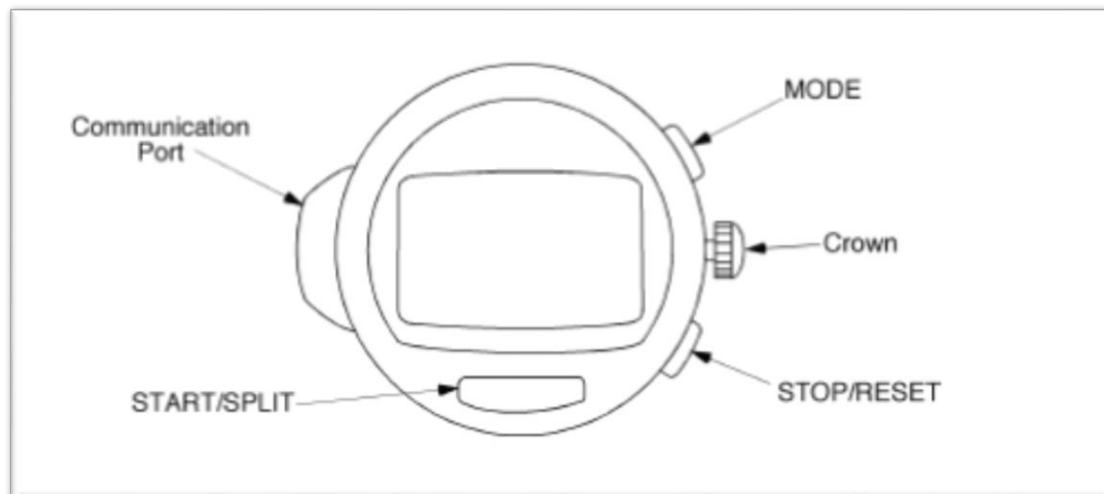- Reading an interesting book or magazine **(Reading)**

Date	Time	Activity	Tick if tone present

Appendix G: Instructions on using the watch

<u>**Using the watch**</u>

<u>**Controls**</u>

The figure below illustrates the locations of the watch controls.

<u>**How to start the tones:**</u>

First, **activate the 'INTERVAL TIMER', by pressing the 'MODE' button** at the top right corner of the watch. The words 'INTERVAL TIMER' will appear on the display, followed by a screen with INT 1 on top, a number and the word ACTIVITY.

Then, **to start the tones press the 'START/SPLIT' button** below the display. The watch will now play tones at varying intervals.

To stop the tones, press the 'STOP/RESET' button on the bottom right corner of the watch. To reset the tones, press the 'STOP/RESET' button and hold it down.

To return to the display of the time, press the 'MODE' button at the top right corner of the watch.

If you have any questions, please email me: Nina.Brauner@mrc-cbu.cam.ac.uk.