Mind Wandering, Memory and Mood

Joseph Hickey

D.Clin.Psy Thesis (Volume 1), 2013

University College London

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.

Joseph Hickey

21 June 2013

Overview

Unplanned off-task thinking (mind wandering) is a common ephemeral experience which has recently received increased scientific and clinical attention. This thesis investigated continuity between unplanned thought and memory processes and sought to show that mind wandering may disrupt pleasurable experience in dysphoria.

The literature review aimed to determine whether the constructs of involuntary autobiographical memory and retrospective mind wandering describe the same phenomenon. The memory literature suggested four predictions about the correlates of retrospective mind wandering. A review of 11 mind wandering studies found some support for the prediction that unplanned thoughts are less subject to executive control when they are retrospective. Predictions about the cueing, recall probability and content biases of retrospective mind wandering require further research. Contextualisation in the memory literature offers promise for better understanding the causes and content of mind wandering.

The empirical paper tested the hypothesis that mind wandering is a causal mechanism of disrupted pleasure (anhedonia). An unselected sample of 49 participants underwent positive mood inductions with and without distraction, followed by a task training inhibitory control of negative material and repeated mood inductions. Negative distraction successfully increased mind wandering and reduced sadness repair from positive material but these attenuations were not altered by inhibitory control training. Longer training and more precise manipulations of mind wandering were suggested for future studies.

The critical appraisal noted some of the challenges encountered in pursing the aims of the thesis, proposed some improvements to mind wandering measurement in light of recent theoretical developments and outlined how errors in affective forecasting for memories, encountered anecdotally during testing, might be studied empirically.

Table of Contents

List of Tables

PART ONE: LITERATURE REVIEW

PART TWO: EMPIRICAL PAPER

List of Figures

PART ONE: LITERATURE REVIEW

PART TWO: EMPIRICAL PAPER

Acknowledgements

I am grateful to participants from the UCL subject pool who took part in the empirical study.

I wish to thank my supervisors, Dr Barney Dunn and Professor Nancy Pistrang, for their expertise, patience and encouragement throughout this project.

Part One: Literature Review

Retrospective Mind Wandering and Involuntary Autobiographical Memory: A Theoretical and Empirical Review

Abstract

Aims

Involuntary memories and mind wandering have received significant but separate research attention in the past decade. Different interventions are used when these events present clinically. This review aimed to determine whether the constructs of involuntary autobiographical memory (IAM) and retrospective mind wandering (MW) describe the same underlying phenomenon, by identifying: (i) the frequency of retrospective MW; (ii) what variables affect retrospective MW; and (iii) whether those variables support predictions from the memory literature in relation to environmental cues, working memory, recall probability and content biases.

Method

The PsychInfo, EMBASE, MEDLINE and Social Sciences Citation Index databases were systematically searched for data with which to evaluate the four predictions. Study inclusion criteria were at least one quantitative or qualitative measure of the temporal focus of MW, adult participants and any experimental or naturalistic design.

Results

Eleven papers were identified by the search. There was some evidence that the association between working memory and retrospective MW is weaker than with other types of MW. There was limited evidence for associations between retrospective MW and negative mood. The predictions about environmental cues and content biases could not be evaluated with the available evidence.

Conclusions

MW appears to be less subject to executive control when it is about the past. Retrospective MW and IAM may describe similar underlying phenomena. Further research is needed to clarify the extent of the overlap and fully to evaluate the

predictions made above. Establishing these links could support the development of integrative clinical interventions related to involuntary memory and MW.

Introduction

In the past decade, two types of ephemeral mental event – mind wandering and involuntary autobiographical memories – have received concerted investigation from a cognitive psychology perspective for the first time. When mind wandering is about the personal past, is it the same as involuntary autobiographical memory? This review aims to answer that question, by examining recent research into retrospective mind wandering in the context of what is known about involuntary autobiographical memory.

A better understanding of mind wandering and involuntary autobiographical memory is of use to the clinician as well as the researcher. Most simply, these events are a routine part of mental life; understanding them better may yield new ways of engaging with clients' subjective experience. There are also good reasons to believe that mind wandering and involuntary autobiographical memories are relevant to poor mental health. As will be seen, these phenomena are thought to share underlying memory systems with the distressing intrusive memories reported in difficulties such as post-traumatic stress disorder. Repetitive negative thoughts, not related to current activity, characterise many psychological disorders. Conceptualized as rumination, repetitive negative thinking about the past is predictive of the onset and maintenance of depressive disorders (e.g. Nolen-Hoeksema, 2000). Mind wandering is more frequent when individuals are depressed or dysphoric (Smallwood, O'Connor, Sudbery & Obonsawin, 2007; Watts, MacLeod & Morris, 1988). Mindful awareness of the present moment, the opposite of mind wandering (Mrazek, Smallwood & Schooler, 2012), may form the basis of effective interventions for depression relapse (Ma & Teasdale, 2004; Piet & Hougaard, 2011; Teasdale at al., 2000).

If these aspects of mind wandering and involuntary memory indeed overlap, clinical interventions from one field could be useful for presentations associated with

the other. For example, clinicians working with problems of inattention in depression might explore the mnemonic content of a patient's off-task thinking. Techniques aimed at reducing memory frequency and vividness could then be useful for difficulties that initially present as concentration problems. For intrusive memories in depression, attributions and beliefs may mediate distress (Newby & Moulds, 2010). Targeting the metacognitive aspects of repetitive thought (e.g. Watkins et al., 2006) might be applicable to problematic intrusive memories in depression. The relationship between retrospective mind wandering and involuntary autobiographical memory could therefore be of interest to the clinician in a number of ways. The first stage in comparing these constructs is to define them in greater detail.

Mind wandering occurs when thoughts unrelated to a current task enter conscious awareness. It is a ubiquitous experience, estimated to occupy at least 30% of waking time (Killingsworth & Gilbert, 2010). Historically, mind wandering has been studied under a number of guises. In the first half of the 20th century the phenomenon was understood in terms of Freudian psychodynamics, as a projective expression of unconscious fantasies and wishes (e.g. Freud, 1907/2001). The quantitative study of daydreaming was pioneered by Singer (1966), using a Jamesian stream of consciousness as the conceptual framework (James, 1890/2000; Giambra, 1974, 1980). The terminology has gradually become more descriptive: task-unrelated thought (Giambra, 1989; Smallwood, Baracaia, Lowe & Obonsawin, 2003), stimulus-independent thought (Teasdale et al., 1995) and, most recently, stimulus-independent task-unrelated thought (Stawarczyk, Majerus, Maj, Van der Linden & D'Argembeau, 2011). In this review, the term mind wandering will be used to mean off-task thinking in general, and other specific terms will be used only when distinctions (e.g. between stimulus- and task-independence) are relevant. The recent growth in mind wandering research was stimulated by Smallwood and Schooler's

review (2006). This surveyed the growing experimental literature on mind wandering, and argued strongly for its relevance to the study of consciousness, attention and executive function.

Over the same time, following Berntsen (1996), there has also been a surge in interest in routine involuntary memory, as distinct from flashbacks and intrusions following traumatic events. Involuntary autobiographical memories have been defined as those which “come to mind with no preceding conscious attempt at retrieval” (Berntsen, 2009, p. 2). Most people have several such experiences each day and routine events may be remembered voluntarily and involuntarily with equal frequency (Berntsen, 1996, 2007). Spontaneous recall of non-autobiographical material (involuntary semantic memory) has also been explored. These appear to be less frequent than their autobiographical counterparts (Kvavilashvili & Mandler, 2004) but may be linked to hallucinations (Elua, Laws & Kvavilashvili, 2012).

The temporal focus of the mental events defined above is central importance to this review. Involuntary autobiographical memories are always about the personal past, but mind wandering may be about real or imagined events in the past, present or future. Within mind wandering research, temporal focus has received relatively little attention. A notable exception was carried out by Giambra (1977) as part of an important early research programme on mind wandering. He found that, contrary to popular belief, mind wandering about the past does not increase with age. More recently, retrospective mind wandering has been found to be less frequent that prospective mind wandering (e.g. Smallwood, Nind & O’Connor, 2009), but the proportion and absolute frequency of retrospective mind wandering has not been compared across studies using different methodologies.

Are involuntary autobiographical memories and retrospective mind wandering the same thing? When the content of mind wandering is retrospective but

not autobiographical (e.g. off-task thoughts about ancient Rome), the answer must be no. Similarly, task-irrelevance must not be confused with the absence of volition. A common self-report measure of retrospective mind wandering asks participants how often they "thought about something that happened in the distant past" during a task they have just completed (Thinking Content scale of the Dundee Stress States Questionnaire; DSSQ-TC; Matthews, Joyner, Gilliland, Huggins & Falconer, 1999). In other words, off-task thinking may arise because of a deliberate recall process. Spontaneous off-task thoughts about the *personal* past, however, would seem to fit both constructs equally well.

The rest of this introduction will present an account of current theory relating to mind wandering and involuntary autobiographical memory. This reveals some interesting similarities at the phenomenological and theoretical levels, which are summarised in a synthesis section. This synthesis yields a number of predictions about retrospective mind wandering, relating to how it is cued, the role of executive control processes, the influence of attention biases and mind wandering content. These predictions will then be evaluated against the available empirical literature.

Models of Mind Wandering

Cognitive psychology accounts of mind wandering broadly agree that the occurrence and content of task-unrelated thoughts reflect an interaction between executive processes, environmental cues and automatic thoughts. When studying executive processes, a common approach (e.g. McVay & Kane, 2010) is to mix trait and state measurement, with span-type working memory tasks to predict individual differences in executive functioning and working memory demands systematically varied across different tasks. In general, the mind wanders less when it is occupied. Reported mind wandering is consistently found to decrease as task demands increase (e.g. Teasdale, Proctor, Lloyd & Baddeley, 1993), and working memory is

negatively correlated with mind wandering during cognitively demanding tasks (Kane et al., 2007; McVay & Kane, 2009).

The resource consumption debate. Whether mind wandering itself consumes executive resources is a disputed point. McVay and Kane (2009, 2010) argue that it does not. Their *control failures* × *concerns* hypothesis states that mind wandering occurs when a lapse of attention control permits off-task thoughts to intrude into awareness. McVay and Kane suggest that these intrusions are prompted by environmental cues and arise from a continuous stream of thought, fed by current concerns (unresolved goals which are active in the individual's awareness; Klinger, 1978). The opposing view, in which mind wandering requires executive resources (e.g. Smallwood & Schooler, 2006), may be characterised as a resource competition model, whereby task-unrelated thoughts compete for the processing resources originally dedicated to task-focused cognitive activity. This position was supported in a recent study of task-unrelated thought in undemanding conditions (Levinson, Smallwood & Davidson, 2012).

Smallwood (2010) posited a global availability hypothesis which integrates some aspects of these stances. This states that mind wandering occurs when task-unrelated material captures sufficient executive resources to become globally available and enter conscious awareness. In Smallwood's (2010) model, proactive and reactive control processes constrain the access to a global workspace by task-unrelated material generated from current concerns. The default mode network (a distributed brain network more active during wakeful rest than during demanding tasks; e.g. Whitfield-Gabrieli & Ford, 2012) is suggested as a neural substrate for spontaneous self-referential mental activity, including intrinsic attention and current concerns. The global workspace is a hypothesised distributed brain network which shares information across a range of verbal and memory processes. When task

demands are high, Smallwood's (2010) model broadly concurs with that of McVay and Kane (2010). When task demands are low, however, Smallwood (2010) argues that the control failures account is insufficient because these processes are not significantly engaged. He suggests that in these situations, default mode material can gain unconstrained access to the workspace, resulting in sustained mind wandering.

Summary. The question of resource consumption is debated, but there is agreement on a gating role for the central executive and on the importance of environmental cues and current concerns in generating interfering thoughts. The mind wandering models outlined above have not been specified to account for the temporal focus of mind wandering. It may be inferred, however, that the content of mind wandering will be determined by availability of cues in the individual's environment, and by their goals or concerns as sustained by default mode processing.

Models of Involuntary Autobiographical Memory

Current theoretical understanding of involuntary autobiographical memory is informed by research from diverse fields, including episodic or autobiographical memory, involuntary memory and clinically significant intrusions, imagery and flashbacks. A disputed question is whether there is a distinct involuntary memory system. Berntsen (2009) argues that involuntary autobiographical memories are generated from the same underlying episodic memory system as voluntary memories. This implies that the same factors promoting encoding and maintenance (e.g. emotional intensity, positivity, recency and rehearsal) will apply to both types of recall.

Involuntary memory retrieval. According to Berntsen (2009), the mode of retrieval is the key difference between voluntary and involuntary memory. In an established cognitive account of autobiographical memory (e.g. Conway & Pleydell-Pearce, 2000; Conway & Loveday, 2010; Conway, 2009), there are two modes of

retrieval, generative and direct. Generative retrieval is characterised as an effortful, iterative search process in which search information is used to activate knowledge representations. The knowledge thus activated modulates the search information, which is then used to access further representations, and so on. Generative retrieval continues until direct retrieval occurs, when the search information indexes or corresponds to information in the target knowledge representations. Direct retrieval fulfils the encoding specificity principle (Tulving & Thompson, 1973), which states that in order to access a memory, there must be some match between the search information or cue and the target memory information. All involuntary remembering thus occurs by direct retrieval, when an internal or external cue activates the basic episodic element or a related conceptual frame (Conway, 2009).

Berntsen suggests two further constraints on retrieval besides the specificity principle, to account for the fact that involuntary memories typically occur much less frequently than viable cues. The first, she argues, is situational cognitive demands: involuntary autobiographical memories are promoted by a "relaxed state of awareness" (Berntsen, 2009; p. 96). This is a consistent phenomenon in diary studies (e.g. Berntsen, 1998; Kvavilashvili & Mandler, 2004), but these do not include independent measures of attention focus. Cognitively undemanding states could promote involuntary autobiographical memories by allowing activation to spread more quickly (Mace via Ball 2007), or because executive control over which memories enter awareness is reduced (Conway & Pleydell-Pearce, 2000). Ball (2007) found that increasing cognitive load using a concurrent vigilance task resulted in participants reporting fewer autobiographical memories. The second constraint is referred to as cue-item discriminability (Rubin, 1995). When a cue is distinctive, more relevant memory representations are activated and irrelevant ones deactivated.

Berntsen suggests that cue-item discriminability is promoted by six hypothetical cue factors: cue underload (an environmental cue matches a single memory); multiple cues (several coincident cues match a single event); distinctiveness (the most different memory is activated when multiple memories match a cue); encoding or maintenance factors (such as rehearsal, emotion and recency); and motivational biases. Motivational biases here refer to preferential attention to memory cues which are associated with the person's current concerns (Klinger, 1978). This element is consistent with the goal system that links long-term plans with the hierarchy of memory structures in Conway's model of autobiographical memory (Conway, Singer & Tagini, 2004). In summary, Berntsen (2009) proposes that involuntary autobiographical memory is part of the general episodic memory system and characterised by direct associative retrieval, constrained by the encoding specificity principle, cognitive resource availability and cue-item discriminability.

Clinical perspectives on involuntary memories. The clinical tradition of research into involuntary memories inevitably places greater emphasis on atypical or maladaptive processes. An influential model is the dual representation theory of Brewin and colleagues (Brewin, Dalgliesh & Joseph, 1996). In its revised form (Brewin, Gregory, Lipton & Burgess, 2010) this model proposes two types of memory. Sensory memory representations (S-reps) encode perceptual information, via low-level sensory cortical areas, amygdala and insula. Contextual memory representations (C-reps) encode relatively abstract declarative and spatio-temporal information via sensory association areas and the hippocampus. In routine memory formation, S-reps are linked with C-reps, contextual information becomes integrated into semantic and autobiographical memory, and the S-reps gradually become inaccessible to retrieval without an appropriate cue (following the encoding

specificity principle). During encoding of traumatic events, some association between S-reps and C-reps is maintained in healthy individuals. During pathological encoding of traumatic events, S-reps are stronger relative to C-reps, and the connections between the two are impaired or absent.

According to Brewin's revised dual representation theory (Brewin et al., 2010), the intrusive memories and images now known to occur in many disorders (e.g. depression, specific phobia of vomiting) often reflect the normal activity of the autobiographical memory system. They may arise through direct retrieval of long-lasting S-reps by emotional or environmental cues, or when generative retrieval of C-reps produces images which involuntarily activate intensifying S-reps. Compared with intrusive memories in other disorders, flashbacks in post-traumatic stress disorder (PTSD) are experienced as an involuntary reliving of the experience in the present moment. The revised model suggests that during flashbacks, the S-rep activated by cue-driven direct retrieval is not modulated by contextual and autobiographical information from C-reps and experienced more like perception than memory.

Summary. While Brewin's dual representation theory has been criticised by Berntsen for advocating a special system for involuntary memory, there is actually considerable overlap between Brewin's revised theory (Brewin et al., 2010) and Berntsen's (2009) proposed model. Notably, S-reps and C-reps are conceived as hierarchical elements in a general autobiographical memory system. There is also broad agreement on the factors influencing involuntary memory production between these two perspectives. The role of cue-driven direct retrieval is fundamental to both accounts. Some of the cognitive factors proposed by Brewin et al. (2010) to account for the increased frequency and intensity of intrusive memories in clinical groups

(e.g. selective attention and negative appraisals) correspond to the cue-item discriminability factors hypothesised by Berntsen (2009).

Emotion, Involuntary Autobiographical Memory and Mind Wandering

Emotional valence and intensity are important variables for both involuntary autobiographical memory and mind wandering. Dual representation theory outlines the marked effect of intense negative emotion during encoding. Emotion in non-clinical involuntary memory has received less attention. In a laboratory study, Kvavilashvili and Schlagman (2011) found that dysphoric and non-dysphoric participants reported the same number of involuntary autobiographical memories, and that their memories did not differ objectively in the amount of negative content. They did, however, observe a mood congruency effect whereby dysphoric participants rated memories as subjectively more negative and experienced more adverse mood shift from negative involuntary autobiographical memories. A range of diary studies have found that the intensity and positivity recall biases known to exist in voluntary memory also apply to involuntary autobiographical memories (Berntsen, 1998, 2001; Berntsen & Hall, 2004; Berntsen & Rubin, 2008).

Mind wandering research has also found links with mood. Mind wandering appears to increase during periods of dysphoria in laboratory studies (Smallwood et al., 2004; Smallwood, O'Connor, Sudberry, Haskell & Ballantyne, 2004), and in everyday life is related to a subsequent reduction in mood (Killingsworth & Gilbert, 2010). There is preliminary evidence that this relationship is mediated by reduced attention to the present moment (Stawarczyk, Majerus, Van der Linden & D'Argembeau, 2012), and may also be due to greater accessibility of post-task negative thinking, rather than negative valence of the task-interfering thoughts themselves (Marchetti, Koester & De Raedt, 2012).

Overall, these results suggest that both mind wandering and involuntary autobiographical memory can affect mood state via their content, or by attention capture away from the present moment. The memory literature also indicates that the involuntary memory content will be moderated by valence and intensity of emotion at encoding.

Synthesis

The foregoing overview of mind wandering and involuntary autobiographical memory shows that there is empirical and theoretical correspondence between these constructs in four areas: cues, executive function, goals and emotion. Both of these involuntary mental events are primarily cued by environmental stimuli, though the memory literature gives a more detailed account of how this happens. The contribution of executive resources is acknowledged but contentious in both literatures. There is agreement on a gating function, with executive control moderating the entry into conscious awareness of task-irrelevant thoughts and activated memory representations. There is debate about whether mind wandering requires executive resources. Berntsen (2009) hints that resource competition occurs in involuntary autobiographical memory formation, but involuntary memories are generally thought to occur through bottom-up, associative processes which are not directly subject to executive control. Current concerns or goals are assigned a different role in the memory and mind wandering literatures. An individual's current concerns and goals are proposed as a direct source of mind wandering content, whereas in autobiographical memory cue-goal congruence increases the likelihood of a specific memory being retrieved. Finally, emotion has an impact on content and subsequent mood effects of mind wandering and involuntary autobiographical memories. The memory literature emphasises emotion at encoding and demonstrates intensity and valence biases in content generation, whereas the mind wandering

research suggests that these attention-grabbing events could have a deleterious effect on mood regardless of their content.

Predictions

What are the implications of this discussion for the study of retrospective mind wandering? The involuntary autobiographical memory literature allows us to make a number of predictions about mind wandering to the past. First, following the factors which are proposed to influence involuntary autobiographical memory retrieval, we may predict that retrospective mind wandering will be more often triggered by environmental cues than will mind wandering in general, and that cue underload, multiplicity and distinctiveness will increase the likelihood of the mind wandering to a given past event. Second, working memory will be less strongly associated with retrospective mind wandering than with mind wandering in general. This follows from the proposition that executive control processes cannot influence which memory representations are activated, only gate access to which activated representations enter consciousness; the overall retrieval process is under less top-down control. Third, we may predict that attention and motivational biases related to current concerns and goals will influence the probability of the mind wandering to a given past event. Fourth, we may predict that the content of retrospective mind wandering will show emotional intensity and positivity biases, as found in the involuntary autobiographical memory literature.

Aims of the Current Review

So far, some areas of theoretical and empirical correspondence between involuntary autobiographical memory and mind wandering have been suggested, and a number of predictions about retrospective mind wandering have been made from the memory literature. The next step is to assess whether these predictions are supported by existing studies of retrospective mind wandering. This is clinically

useful because an improved model of retrospective mind wandering will increase our understanding of its occurrence and content in psychological disorders. A review of the mind wandering literature was carried out for this purpose. The review aimed to identify all published studies of mind wandering which included temporal focus as a variable, in order to establish: (i) the frequency of retrospective mind wandering; (ii) what variables affect mind wandering to the past and (iii) whether these variables support the predictions made about retrospective mind wandering in relation to environmental cues, working memory, recall probability and emotional intensity and positivity content biases.

Method

Inclusion Criteria

Studies of retrospective mind wandering were selected for the review according to the criteria below.

Participants. Adults aged 18-65 recruited from any clinical or non-clinical population.

Outcomes. At least one quantitative or qualitative measure of the temporal focus of mind wandering.

Study design. Any experimental or naturalistic design, including randomised controlled trials (RCTs), controlled trials, cohort studies, case series and case reports were considered for inclusion.

Search Strategy

The search strategy was informed by two features of the literature. First, retrospective mind wandering has been studied under a range of names and empirical constructs; second, studies may have gathered relevant data despite not focusing explicitly on the temporal focus of mind wandering.

Studies were identified from a combination of database searches, reference lists of relevant papers, citations searching, and publication lists of researchers in the field. To identify all studies relating to mind wandering (regardless of temporal focus), title and abstract searches were conducted using the following databases: PsychInfo, EMBASE, MEDLINE and Social Sciences Citation Index. The final search structure consisted of two sets of terms, each with a number of the variants as specified below.

1. Mind wandering

(mindwander* OR mind-wander* OR (mind NEAR wander*) OR (zone NEAR out*) OR (mind NEAR pop*) OR daydream)

OR

2. Task-unrelated thoughts

((task OR stimul* OR goal) NEAR (*relevant OR *related OR intefer* OR *dependent)) NEAR (thought* OR think* OR cognition* OR image*)

Study Selection

Figure 1 shows the search results and study selection process. Titles of studies returned by the database searches were screened to remove duplicates, and identify peer-reviewed journal articles in English. The titles and abstracts of these items were read to identify studies likely to be relevant to mind wandering. The full texts of these articles were then compared to the inclusion criteria to identify suitable studies of past-focused mind wandering.

Twenty-two studies met the inclusion criteria. A group of 13 older studies used a 344-item questionnaire about daydreaming and related mental processes, called the Imaginal Processes Inventory (IPI; Singer & Antrobus, 1963). These studies met the inclusion criteria because the IPI includes a “Past in Daydreaming” scale. This appears to tap global beliefs about mental activity without distinguishing

between planned or unplanned thoughts (e.g. asking respondents whether they agree with statements such as “I think a lot about the past”). This is problematic for the current review because the nine other studies (all published since 2006) all specifically examined unplanned or off-task thinking. The extent to which the IPI has convergent validity with *in vivo* measures of mind wandering has also not been established. The 13 IPI-only studies were therefore excluded from the results to ensure a reasonable level of consistency in the studies under review. The single study which used some parts of the IPI in conjunction with other measures (Mason et al., 2007a, 2007b) was retained.

An additional two studies were identified from the reference lists of studies returned from the database search. A total of 11studies were included in the final group for review.

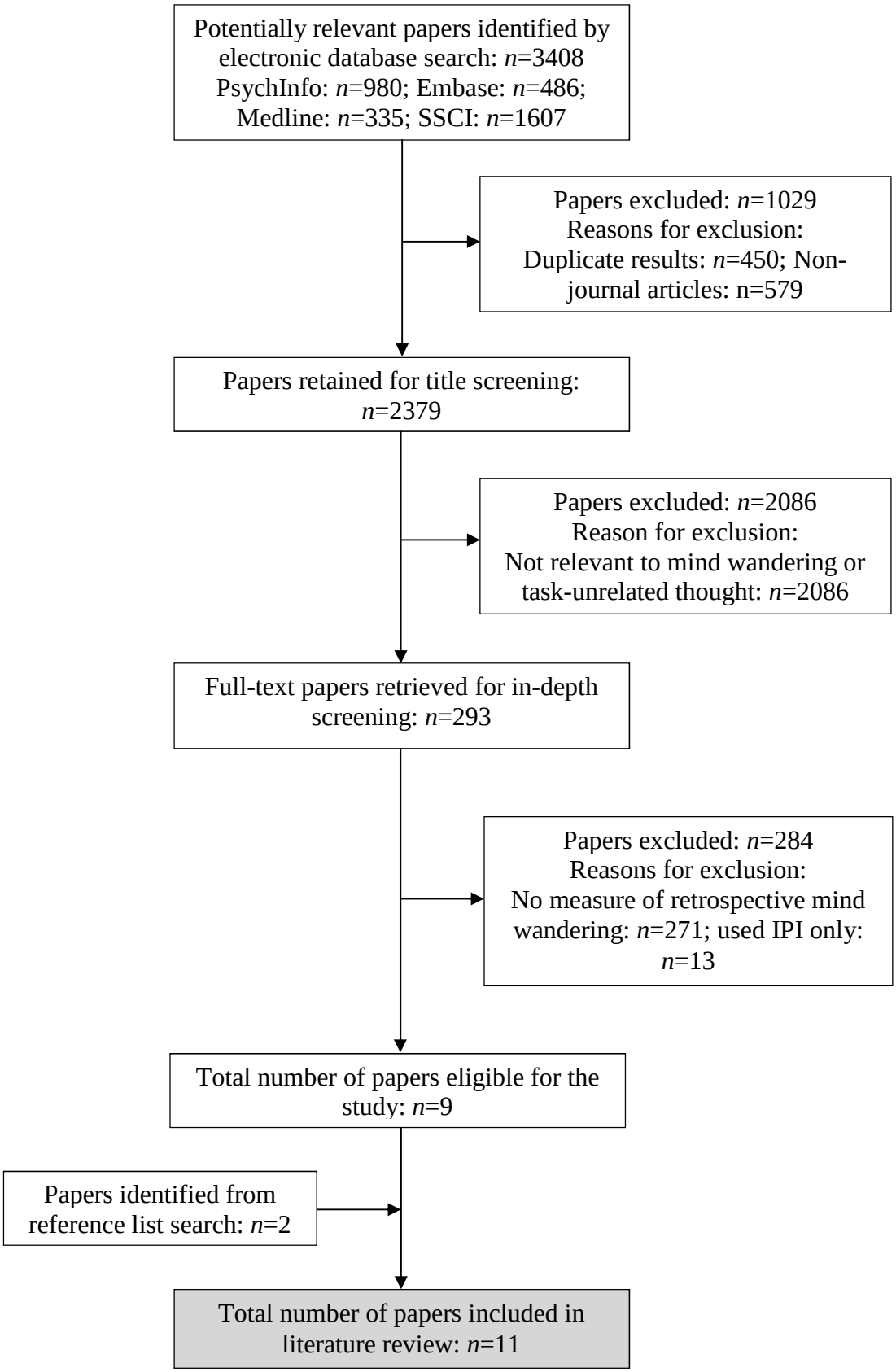


Figure 1

Selection of mind wandering studies for review

Results

Study Characteristics

Features of the individual studies included in the review are described in Table 1 below.

Paradigms. The majority (eight) of the reviewed studies used experimental designs to collect data in the laboratory with mind wandering as a dependent variable. The paradigms used in these studies were broadly representative of the mind wandering literature as a whole, with a task requiring some degree of mental focus used as a cognitive context for identifying off-task thinking. A brief summary of these paradigms is necessary to clarify how these studies relate to the four predictions made above.

Three main types of task were used in the experimental studies. The choice reaction time task, used in a number of studies by Smallwood, Schooler and colleagues, was most common. In this task participants must distinguish between stimuli and non-stimuli and react accordingly, such as pressing a key to indicate the parity of a coloured digit (stimuli) appearing among a series of black digits (non-stimuli). Other studies used the sustained attention to response task (SART) or working memory tasks. The SART is commonly used as a behavioural measure of mind wandering (Manly, Robertson, Galloway & Hawkins, 1999). Participants are instructed to press a key in response to each of a series of digits presented on a screen. They are told not to press for an infrequent target digit (e.g. the number 3). Key presses in response to this target digit (i.e. errors of commission) are taken to be a proxy for mind wandering. Working memory tasks require participants to retain information (such as the parity of a number or a number sequence) for a brief period, and often perform some operation on the information (typically reversing or re-ordering it). The task can be made more demanding by increasing the amount of

information to be retained and the complexity of the operation performed, or by mixing encoding with processing tasks (e.g. reading or simple sums), as in the operation span task (OSPAN; Turner & Engle, 1989).

Only one study (Song & Wang, 2011) used a more naturalistic approach, collecting mind wandering data from daily life rather than during a laboratory task. Two studies (Critcher & Gilovich, 2010; Delaney et al., 2010) treated the temporal focus of mind wandering as an independent variable which was manipulated during an experimental procedure.

Table 1

Studies of the temporal focus of mind wandering

Author(s) (Year)	Study	Construct	Design	*N*	Independent variable (Tasks)	Mind wandering measure	Selected findings
Baird, Smallwood & Schooler (2011)	-	MW	Experimental, between-subjects	47	Working memory (Choice RT, Operation span)	Free text entry thought probes during choice RT task. Responses coded on task focus (on-task / off-task), temporal focus (past / present / future) and cognitive orientation (self-related / goal-directed)	Past was least frequent temporal focus for both self-related and goal directed off-task thoughts. Working memory differentially correlated with MW based on temporal focus. Most retrospective off-task thoughts self-related, whereas most prospective off-task thoughts mixed self-related and goal-directed content
Critcher & Gilovich (2010)	Study 2	MW	Experimental, between-subjects	101	Temporal focus (MW scenario with concurrent and past conditions)	Novel four-item questionnaire with three attribution items and one pleasure item	MW to past event less likely to be interpreted as sign of boredom than MW to concurrent event.
	Study 4	MW	Experimental, between-subjects	55	MW attribution (Attribution manipulation, puzzle task, writing task with concurrent and past conditions)	11-point rating scale asking how often participants' minds tended to wander to thoughts of doing other things (anchors almost never / all the time).	Concurrent MW reduces task enjoyment when no alternative attribution for the MW is available.
Delaney, Sahakyan, Kelley, & Zimmerman (2010)	Study 1	DD	Experimental, between-subjects	138	Temporal focus (Word lists task, temporal focus manipulation, free recall test)	Word recall proportion	Participants thinking of older event recalled fewer words. Inverse linear relationship between age of parental visit memory and word recall proportion.

Author(s) (Year)	Study	Construct	Design	*N*	Independent variable (Tasks)	Mind wandering measure	Selected findings
Fransson (2006)	-	TUT	Experimental fMRI, between-subjects	14	Default mode network activation (Rest and working memory task)	Five retrospective visual analogue scales rating characteristics of task-unrelated thought during working memory task	Task-unrelated thoughts concerning autobiographical memories were reported as frequently as future / planning thoughts
Mar, Mason & Litvack (2012)	Study 2	DD	Questionnaire, between-subjects	17566	Social focus of DD (Online questionnaire)	Three-item questionnaire with five-point scale rating agreement with past-, present- and social-focus daydreaming items	Daydreams most often focus on social interactions, followed by future, with retrospective daydreams least common.
Mason, Norton, Van Horn, Wegner, Grafton, Mcrae (2007a, 2007b)	-	MW	Experimental fMRI, within-subjects	19	Default mode network activation (Resting baseline, novel and practiced working memory tasks)	Self-reported post-task rating scales, post-scan interviews, Imaginal Process Inventory (daydream frequency scale)	Increased default network activity occurred in conditions where stimulus-independent thoughts were more common. Similar proportions of retrospective and prospective MW reported in post-scan interviews
Smallwood, Nind & O'Connor (2009)	Study 1	MW	Experimental, within-subjects	76	Working memory (Choice RT)	Forced-choice thought probes during choice RT and working memory tasks (task / past / future)	Increasing working memory load reduces prospective but not retrospective mind wandering.
	Study 2	MW	Experimental, within-subjects	77	Working memory (Reading task)	Forced-choice thought probes during working memory task (present / past / future / no temporal period)	Retrospective and prospective MW equally suppressed by reading task, relative to working memory task. When interest in reading matter low, greater experience of reading matter associated with retrospective MW bias
Smallwood & O'Connor (2011)	Study 1	MW	Experimental, mixed	59	Mood (Video mood induction, SART)	DSSQ-TC following SART	MW about distant past more frequent following negative mood induction
	Study 2	MW	Experimental, mixed	82	Mood (Velten mood induction, choice RT task)	Forced-choice thought probe during choice RT (present / past / future / no temporal period)	Three-way interaction between time point, mood condition and depression symptoms. Retrospective MW increased following negative mood induction, magnitude of increase associated with BDI-II score

Author(s) (Year)	Study	Construct	Design	*N*	Independent variable (Tasks)	Mind wandering measure	Selected findings
Smallwood, Schooler, Turk, Cunningham, Burns & Macrae (2011)	Study 1	MW	Experimental, mixed	45	Self-reflection, working memory (Self-reflection manipulation, choice RT, working memory task)	Forced-choice thought probe (present / past / future)	Self-reflection induces prospective MW bias
	Study 2	MW	Experimental, mixed	70	Self-reflection, working memory (Self-reflection manipulation, choice RT, working memory task, surprise word recall)	Forced-choice thought probe (present / past / future / no temporal period)	Strength of self-reference effect associated with prospective MW bias
Song & Wang (2012)	-	MW	Experience sampling, mixed	165	(Six prompts over three days to complete MW questionnaire)	Novel 23-item questionnaire concerning MW content, reasons/cues, current context and meta-awareness	Cues from internal thoughts, but not external surroundings, predicted MW episodes. Retrospective MW less frequent than prospective or no temporal period, more frequent than present-focused mind wandering.
Stawarczyk, Majerus, Maj, Van der Linden, D'Argembeau (2011)	Study 2	MW	Experimental, between-subjects	53	Self-reflection (Personal goals or mental navigation writing task, SART)	Forced-choice thought probes during SART (past / present / future / no precise temporal orientation), post-task assignment of future and past thoughts into age categories, novel nine-item Thought Characteristics Questionnaire.	Future-orientated mind wandering more frequent than past / present / none. More future-orientated mind wandering in personal goals group. Mind wandering relating to day of testing was more common than other time periods.

Note. MW = mind wandering; DD = daydreaming; RT = reaction time; fMRI = functional magnetic resonance imaging; SART = sustained attention to response task.

Measures of mind wandering temporal focus. Most studies measured the temporal focus of mind wandering in straightforward ways, often treating time as a categorical variable. Measurement approaches will be briefly outlined below, in order to assess the strengths and weaknesses of the evidence.

Novel or adapted questionnaires following an experimental task were the most common means of measuring mind wandering and its temporal focus (six studies). Only Smallwood and O'Connor (2011) used a validated instrument for this purpose, the Dundee Stress States Questionnaire (DSSQ; Matthews et al, 1999). The Thinking Content scale of the DSSQ is a 16-item measure assessing thought content during a recent task. Two eight-item factors tap task-related interference (e.g. "I thought about how I should work more carefully") and task-unrelated thought (e.g. "I thought about something that happened earlier today") by asking participants to rate agreement with the statements on Likert-type scales. The DSSQ-TC contains several items in the task-unrelated thought factor which relate to temporal focus. The separate Thought Characteristics Questionnaire, used in conjunction with thought probes by Stawarczyk, Majerus, Maj, Van der Linden and D'Argembeau (2011) was used in a number of earlier studies of involuntary memories. This requires participants to rate thoughts during a recent task on a number of scales, including level of visual imagery and affective content.

Experience sampling thought probes were used in four studies. These consist of on-screen questions which interrupt a task and ask participants about their thoughts at that moment. Most common were forced-choice probes which required participants (or judges, as in Baird, Smallwood and Schooler, 2011) to characterise off-task thinking as past-, present- or future-focused. Three of the probe studies were laboratory-based, whereas Song and Wang (2012) used mobile phone text messages to collect data during daily life. Stawarczyk et al. (2011) was the only study to

distinguish between different types of off-task thinking by using both task-relatedness and stimulus dependency dimensions in thought probes.

Only two studies measured the temporal distance of retrospective mind wandering episodes. The DSSQ-TC (used by Smallwood and O'Connor, 2011) allowed participants to rate their overall mind wandering focus during a task to today, the recent past, the distant past and the future. Stawarczyk et al. (2011) required participants to assign each of self-rated past and future thoughts to one of six temporal distance categories, ranging from the present day to greater than one year away in the past or future.

Samples. All studies used non-clinical samples, six of which were comprised of undergraduates. Clinical inferences based on these data will necessarily be tentative. Most (eight) sampled fewer than 100 participants, with Mar, Mason and Litvack's (2012) large-scale online study a significant outlier. No study included a power analysis with their results, although Mar et al. (2012) used effect size analysis rather than traditional null hypothesis statistical tests due to the very large power afforded by their sample.

Frequency of Retrospective Mind Wandering

Of the 11 reviewed studies, 9 presented data about the frequency of retrospective mind wandering. Retrospective mind wandering was consistently found to be less frequent than prospective, with six studies reporting statistically significant results.

The four studies by Smallwood, Schooler and colleagues all reported similar data. Baird, Smallwood and Schooler (2011) treated retrospective and prospective mind wandering as non-exclusive categories, scoring each temporal focus as 0 (absent) or 1 (present) for each off-task thought. The mean score for retrospective off-task thought (.12) was significantly less than that of present (.28) and future (.43)

off-task thought. Three further studies from this group found significantly lower rates of retrospective mind wandering. Combining data from high- and low-demand tasks, Smallwood, Nind and O'Connor (2009) found that the mean probability of reporting a retrospective task-unrelated thought when prompted was .23, compared to .33 for a prospective task-unrelated thought. Smallwood and O'Connor (2011) found that the mean probability of retrospective task-unrelated thoughts was .12, compared to .21 for prospective task-unrelated thoughts. Smallwood, Schooler, Turk et al. (2011) observed a probability of .20 for retrospective task-unrelated thought, compared to .32 for prospective task-unrelated thought.

Of the remaining five studies reporting frequency data, four were consistent with the findings above. Song and Wang (2012) also found that prospective mind wandering was more frequent than all other types. In their study of mind wandering in daily life, 22% of mind wandering episodes were retrospective, 16% were present-focused, 41% were prospective and 22% had no time orientation. Stawarczyk et al. (2011) found that prospective stimulus-independent task-unrelated thoughts (SITUTs) were more common than all other orientations. Stawarczyk et al. (2011) also found a recency effect whereby retrospective SITUTs about the present day were more common than any other category (last week, month, year, or longer). Mar et al. (2012) found that 29% of participants "always" or "frequently" daydreamed about the past, whereas 41% "always" or "frequently" daydreamed about the future. Significance testing was not used due to the very large sample size in that study. Mason, Norton, Van Horn et al. (2007b) found that stimulus-independent thoughts about the past (31% of all such thoughts) were slightly less frequent than stimulus-independent thoughts about the future (35%) during a pre-task fixation period.

Fransson's (2006) study provided the only data inconsistent with the existence of a prospective bias to mind wandering. That study found that task-

unrelated thoughts about episodic memory events occurred as frequently as task-unrelated thoughts about future planning.

These studies show a consistent prospective bias to mind wandering, despite their range of reporting and measurement methods. One study reported no bias, albeit with the smallest sample; no study reported a retrospective bias. The data suggest that the ratio of retrospective to prospective mind wandering is about 1:2, and that approximately 20% of total mind wandering activity is retrospective.

Factors Associated With the Temporal Focus of Mind Wandering

Data from nine of the reviewed studies reported an association between mind wandering and at least one other factor. Understanding the direction of causation is important to evaluating these studies. In terms of theory, establishing the direction of associations is central to developing models of the antecedent conditions for retrospective mind wandering. It is also important clinically, so that interventions can be targeted at the right process based on these models. In a simple example, a therapist would work differently if retrospective mind wandering was thought to trigger low mood, or was seen as a maintenance factor for a period of low mood once begun.

One of the reviewed studies (Baird et al. (2011) used a correlational design, limiting the inferences which may be made about the direction of causation. The remaining eight studies used experimental designs which may permit causality to be inferred.

Working memory. Four studies reported data about the relationship between working memory and the temporal focus of mind wandering. Three of these studies measured mind wandering at different levels of working memory load. The probability of recording a task-unrelated thought as retrospective did not vary as working memory load increased across the passive viewing, choice reaction time and

one-back tasks used by Smallwood et al. (2009, study one). By contrast, prospective TUT was suppressed under high working memory demand (one-back task) and showed a similar frequency to retrospective TUT in this condition. Smallwood et al. (2011; study one) also found that retrospective TUT frequency did not differ between choice RT and one-back tasks, whereas prospective TUT frequency was lower in the one-back task. Fransson (2006) found that a demanding working memory task reduced off-task thoughts about episodic memory events to near zero levels (with a similar reduction for future planning thoughts), but did not report significance testing of these changes.

In contrast to these designs, Baird et al. (2011) considered individual differences in working memory capacity by including performance on the OSPAN task as a correlate in their analysis of mind wandering during low-demand tasks. Working memory capacity was not significantly associated with the proportion of retrospective off-task thoughts reported by participants, despite a positive correlation with prospective thoughts and a negative correlation with present-focused thoughts.

The available evidence suggests that the frequency of retrospective mind wandering is unrelated to working memory demands or individual working memory capacity. This pattern holds across the correlational and experimental designs. The reviewed studies are at odds with research showing that general mind wandering and involuntary autobiographical memories are reported less frequently when working memory load increases.

Mood. One study examined the impact of mood upon the temporal focus of mind wandering, using an experimental design in which mood change preceded mind wandering measurement. Smallwood and O'Connor (2011) used two different mood inductions (video and Velten procedure), and two different measures of mind wandering on the SART (post-task DSSQ-TC and thought probes). They found that

negative mood was associated with a retrospective bias to mind wandering. On the post-SART questionnaire measure following a mood induction (study one), participants who observed the negative video reported significantly more thoughts about the distant past than those who observed the positive video. Mood condition did not influence the frequency of thoughts to other time periods (earlier today, recent past and future). In study two, Smallwood and O'Connor (2011) found that retrospective thought increased almost twofold following the negative mood induction, but did not change following the positive induction. The magnitude of this increase in retrospective thought retrospective was related to participants' self-reported depression symptoms (BDI score; sample mean = 7.8). The limited available evidence therefore suggests that negative moods promote retrospective mind wandering.

Self-reflection. Three studies presented data which permitted examination of the relationship between self-reflection variables and the temporal focus of mind wandering. Smallwood et al. (2011; study one) systematically varied self-reflection by asking participants to consider one of three referents (self, best friend, Gordon Brown) and rate the applicability of a series of adjectives. Results showed that the frequency of retrospective thought did not vary between conditions, although prospective thought was more common in the self condition. In a further experiment, Smallwood et al. (2011; study two) used a similar adjective task with a surprise recall test to examine whether the temporal focus of mind wandering between encoding and retrieval was related to preferential remembering for self-relevant over other-relevant material. They found that the strength of this self-reference effect was associated with the frequency of prospective mind wandering (but not retrospective mind wandering) between encoding and retrieval.

Stawarczyk et al. (2011; study two) manipulated goal focus by asking participants to write either about personal goals or about a familiar itinerary. They found that retrospective SITUTs did not differ between groups, but prospective SITUTs were significantly higher in the personal goals group. Since thinking about personal goals may well have involved an increased focus on the future, self-refection and temporal focus were arguably confounded in the study by Stawarczyk et al. (2011), which somewhat limits the applicability of these findings.

The study by Baird et al. (2011), as well as investigating working memory as described above, rated the content of mind wandering on the presence or absence of self-focus and goal-focus (these categories were not exclusive). They sought evidence for an autobiographical planning function for prospective mind wandering and hypothesised that the interaction of self- and goal-related thoughts would be most strongly predictive of a future focus compared to present or past. Baird et al. (2011) found that thoughts containing self-related and goal-related content (presumed to reflect autobiographical planning) were significantly more likely to be prospective than present-focused or retrospective. They found that 70% of retrospective off-task thoughts were about the self, compared with 39% of prospective off-task thoughts. Just 7% of retrospective thoughts combined a self and goal focus, against 53% of prospective thoughts.

These three studies operationalize self-focus in rather different ways, meaning that no firm conclusions can be drawn. The data from Smallwood et al. (2011), Stawarczyk et al. (2011) and Baird et al. (2011) indicate, however, that self-reflection is associated with prospective but not with retrospective mind wandering.

Attributions. One study, Critcher and Gilovich (2010), examined how people interpret mind wandering events, based on its content and the availability of an explanation for the mind wandering. Their study differs from most others in this

review in two ways. In one of their experiments the index mind wandering event was presented to participants in a scenario. In two experiments, temporal focus was manipulated as an independent variable.

In study two, Critcher and Gilovich (2010) presented participants with a scenario in which their mind wanders to a pleasant event occurring either concurrently (a road trip with friends) or in the past (a fun party in the previous week). Participants then completed a brief questionnaire about what they would infer if their mind wandered in this way. Participants in the retrospective condition judged mind wandering as reflecting less boredom and dissatisfaction with participants' current activity than did the concurrent group. In study four, Critcher and Gilovich (2010) induced mind wandering by asking participants to write about enjoyable things they could have been doing during the testing session (concurrent condition), or about enjoyable things they would have done in high school (retrospective condition). All participants then completed a crossword task, with half told that they would shortly need to describe their answer to the writing task (explanation for mind wandering condition) and half told nothing (no explanation condition). Participants in the concurrent / no explanation condition enjoyed the puzzle less than the other three groups, though the difference with the retrospective / no explanation condition showed only a trend approaching significance. Critcher and Gilovich (2010) did not report applying a corrected significance level to account for the inflated risk of type I error in their post-hoc analysis.

The study by Critcher and Gilovich (2010) suggests that retrospective mind wandering is less likely to be attributed to one's own boredom or dissatisfaction than is concurrent mind wandering, and that unexplained mind wandering may be treated as more informative about task enjoyment. The available evidence about attributions

and mind wandering is limited to two studies within a single paper, and the role of explanation is not conclusively demonstrated.

Forgetting. One study, by Delaney et al. (2010), examined how the ability to remember is affected by the temporal focus of mind wandering. Like Critcher and Gilovich (2010), Delaney et al. (2010) manipulated temporal focus as an independent variable. Delaney et al (2010; study one) manipulated whether participants thought about either a place they had visited that day (near-change) or one they had visited weeks ago (far-change), between learning two word lists. Participants in the far-change group recalled fewer words from the first list than participants in the near-change group or a control group; the proportion of words recalled in the far-change group decreased linearly with time elapsed since the last visit. A follow-up study (study two) obtained similar results when manipulating geographical, rather than temporal, remoteness.

The study by Delaney et al. (2010) indicates that increased temporal distance during mind wandering is associated with greater forgetting. The evidence linking retrospective mind wandering to present-moment forgetting is limited to a single study. As Delaney et al. (2010) note, their method in study one may have confounded temporal distance with other types, such as spatial, conceptual and emotional distance.

Discussion

This review was undertaken as a first step to establishing whether the constructs of retrospective mind wandering and involuntary autobiographical memory describe the same underlying phenomenon. The approach used was to compare the theoretical literatures on these constructs, and to examine whether predictions from the involuntary autobiographical memory field could be supported in the empirical literature on mind wandering. This approach has consolidated

knowledge about clinically-relevant mental events from two different areas of cognitive science. It has suggested new areas for clinical investigation and intervention, which are outlined at the end of this discussion.

The findings of the review yielded the clearest evidence about the frequency of retrospective mind wandering, and the association between retrospective mind wandering and working memory. Four specific predictions were made about retrospective mind wandering, derived from the assumption that it would show similar characteristics to involuntary autobiographical memory. Prediction one concerned triggers for mind wandering, and stated that retrospective mind wandering will be more often triggered by environmental cues than mind wandering in general, with cue underload, multiplicity and distinctiveness increasing the likelihood of the mind wandering to a given past event. Prediction two was that retrospective mind wandering will be more weakly associated with working memory than current or prospective mind wandering. The third prediction was that motivational biases, related to current concerns and goals, will influence the probability of the mind wandering to a given past event. The fourth prediction was that the content of retrospective mind wandering will show emotional intensity and positivity biases.

Of these predictions, two were partially supported by the review (working memory and motivational biases) and two could not be evaluated from the available empirical literature (triggers and intensity/emotion biases). This discussion will first summarise what the review revealed about the basic frequency of retrospective mind wandering. The four predictions will then be evaluated in turn, before directions for future research and general limitations are considered.

Frequency of Retrospective Mind Wandering

The results of the review indicate that about one-fifth of mind wandering is retrospectively focused. This finding held across a range of different designs and

measurement strategies, and the one dissenting study had the smallest sample of any addressing the question. The one-fifth figure may be speculatively combined with data about overall mind wandering to suggest how much time is spend in off-task thoughts about the past. In a recent large-scale study (which did not measure temporal focus) Killingsworth and Gilbert (2010) asked participants to report mind wandering during daily life using an app on their mobile phones. They found that people engage in mind wandering for about 30% of their waking time. If the one-fifth figure form the present review is accurate, this suggests that approximately 6% of waking time is spent engaging in retrospective mind wandering.

There are obvious limitations to this evidence. Only a small number of studies have addressed this question, and most of the evidence comes from laboratory paradigms. More naturalistic research into the relative proportions of mind wandering time focus is needed.

Direct comparisons with the frequency of involuntary autobiographical memories are hard to draw because of the differing methodologies involved. Diary studies indicate that people have around 3-5 involuntary autobiographical memories per day (Berntsen, 2007). Diary studies have not yet measured involuntary memory length or rates of concurrent voluntary remembering. In addition, some diary studies have requested only the first one or two involuntary autobiographical memories of each day to prevent demand bias. A comparable figure for the amount of time engaged in involuntary autobiographical memories is therefore not known.

The finding of a prospective bias to mind wandering is theoretically important in the context of the proposed functions of these two types of thought. Autobiographical memories are thought to be useful for social, personal and directive reasons, whereas future thinking may have a more solely directive purpose (D’Argembeau, 2012).

The likelihood for off-task thoughts to be about the future is also clinically relevant. Lack of a prospective and positive bias in voluntary thought tasks has been linked to increased risk of self-harm (O'Connor et al., 2007). Based on the proposed functions of this prospective mind wandering, depressed clients may miss out on many opportunities for *ad hoc* planning or simulation of the future. This could contribute to reduced engagement with activities, targeted as a maintenance factor in all behavioural and cognitive treatments. A prospective mind wandering bias could also be relevant to the disturbances in anticipation and affective forecasting found in dysphoric and depressed individuals (for a review, see Dunn, 2012). Individuals are asked to predict affective response to specific events in most of these studies; measuring the anticipated pleasure from an involuntary simulation of a future event would be an interesting extension. Finally, this bias is also relevant to depression interventions which seek to reduce negative thoughts unrelated to current activity. Rumination-focused cognitive behaviour therapy (Watkins et al., 2006), for example, trains clients to engage in concrete and specific thoughts and behaviours that are grounded in direct experience, rather than global abstraction and analysis. In the future, assessing disruptions to this prospective bias could be a useful indicator of problematic mind wandering and rumination at assessment.

Prediction One: Triggers for Mind Wandering

There were no data to permit evaluation of the first prediction, namely that that retrospective mind wandering will be more often triggered by environmental cues than mind wandering in general, and that cue underload, multiplicity and distinctiveness will increase the likelihood of the mind wandering to a given past event. This reflects the fact that no study included in the review investigated cues relating to specific mind wandering episodes. The study by Smallwood and O'Connor (2011) provided a form of environmental cue by manipulating mood using

videos. Since Smallwood and O'Connor did not include a no-video condition, the effect of environmental cueing on mind wandering remains to be investigated empirically.

Prediction Two: Working Memory

The reviewed studies indicate that working memory is not associated with retrospective mind wandering. This is an intriguing pattern, at odds with the prediction of a weak association relative to prospective mind wandering. It is also divergent from current theoretical orthodoxy and empirical knowledge concerning mind wandering in general.

The possibility of a spurious finding must be considered. The number of studies available for inclusion in this part of the review was low. The lack of an association could reflect insufficient power to detect a significant effect in these studies. It could also, as suggested by Smallwood et al. (2009), be that the working memory tasks were insufficiently demanding and more complex operations would reduce levels of retrospective mind wandering.

The pattern that retrospective mind wandering needs fewer cognitive resources is, however, explicable from the perspective of involuntary autobiographical memory. If retrospective mind wandering is being triggered by direct or associative memory retrieval, it will be less subject to executive control than prospective mind wandering. Executive resources will still gate access to conscious awareness but are not needed to initiate the retrieval process. Prospective mind wandering about future plans, by contrast, would require some executive capacity to initiate and proceed.

This view has important implications for the debate about whether mind wandering itself consumes executive resources. If further experimental research were to confirm the role of associative direct retrieval in retrospective mind wandering,

theoretical accounts would need to acknowledge that not all mind wandering is subject to equal levels of cognitive control. Since direct retrieval processes may bypass current concerns or goals, adding these processes to the model would also imply a greater role for environmental stimuli in triggering mind wandering events than is allowed by the usual emphasis on the default network and current goals. The pattern from the reviewed studies must also be considered in light of the consistent finding from diary studies that a diffuse state of attention promotes involuntary autobiographical memories (Berntsen, 2009). These data would suggest that working memory and mind wandering will be less strongly associated when the focus is retrospective, rather than no association at all.

More research is needed to establish that prospective and retrospective mind wandering use executive capacity differently. Studies should use larger samples and more demanding working memory tasks. They will then be able to clarify whether working memory indeed has little or no association with retrospective mind wandering, or rather a weaker association than is found with other types of temporal focus.

Further research confirming the role of direct retrieval in retrospective mind wandering would also have considerable clinical relevance. There are clearly overlaps between retrospective mind wandering and some types of repetitive negative thinking in depression. Rumination is conceptually closest because it involves extended sequences of thought which are more akin to mind wandering than are transitory negative cognitions. Cognitive models propose a great range of triggers for rumination including negative affect; post-event processing; perceived discrepancies between the self and a current target status or goal; and positive metacognitive beliefs about rumination as a strategy (Smith & Alloy, 2009). No current model of rumination specifies how mnemonic material may be activated

during a rumination event, or at what stage. The involvement of direct retrieval at the initiation of rumination about the past would add to our understanding of why it is so hard to prevent, help focus functional analysis of rumination (Watkins et al., 2006), and highlight the role of environmental contingencies as well as internal ones (such as mood or fatigue).

Prediction Three: Attention and Motivational Biases and Current Concerns

The review's third prediction was that attention and motivational biases related to current concerns and goals will influence the probability of the mind wandering to a given past event. The findings on mood, self-reflection and attributions are somewhat relevant to this prediction, though it could not be evaluated directly. There was some evidence for associations between retrospective mind wandering and negative mood, and no evidence of an association between retrospective mind wandering and self-reflection.

There was evidence from a single study that inducing a negative mood increases retrospective mind wandering, nearly doubling its frequency in one experiment. This finding is understandable within existing models of mind wandering which propose that an individual's current concerns and goals determine the content of mind wandering. As noted by Smallwood and O'Connor (2011), if a change in mood is treated as a problem signal, retrospective mind wandering may be an attempt to integrate self-discrepant information about the self and the personal past. This is a plausible account of low mood leading to a retrospective focus *in general*, but does not explain how a *specific* past event becomes the focus of mind wandering. Again, the memory literature suggests a possible mechanism. Berntsen (2009) argues that mood state acts as a motivational bias for involuntary autobiographical memories, leading to preferential attention to memory cues which match these current concerns. This is a proposed extension of the well-established

mood congruent effect in voluntary autobiographical memory, where lower mood leads to preferential recall of negative memories (Blaney, 1986). Applied to retrospective mind wandering, this suggests that the two mechanisms proposed to explain mood congruent recall – spreading activation within memory nodes and semantic priming of memory content which is similar to current cognitions – are candidates for explaining how specific mind wandering events about the past may begin.

In terms of clinical relevance, the finding of a retrospective mind wandering bias at lower moods should be viewed in the context of a larger body of research linking mood and mind wandering generally. Mind wandering is more frequent in dysphoria in laboratory studies (Smallwood et al., 2004; Smallwood, O'Connor, Sudberry, Haskell & Ballantyne, 2004), and in everyday life is related to a subsequent reduction in mood (Killingsworth & Gilbert, 2010).

The reviewed studies suggested that self-reflection is associated with prospective but not with retrospective mind wandering. Self-focus and goal-focus manipulations (Smallwood et al., 2011; Stawarczyk et al, 2011) were found to increased prospective bias to mind wandering and prospective off-task thoughts were most likely to include both self- and goal-focused content (Baird et al., 2011). These authors propose an autobiographical planning function for prospective mind wandering. This is consistent with the theory that a function of mental time travel is the promotion of a coherent personal identity (e.g. Tulving, 1985). Smallwood et al. (2011) claim that autobiographical memory is especially associated with future thought, based on their observation that a self-reflection task (deciding whether adjectives apply to oneself) promoted later prospective mind wandering. It may be that participants retrieved autobiographical memories during the self-reflection task but this was not directly assessed. It is not yet clear, as Smallwood et al. (2011) note,

whether retrieving autobiographical memories itself increases the prospective bias in subsequent mind wandering. Rasmussen and Berntsen (2009) have proposed that involuntary autobiographical memories also have a self-coherence function. Future research may develop ways of distinguishing more precisely between self- and goal-focused content to investigate self-coherence and retrospective mind wandering.

Prediction Four: Emotion Intensity and Positivity Biases

The fourth prediction was that the content of retrospective mind wandering will show emotional intensity and positivity biases, as found in the involuntary autobiographical memory literature. There were no data on retrospective mind wandering content to permit evaluation of this final prediction. No inferences about the conditions of encoding could be made, and no study sought to vary them experimentally. A recent naturalistic diary study by Finnbogadóttir and Berntsen (2012) indicates that these biases are present in the closely-related concept of mental time travel. Participants recorded the occurrence of positive, negative and neutral mental time travel events using check marks in a simple diary, completed over a four-week period. The study found a positivity bias for all mental time travel events and a greater positivity bias for future versus past mental time travel. An obvious step for future mind wandering research will be to consider the subjective valence of these events in conjunction with the existing laboratory paradigms.

Other Findings

The review yielded some limited evidence about the role of mind wandering attributions. The study by Critcher and Gilovich (2010) showed that negative mind wandering and mind wandering about the present are both more likely to be interpreted as reflecting task dissatisfaction. Retrospective mind wandering appeared to ‘buffer’ the deleterious effect of mind wandering on present-moment pleasure (Killingsworth & Gilbert, 2010).

In a clinical scenario, it is not clear that the same buffering effect would be found in depressed individuals. Mind wandering about the past could be appraised differently in depression as well as being more likely to contain negative content. Critcher and Gilovich (2010) found that negative appraisals about the current task were reduced by attribution manipulations; future clinical research will also need to consider negative attributions about the self. This aspect of the review highlights the importance of focusing on appraisals of mind wandering as a potential mediator between thought and mood – a proposal which is clearly in line with metacognitive therapy (e.g. Wells, 2009). Attributions and appraisals of mind wandering would appear to be a legitimate target for standard cognitive techniques or mindfulness-based interventions promoting acceptance of mental events.

Summary

When mind wandering is about the personal past, is it the same as involuntary autobiographical memory? This review sought to answer that question, by examining recent research into retrospective mind wandering in the context of what is known about involuntary autobiographical memory. Based on the available research, the answer is not yet clear. None of the four predictions made about retrospective mind wandering was disproved, but only one was supported by multiple studies. More research will be needed to verify the proposal that these two research traditions are studying the same underlying mental event. After noting limitations of the present research, some suggestions are made below.

Limitations

This review was exploratory in nature and its findings permit only tentative inferences to be made. The biggest problem is the dearth of published research with which to evaluate the predictions made from the memory literature. Where this could be attempted, the number of studies available was very small in each case.

The different methods typically used to study the two constructs are also relevant. In general, the diary-based involuntary memory literature protocols have higher ecological validity whereas mind wandering paradigms are more tightly controlled. Established tasks such as the SART correlate acceptably with subjective reports of mind wandering experiences in the laboratory, but these are likely to be different in other settings, particularly given the role of environmental cues as hypothesised above.

Future Directions

A number of areas for future research have already been mentioned. This section will summarise these ideas and propose some further areas for investigation.

More verification is required for all of the four predictions made about retrospective mind wandering from the involuntary autobiographical memory. Cues for retrospective mind wandering, and the interaction between internal and external triggers, have never been studied. Possible routes include the use of diary methods from the involuntary memory literature, or experimental manipulations of implicit cue presentation. Presenting environmental cues as SART stimuli could be one way forward. The finding about working memory effects on retrospective focus require replication using more demanding tasks to check for ceiling effects and bigger samples to increase power. This will allow proper testing of the competing hypotheses of no load effect on retrospective mind wandering frequency, a weaker load effect or an effect equal to prospective mind wandering. Attention and motivational biases for recall and retrieval in retrospective mind wandering could be studied by applying theories of mood congruent memory. Emotion intensity and positivity biases could be studied by including emotional valence and intensity ratings in thoughts probes, to look for systematic differences according to temporal focus.

Beyond these specific areas, there are a number of ways in which future research might develop the ideas in this review. The first is to carry out further investigation of correspondences between involuntary autobiographical memory and retrospective mind wandering. The most obvious way would be correlational research in which participants complete the standard paradigms of each research tradition, that is, laboratory measures of mind wandering and involuntary autobiographical memory diaries.

No study has measured the age of the focal events during retrospective mind wandering. Existing laboratory procedures, such as thought probes, could easily be adapted for this purpose, offering more precision than the basic past, present and future categories. Doing so would allow testing of further hypotheses based on the memory literature, such as the presence of a reminiscence bump or whether recency increases retrieval probability.

In general, how mind wandering events unfold over time has received little attention. There is much to discover about how mind wandering sequences are experienced, beyond markers of attention lapses. A recent review by Schooler et al. (2011) highlighted the way in which meta-awareness of mind wandering may be asynchronous with its content. In the memory literature, studies of involuntary memory chains have shown that remembered information tends to be organised conceptually, rather than in temporal clusters. (Talarico & Mace, 2010). Finding similar patterns in retrospective mind wandering chains could indicate access to the same underlying memory structures. Current measurement approaches cannot easily capture shifts in temporal focus within single mind wandering episode, although anecdotally such scenarios are relatively common.

This review also suggests a number of areas for further clinical investigation. The mnemonic aspects of rumination could be subject to some of the predictions

which have been applied to retrospective mind wandering. Considering the operation of direct retrieval processes could enhance our understanding of how rumination cycles begin, for example. For depressed people experiencing poor concentration and increased mind wandering, working with their attributions and appraisals of these experiences may be a useful clinical approach. Mind wandering in depression has been studied (Watts, MacLeod & Morris, 1988; Watts & Sharrock, 1985) but the last decade's empirical findings are largely unreplicated in clinical samples. The association between mood and retrospective mind wandering suggested in this review should be examined more closely in depression. The wider links between mind wandering (to any time period) and present-moment mood will be an important area for understanding the causal mechanism of interventions that seek to reduce mind wandering (e.g. mindfulness). Finally, the links between anxiety and mind wandering to the past or future remain to be explored.

References

Baird, B., Smallwood, J., & Schooler, J. W. (2011). Back to the future: Autobiographical planning and the functionality of mind-wandering. *Consciousness and Cognition, 20,* 1604-1611.

Ball, C. (2007). Can we elicit involuntary autobiographical memories in the laboratory. In J. H. Mace (Ed.), *Involuntary memory* (pp. 127-152). Oxford: Blackwell.

Berntsen, D. (1996). Involuntary autobiographical memories. *Applied Cognitive Psychology, 10,* 435-454.

Berntsen, D. (1998). Voluntary and involuntary access to autobiographical memory. *Memory, 6,* 113-141.

Berntsen, D. (2007). Involuntary autobiographical memories: Speculations, findings, and an attempt to integrate them. In J. H. Mace (Ed.), *Involuntary memory* (pp. 20-49). Oxford: Blackwell.

Berntsen, D. (2009). *Involuntary autobiographical memories.* Cambridge: Cambridge University Press.

Berntsen, D. (2001). Involuntary memories of emotional events: Do memories of traumas and extremely happy events differ? *Applied Cognitive Psychology, 15,* 135-158.

Berntsen, D., & Hall, N. (2004). The episodic nature of involuntary autobiographical memories. *Memory and Cognition, 32*(5), 789-803.

Blaney, P. (1986). Affect and memory: A review. *Psychological Bulletin, 99,* 229-246.

Brewin, C. R., Dalgleish, T., & Joseph, S. (1996). A dual representation theory of posttraumatic stress disorder. *Psychological Review, 103,* 670-686.

Brewin, C. R., Gregory, J. D., Lipton, M., & Burgess, N. (2010). Intrusive images in psychological disorders: characteristics, neural mechanisms, and treatment

implications. *Psychological Review*, *117*, 210-32.

Conway, M. A. (2009). Episodic memories. *Neuropsychologia*, *47*, 2305-13.

Conway, M. A., & Loveday, C. (2010). Accessing autobiographical memories. In J. H. Mace (Ed.), *The act of remembering* (pp. 56-70). Chichester: Wiley-Blackwell.

Conway, M. A., & Pleydell-Pearce, C. (2000). The construction of autobiographical memories in the self-memory system. *Psychological Review, 107*, 261-288.

Conway, M., Singer, J., & Tagini, A. (2004). The self and autobiographical memory: Correspondence and coherence. *Social Cognition, 22*, 491-529.

Critcher, C. R., & Gilovich, T. (2010). Inferring attitudes from mindwandering. *Personality and Social Psychology Bulletin*, *36*, 1255-1266.

D'Argembeau, A. (2012). Autobiographical memory and future thinking. In D. Berntsen & D. Rubin (Eds.), *Understanding autobiographical memory* (pp. 311-330). Cambridge: Cambridge University Press.

Delaney, P. F., Sahakyan, L., Kelley, C. M., & Zimmerman, C. A. (2010). Remembering to forget: The amnesic effect of daydreaming. *Psychological Science*, *21*, 1036-1042

Elua, I., Laws, K. R., & Kvavilashvili, L. (2012). From mind-pops to hallucinations? A study of involuntary semantic memories in schizophrenia. *Psychiatry Research*, *196*, 165-170.

Finnbogadóttir, H., & Berntsen, D. (2012). Involuntary future projections are as frequent as involuntary memories, but more positive. *Consciousness and cognition*. *22*, 272-280.

Fransson, P. (2006). How default is the default mode of brain function? Further evidence from intrinsic BOLD signal fluctuations. *Neuropsychologia*, *44*, 2836-2845.

Freud, S. (2001). Creative Writers and Daydreaming. In *The complete psychological works of Sigmund Freud* (J. Strachey, Trans.; Vol. 9; pp. 141-154). London: Vintage. Original work published 1907.

Giambra, L. (1974). Daydreaming across the life span: late adolescent to senior citizen. *International Journal of Aging and Human Development, 5*, 114-140.

Giambra, L. M. (1977). Daydreaming about the past: The time setting of spontaneous thought intrusions, *The Gerontologist*, *17*, 35-38.

Giambra, L. M. (1980). A factor analysis of the items of the Imaginal Processes Inventory. *Journal of Clinical Psychology*, *36*, 383-409.

Giambra, L. M. (1989). Task-unrelated thought frequency as a function of age: A laboratory study. *Psychology and Aging*, *4*, 136-143.

James, W. (2000). *The Principles of Psychology* (Vols. 1-2). London: Dover. Original work published 1890.

Kane, M. J., Brown, L. H., McVay, J. C., Silvia, P. J., Myin-Germeys, I., Kwapil, T. R., & Study, A. E. (2007). For whom the mind wanders, and when: An experience-sampling study of working memory and executive control in daily life. *Psychological Science*, *18*, 614-621.

Killingsworth, M. A., & Gilbert, D. T. (2010). A wandering mind is an unhappy mind. Science, *330*, 932.

Klinger, E. (1978). Modes of normal conscious flow. In K. Pope & J. Singer (Eds.), *The stream of consciousness* (pp. 225-258). New York: Plenum Press.

Kvavilashvili, L, & Mandler, G. (2004). Out of one's mind: A study of involuntary semantic memories. *Cognitive Psychology*, *48*, 47-94.

Kvavilashvili, L., & Schlagman, S. (2011). Involuntary autobiographical memories in dysphoric mood: A laboratory study. *Memory*, *19*, 331-345.

Levinson, D. B., Smallwood, J., & Davidson, R. J. (2012). The persistence of

thought: Evidence for a role of working memory in the maintenance of task-unrelated thinking. *Psychological Science*, *23*, 375-380.

Ma, S. H., & Teasdale, J. D. (2004). Mindfulness-based cognitive therapy for depression: replication and exploration of differential relapse prevention effects. *Journal of Consulting and Clinical Psychology*, *72*, 31-40.

Mace, J. (2007). Does involuntary remembering occur during voluntary remembering? In J. H. Mace (Ed.), *Involuntary memory* (pp. 50-67). Oxford: Blackwell.

Manly, T., Robertson, I., Galloway, M., & Hawkins, K. (1999). The absent mind: Further investigations of sustained attention to response. *Neuropsychologia*, *37*, 661-670.

Mar, R. A., Mason, M. F., & Litvack, A. (2012). How daydreaming relates to life satisfaction, loneliness, and social support: The importance of gender and daydream content. *Consciousness and Cognition*, *21*, 401-407.

Marchetti, I., Koster, E. H., & De Raedt, R. (2012). Mindwandering heightens the accessibility of negative relative to positive thought. *Consciousness and Cognition*, *21*, 1517-1525.

Mason, M. F, Norton, M. I., Van Horn, J. D., Wegner, D. M., Grafton, S. T., & Macrae, C. N. (2007a). Wandering minds: The default network and stimulus-independent thought. Science, 315, 393-395.

Mason, M. F., Norton, M. I., Van Horn, J. D., Wegner, D. M., Grafton, S. T., & Macrae, C. N. (2007b). Response to comment on “Wandering minds: The default network and stimulus-independent thought”. Science, 317, 43.

Matthews G., Joyner L., Gilliland K., Huggins J., Falconer S. (1999). Validation of a comprehensive stress state questionnaire: Towards a state big three? In Merville I., Deary I. J., DeFruyt F., Ostendorf F. (Eds.), *Personality*

Psychology in Europe (vol. 7) pp. 335–350. Tilburg: Tilburg University Press.

Matthews, S., Simmons, A., Strigo, I., Gianaros, P., Yang, T., & Paulus, M. (2009). Inhibition-related activity in subgenual cingulate is associated with symptom severity in major depression. *Psychiatry Research, 172,* 1-6.

McVay, J. C., & Kane, M. J. (2009). Conducting the train of thought: Working memory capacity, goal neglect, and mind wandering in an executive-control task. *Journal of Experimental Psychology, 35,* 196-204.

McVay, J. C., & Kane, M. J. (2010). Does mind wandering reflect executive function or executive failure? Comment on Smallwood and Schooler (2006) and Watkins (2008). *Psychological Bulletin, 136,* 188-197.

Mrazek, M. D., Smallwood, J., & Schooler, J. W. (2012). Mindfulness and mind-wandering: Finding convergence through opposing constructs. *Emotion, 12,* 442-448.

Newby, J. M., & Moulds, M. L. (2010). Negative intrusive memories in depression: The role of maladaptive safety behaviours and appraisals. *Journal of Affective Disorders, 126,* 147-154.

Nolen-Hoeksema, S. (2000). The role of rumination in depressive disorders and mixed anxiety/depressive symptoms. *Journal of Abnormal, 109,* 504-11.

O'Connor, R. C., Whyte, M., Fraser, L., Masterton, G., Miles, J., & MacHale, S. (2007). Predicting short-term outcome in well-being following suicidal behaviour: The conjoint effects of social perfectionism and positive future thinking. *Behaviour Research and Therapy,* 45, 1543-55.

Piet, J., & Hougaard, E. (2011). The effect of mindfulness-based cognitive therapy for prevention of relapse in recurrent major depressive disorder: A systematic review and meta-analysis. *Clinical Psychology Review, 31,* 1032-1040.

Rasmussen, A. S., & Berntsen, D. (2009). The possible functions of involuntary

autobiographical memories. *Applied Cognitive Psychology, 23,* 1137-1152.

Rubin, D. (1995). *Memory in oral traditions: The cognitive psychology of epic, ballads, and counting-out rhymes*. Oxford: Oxford University Press.

Schooler, J. W., Smallwood, J., Christoff, K., Handy, T. C., Reichle, E. D., & Sayette, M. A. (2011). Meta-awareness, perceptual decoupling and the wandering mind. *Trends in Cognitive Sciences, 15,* 319-326.

Singer, J. L. (1966). *Daydreaming: An introduction to the experimental study of inner experience*. New York: Random House.

Singer, J. L., & Antrobus, J. S. (1963). A factor-analytic study of daydreaming and conceptually-related cognitive and personality variables. *Perceptual and Motor Skills,* 17, 187-209.

Smallwood, J, Davies, J. B., Heim, D., Finnigan, F., Sudberry, M., O'Connor, R., & Obonsawin, M. (2004). Subjective experience and the attentional lapse: Task engagement and disengagement during sustained attention. *Consciousness and Cognition, 13,* 657-690.

Smallwood, J M, Baracaia, S. F., Lowe, M., & Obonsawin, M. (2003). Task unrelated thought whilst encoding information. *Consciousness and Cognition, 12,* 452-484.

Smallwood, J, O'Connor, R. C., Sudberry, M. V, Haskell, C., & Ballantyne, C. (2004). The consequences of encoding information on the maintenance of internally generated images and thoughts: The role of meaning complexes. *Consciousness and Cognition, 13,* 789-820.

Smallwood, J, O'Connor, R. C., Sudbery, M. V, & Obonsawin, M. (2007). Mind-wandering and dysphoria. *Cognition and Emotion, 21,* 816-842.

Smallwood, J, & Schooler, J. W. (2006). The restless mind. *Psychological Bulletin, 132,* 946-958.

Smallwood, J. (2010). Why the global availability of mind wandering necessitates resource competition: Reply to McVay and Kane (2010). *Psychological Bulletin, 136,* 202-207.

Smallwood, J., Nind, L., & O'Connor, R. C. (2009). When is your head at? An exploration of the factors associated with the temporal focus of the wandering mind. *Consciousness and Cognition, 18,* 118-125.

Smallwood, J., & O'Connor, R. C. (2011). Imprisoned by the past: Unhappy moods lead to a retrospective bias to mind wandering. *Cognition and Emotion, 1,* 1481-1490.

Smallwood, J., Schooler, J. W., Turk, D. J., Cunningham, S. J., Burns, P., & Macrae, C. N. (2011). Self-reflection and the temporal focus of the wandering mind. *Consciousness and Cognition, 20,* 1120-1126.

Smith, J. M., & Alloy, L. B. (2009). A roadmap to rumination: A review of the definition, assessment, and conceptualization of this multifaceted construct. *Clinical Psychology Review, 29,* 116-128.

Song, X. L., & Wang, X. (2012). Mind wandering in Chinese daily lives: An experience sampling study. *PLoS ONE, 7,* e44423.

Stawarczyk, D., Majerus, S., Maj, M., Van der Linden, M., & D'Argembeau, A. (2011). Mind-wandering: phenomenology and function as assessed with a novel experience sampling method. *Acta Psychologica, 136,* 370-381.

Talarico, J., & Mace, J. (2010). Involuntary and voluntary memory sequencing phenomena. In J. H. Mace (Ed.), *The act of remembering* (pp. 71-82). Chichester: Wiley-Blackwell.

Teasdale, J. D., Dritschel, B. H., Taylor, M. J., Proctor, L., Lloyd, C. A., Nimmosmith, I., & Baddeley, A. D. (1995). Stimulus-independent thought depends on central executive resources. *Memory and Cognition, 23,* 551-559.

Teasdale, J. D., Proctor, L., Lloyd, C. A., & Baddeley, A. D. (1993). Working memory and stimulus-independent thought: Effects of memory load and presentation rate. *European Journal of Cognitive Psychology, 5*, 417-433.

Teasdale, J. D., Segal, Z. V., Williams, J. M., Ridgeway, V., Soulsby, J. M., & Lau, M.. (2000). Prevention of relapse/recurrence in major depression by mindfulness-based cognitive therapy. *Journal of Consulting and Clinical Psychology, 68*, 615-623.

Tulving, E, & Thomson, D. (1973). Encoding specificity and retrieval processes in episodic memory. *Psychological Review, 80*, 352-373.

Tulving, E. (1985). Memory and consciousness. *Canadian Psychology, 26*, 1-12.

Watkins, E., Scott, J., Wingrove, J., Rimes, K., Bathurst, N., Steiner, H., Kennell-Webb, S., Moulds, M. & Malliari, Y. (2007). Rumination-focused cognitive behaviour therapy for residual depression: A case series. *Behaviour Research and Therapy, 45*, 2144-2154.

Watts, F. N., MacLeod, A. K., & Morris, L. (1988). Associations between phenomenal and objective aspects of concentration problems in depressed patients. *British Journal of Psychology, 78*, 241-250.

Watts, F. N., & Sharrock, R. (1985). Description and measurement of concentration problems in depressed patients. *Psychological Medicine, 15*, 317-326.

Wells, A. (2009). *Metacognitive therapy for anxiety and depression*. London: Guilford.

Whitfield-Gabrieli, S., & Ford, J. M. (2012). Default mode network activity and connectivity in psychopathology. *Annual Review of Clinical Psychology, 8*, 49.

Part Two: Empirical Paper

Can Anhedonia Be Repaired By Strengthening Inhibitory Control of Negative Material? A No-Go Training Study.

Abstract

Aims

Anhedonia is an important but under-studied feature of depression and its cognitive mechanisms are not well understood. One possibility is that inhibitory control deficits cause depressed people to be more easily distracted by negative material during pleasant activities, with a resulting attenuation in positive affective responses. The study aimed: (i) to test a causal relationship between negative distraction and cognitive and affective responses to idiosyncratic pleasant material; (ii) to examine the moderating role of depression on these responses; (iii) to demonstrate proof-of-concept of inhibitory control training; and (iv) to examine how depression severity moderates any observed training effects.

Method

A community sample (N = 49) with varying levels of depression severity engaged with idiosyncratic positive mood inductions (narrating pleasant memories), with and without negative auditory distraction. Participants then received either an inhibitory control task or a control task, before repeating the mood induction procedures.

Results

Negative distraction caused increased mind wandering and reduced sadness repair, but not lower happiness increase, during the initial positive mood inductions. Participants receiving the inhibitory control task did not differ from controls in the extent of these attenuations after training. Distraction effects and response to training were not moderated by depression severity.

Conclusions

Increasing levels of task-irrelevant negative information impairs the reduction in negative affect otherwise obtained from engaging with meaningful

pleasant material. The elements of inhibitory control involved in processing affective information require greater specification if training interventions are to be effective. Future research with clinical samples is needed to clarify how these processes may be disrupted at higher levels of depression severity.

Introduction

Anhedonia is the loss of interest or pleasure, and is an important feature of depression. The American Psychiatric Association and the World Health Organisation recognise anhedonia in their diagnostic classification of Major Depressive Disorder (MDD) and Severe Depression (DSM-IV, American Psychiatric Association, 1994; ICD-10, World Health Organisation, 1993). Self-reported anhedonia is robustly associated with depression (e.g. Shankman, Nelson, Harrow & Faull, 2010; Watson, Clark & Tellegen, 1988), predicts a poor prognosis of the illness (Morris, Bylsma & Rottenberg, 2009) and is associated with increased relapse risk (Wichers, Peeters, Geschwind et al., 2009). Experimental evidence shows that depressed individuals consistently report reduced positive affect (PA) in response to positive stimuli (Bylsma, Morris & Rottenburg, 2008), tend to predict fewer positive events (MacLeod & Byrne, 1996) and estimate them to be less pleasurable (e.g. Strunk & Adler, 2009). Physical anhedonia, or loss of pleasure in sensory experiences, is also consistently related to the severity of other symptoms of MDD (e.g. Loas, Salinas, Guelfi & Samuel-Lajeunesse, 1992; Shankman et al., 2010).

Current psychological treatments for depression are relatively ineffective at reducing anhedonia, with low PA persisting after otherwise successful recoveries (Brown, 2007). Depression interventions focus far more on reducing negative affect (NA) than promoting PA. Classical cognitive behavioural therapy, for example, aims to produce affective change by working with the cognitions and behaviours which maintain NA (e.g. Beck, 2005). Behavioural activation approaches do use positive event scheduling to put people back in touch with rewarding events, but do not target individuals' *capacity* to enjoy these rewards. Mindfulness-based interventions show some promise in promoting PA in remitted depressed individuals (Geschwind et al., 2011), but their effectiveness during acute depression remains unproven.

In order that psychological treatments may better address anhedonia in depression, research is needed to identify how PA mechanisms are disrupted (Dunn, 2012). A candidate process involves a failure to inhibit irrelevant or negative material entering the mind during positive activities (McVay & Kane, 2010), resulting in positive experience being attenuated. For example, when going for a walk in a pleasant location, if a depressed person's mind is filled with unwanted and unintended thoughts about a previous failure experience, their enjoyment of this event will be reduced. Within behavioural activation approaches this has been conceptualised as an inability to maintain attention to experience, with positive activities being undermined by ruminating about negative themes (Martell, Dimidjian & Herman-Dunn, 2010). This is also similar to the concept of mind wandering (an inability to keep attention in the present moment), which has been linked to reduced PA in the general population (Killingsworth & Gilbert, 2010). Mind wandering is known be a particular problem in depression (Mrazek, Smallwood & Schooler, 2012), and to be more frequent in dysphoric individuals (Smallwood, Fitzgerald, Miles & Phillips, 2009; Smallwood & O'Connor, 2009; Smallwood & Schooler, 2006). Most of this work is currently correlational in nature. Stronger evidence for the claim that negative distraction interferes with positive affect would come from experimental manipulations of the level of distraction. The first aim of the present study was therefore systematically to test the effect of negative distraction on affective responses to pleasant stimuli. Auditory distraction with negative words was used, since this was presumed to be a closer analogue of internally-generated negative material in depression than visual distraction.

The notion of affective interference suggests that depressed people's preferential processing of emotional material will interfere with performance when the material is task-irrelevant (e.g. Siegle, Ingram & Matt, 2002), as will be the case

when the auditory negative distraction is heard. As noted above, dysphoric people are likely to be experiencing more mind wandering and to have greater difficulties inhibiting focus on these off-task thoughts. The second aim of the study was therefore to investigate whether the effect of negative distraction on pleasure response was moderated by depression severity.

To induce pleasure, participants were asked to recall personally experienced positive memories. Responses to internally-generated events have received little attention in the literature, despite the acknowledged role of internal events (such as rumination or appraisals) in determining negative mood. Autobiographical memories offer one means of accessing idiosyncratic, internally-generated positive material. Memory procedures have been successfully used in previous research investigating mood repair (Joormann & Siemer, 2004; Joormann, Siemer & Gotlib, 2007). Self-referent (idiographic) stimuli were chosen over standardised (nomothetic) stimuli like films or images because these are believed to be more powerful inductions (Bylsma, Morris & Rottenberg, 2008; Dunn, 2012).

It is also necessary to consider the mechanism by which negative distraction might attenuate pleasure in depression. Pilot work from Dunn's group suggests that a deficit in keeping attention in the moment mediates the relationship between depression severity and increased sadness during every-day positive events (Stewart, Edwards, Barker & Dunn, submitted). The mind wandering literature offers a way to conceptualise this deficit, in line with the view that mind wandering and mindful attention to the present moment represent two sides of the same coin (Mrazek et al., 2012). For example, McVay and Kane (2010) model the intrusion of cognitive material as a 'control failure × concerns' equation. According to this view, automatically-generated thoughts relating to current concerns and goals, combined with an inability of the executive control system to prevent these thoughts from

entering awareness, results in the contamination of experience. This model is consistent with the finding that there is an inverse relationship between working memory capacity and lapses in a range of thought suppression tasks in the general population (e.g. Brewin & Smart, 2005; see Hoffmann, Schmeichel & Baddeley, 2012). In the context of depression, current concerns and goals are more likely to be negative in nature, presumably meaning that executive lapses will result in negative material intruding into consciousness.

One way to investigate this possibility is to attempt experimental manipulation of inhibitory control. Previous research in euthymic participants has attempted to do so by recruiting so-called 'spill-over effects'. These occur when intentional inhibition in one domain leads to non-intentional inhibition in another. For example, recent research by Houben and colleagues has shown that repeatedly practicing inhibitory control over food stimuli, using go/no-go tasks or stop-signal tasks, can reduce intake in subsequent taste tests (Houben, 2011; Houben & Jansen, 2011). The go/no-go task requires the participant to inhibit a prepotent motor response (Verbruggen & Logan, 2008a). Participants typically perform a choice reaction time task in response to items presented on a screen (the go stimuli; e.g. press left for an X, right for an O). On no-go trials, the go stimulus is accompanied by a cue indicating that the key press should be withheld. When stimuli are consistently paired with no-go cues over repeated trials, automatic response inhibition develops by associative learning (Verbruggen & Logan, 2008b). The use of a motor task to influence cognitive-affective inhibition is supported by reliable associations between inhibitory performance across modalities such as cognition, affect and motor control (e.g. Muraven & Baumeister, 2000), and by neuroscience research suggesting a common neural substrate for different inhibition modalities, located in the right inferior frontal cortex (Berkman, Burkland and Lieberman, 2009;

Berkman, Falk & Lieberman 2011; Cohen & Lieberman, 2010; Depue, Curran & Banich, 2007).

The third aim of the current study was therefore to demonstrate inhibitory control training effects in relation to affective (rather than food) stimuli. This was done using an affective version of the no-go task in which participants were trained to inhibit motor responses to negative material.

In order to maximise the potential training effect, the no-go stimuli (visually-presented negative words) were the same as the negative auditory stimuli in the distraction procedure. It was predicted that the training intervention would help participants inhibit off-task cognitive and affective responses to similar negative material, when it was later used to distract them during a pleasant event. Off-task cognitive responses were operationalized as mind wandering co-occurring with the distracting stimulus. Positive and negative affective responses were measured separately, in line with current models of distinct affect systems (Clark, 2005; Mineka, Watson & Clark, 1998). To isolate possible training effects, a second group of participants was given a control task in which they received the same stimuli as the training group but were never required to inhibit motor responses.

It is also possible that any training effects could be confounded by differences between the training and control group in hedonic capacity, working memory ability or propensity to mind wander. These variables were therefore controlled by administering a number of standard measures and tasks at baseline: the Snaith-Hamilton Anhedonic Pleasure Scale (SHAPS; Snaith, Hamilton, Morley & Humayan, 1995), digit span (cf. Brewin & Smart, 2005), sustained attention to response task (SART; Manly, Robertson, Galloway & Hawkins, 1999) and Thinking Content subscale of the Dundee Stress States Questionnaire (DSSQ-TC; Matthews, Joyner, Gililand, Campbell & Faulconner, 1999; following Smallwood et al., 2009).

There is now good evidence that inhibitory control is reduced in depression, particularly in relation to negative material. It has been argued that there are at least two stages to inhibitory control: interference control (preventing irrelevant information from entering working memory) and updating (later removal of irrelevant information from working memory (Hasher, Lustig & Zacks, 1999). Both stages appear to be affected in depression. For example, depressed individuals show a reduction in negative priming effects on both word and emotional face stimuli (Joormann, 2004; Joormann & Gotlib, 2007; Goeleven et al., 2006). Moreover, depressed individuals are less able purposively to forget negative material on variants of directed forgetting paradigms (Joormannn & Gotlib, 2008; see also Hertel & Gerstle, 2003). In summary, a number of lines of research suggest that inhibitory control is impaired in depression. There is preliminary evidence that reduced mindful awareness mediates the relationship between depression and anhedonic experience (Stewart et al., submitted). Inhibitory control training was therefore expected to be more beneficial for participants experiencing greater levels of depression symptoms. Examining the moderating role of depression severity on training effects was therefore the fourth aim of the study.

In summary, the study had four overall objectives, designed to develop our understanding of why anhedonia happens. In examining negative distraction effects, it aimed (i) to show a causal relationship between negative distraction and cognitive and affective responses to idiosyncratic pleasant material; and (ii) to examine the moderating role of depression on these responses. In studying training effects, it aimed (iii) to explore inhibitory control as a causal mechanism of anhedonia, by demonstrating proof-of-concept of inhibitory control training; and (iv) how depression severity moderates these training effects.

Hypotheses

1. Mind wandering will be higher in the distractor narration task than in the non-distraction task. This effect will be more marked with increasing depression severity.
2. PA will be lower in the distractor narration task than in the non-distraction task. This effect will be more marked with increasing depression severity.
3. NA will be higher in the distractor narration task than in the non-distraction task. This effect will be more marked with increasing depression severity.
4. Following intervention, distraction will be associated with less additional mind wandering in the training group than in the control group. This effect will be more marked with increasing depression severity.
5. Following intervention, distraction will be associated with a less attenuated pleasure response in the training group than in the control group. This effect will be more marked with increasing depression severity.
6. Following intervention, distraction will be associated with less attenuated sadness repair in the training group than in the control group. This effect will be more marked with increasing depression severity.

Method

Ethical approval for the study was obtained from the UCL Research Department of Clinical, Education and Health Psychology (see Appendix A).

Design

The study used a randomised controlled design to test the effect of no-go training on participants' inhibitory control of negative material. This yielded a mixed 2×2×2 factorial structure, with training (training, control) as the between-subjects factor and time (pre-, post training) and narration task version (standard, distraction) as within-subjects factors.

The main dependent variables were participants' self-reported mind wandering, pleasure and sadness during the pleasant memory task.

Power calculation. As estimate of the sample size required to achieve power in excess of .80 was calculated using G*Power software. A medium effect size of η_p^2 = .06 was assumed for the critical group × distraction × time interaction term. Under these conditions and a sample size of N = 48 was required to achieve power of .80.

Participants

Participants (N = 49) were recruited from the UCL subject pool and were reimbursed for their time at the rate of £6 per hour. Inclusion criteria were fluent English language ability, no hearing problems and no vision problems (correction with glasses or lenses was accepted). The sample was a mixture of undergraduate and postgraduate students (n = 17) and the general population. The majority of the sample was female (n = 27) and the mean age was 32.27 years (range 19-62, SD = 11.85). All participants reported having no hearing or vision problems. Participants were paid £12 for attending a single testing session lasting two hours.

In the final sample, 7 participants scored above threshold for dysphoria on the BDI-II (13/63). The average level of depression symptoms in the sample, although in the subclinical range, was judged adequate to consider moderation analyses in this exploratory study (BDI-II M = 7.04, SD = 8.54, range 0-32).

Procedure

Participants first read the study information sheet (Appendix B) and completed the informed consent form (Appendix C). The then completed the baseline self-report measures (BDI-II and SHAPS), and nominated four positive memories for the later narration tasks. Next they completed the baseline cognitive measures of working memory and mind wandering (digit span, SART followed by DSSC-TC). These were followed by the pre-test block of two narration tasks (one

distractor and one non-distractor). Present-moment happiness and sadness VAS scores were recorded at the start of each narration. Immediately after each narration, participants reported how much happiness, sadness and mind wandering they had experienced during the narration, using VASs. Participants then received either the no-go training or the control task (based on random allocation prior to the testing session). Finally, the post-test block of two further narration tasks was given, using the same structure as the pre-test block. The study procedure is shown in Figure 1.

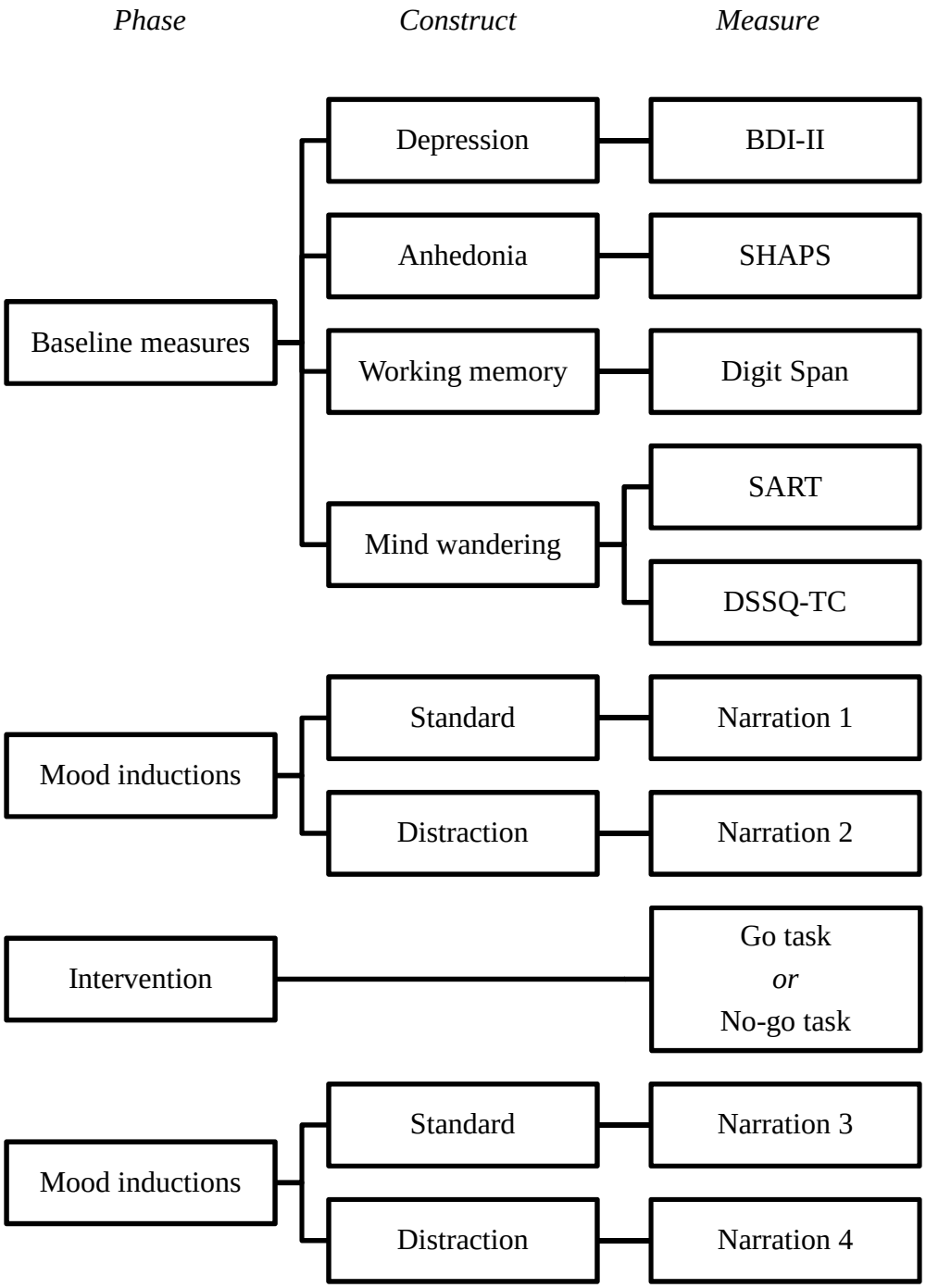


Figure 1. Measures and tasks in the study. Measures are shown in order of administration during the testing session.

Training task. (Billieux, Gay, Rochat & Van der Linden, 2010). Participants allocated to the training condition received a go/no-go task adapted from Verbruggen and Logan (2008b). A series of word stimuli were displayed on a screen, left-aligned or right-aligned within a 20cm by 10cm text box with lines of five pixels. The words were shown in 48-point black sans serif text for 500ms, followed by a blank screen for 1000ms. Participants were instructed to press a keyboard key to indicate the alignment of the word within the box (i.e. left arrow key for left side, right arrow key for right). The no-go signal was the text box lines becoming markedly thicker (20 pixels) for the duration of the 500s word presentation interval. Participants were instructed not to press for words appearing in a box with thicker lines.

In total participants received 200 word trials. These were delivered in ten blocks, with a rest period of ten seconds between blocks. Each block consisted of ten go trials and ten no-go trials, delivered in a random order. Importantly the task was arranged so that negative words were always paired with the no-go signal, and neutral words were never paired with this signal.

The word stimuli were taken from the Affective Norms for English Words database of 1000 words (ANEW; Bradley & Lang, 1999). Words in the ANEW set were rated by for emotional valence, arousal, and dominance. For the present study negative words were chosen from those rated on the valence scale between one (low) and two; neutral words were selected from those rated between five and six.

Control task. Participants allocated to the control condition received a go-only task using the same word stimuli as the go/no-go task training condition. The only variation was that the no-go signal was never shown. Participants were therefore required to press a key in response to 200 negative and neutral word trials.

Positive narration task. This task was used as a pleasant mood induction. Participants nominated four pleasant autobiographical memories at the start of the

testing session. They were instructed to choose memories which (i) had really happened to them; (ii) were pleasurable to remember; (iii) consisted of a sequence of events suitable for narration (as opposed to flashbulb memories); and (iv) occurred within a single day. Two memories were narrated before administration of the training or control intervention, and two after the intervention. At the start of each narration, participants were given the following instructions:

> "Now I would like you to remember the memory in which [*memory event*] in as much detail as possible for the next two minutes. I want you to say it out loud like a story, starting from the beginning, working through in order until you reach the end. This will be audio recorded but I will leave the room while you speak, so you can focus completely on [*memory event*]. Tell the story from the first person, as if you are seeing it through your own eyes. Try to speak about the memory for the full two minutes, including all the details you can remember about it."

Participants were asked explicitly to enter a positive mood state, and to focus on the detail of the event from a first person perspective, in order to maximise the mood effect of processing the positive material (Kuyken & Moulds, 2009; Westermann, Spies, Stahl & Hesse, 1996). During the task, participants sat in front of a blank grey screen. A countdown for the two-minute period was not provided in order not to distract participants. Instead, the end of each narration was signalled by the grey screen disappearing and the experimenter re-entering the room.

Participants narrated two of their memories without any distraction (standard phase) and two with intermittent negative auditory material (distraction phase). In each distraction phase narration, participants were played four negative words through headphones. The four words were randomly selected from the same list of ten negative words used in the no-go and go-only tasks. The four words were played at intervals anchored at 00:20, 00:50, 01:20 and 01:50. A random jitter of up to ±5s was inserted, so that (for example) the first word was played at a random point between 00:15s and 00:25s. The headphone volume was set to 30% of the available

maximum using software controls. Participants confirmed before the task that the volume was comfortable. Before each distraction phase, participants were told "You will hear some words through the headphones from time to time but just keep telling the story". The order of the phases was fixed for all participants, with standard followed by distraction at both time points.

Measures

Beck Depression Inventory, Second Edition (BDI-II; Beck et al., 1996). The BDI-II is a 21-item self-report inventory measuring the intensity of depression symptoms over the past two weeks. It was used to assess depression severity for the moderation analyses. It is well-established as reliable and valid research with non-clinical populations (e.g. Osman et al., 1997). For each item, participants endorsed a statement that best describes their experience, on a 4-point (0-3) scale.

Snaith-Hamilton Pleasure Scale (SHAPS; Snaith et al., 1995). The SHAPS was used at baseline to rule out group differences in hedonic capacity, since it is more sensitive to the anhedonic component of depression than that provided by the BDI-II's single anhedonia item. The SHAPS is a 16-item self-report questionnaire measuring hedonic capacity and its absence. Items asked about everyday events in the last few days e.g. 'I would enjoy seeing other peoples smiling faces.' The wording allowed participants to complete the measure without actually having had every experience described in the period under study ('The last few days'). Responses were made using a 4-point scale with options 'Definitely agree' 'Agree' 'Disagree' 'Definitely disagree'. The SHAPS has been shown to have adequate reliability, adequate convergence with other measures of anhedonia, and discriminant validity relative to depression measures (Snaith et al., 1995; Leventhal, Chasson, Tapia, Miller & Pettit, 2006). See Appendix D.

Digit span (DS; Wechsler, 2008). DS is a well-established measure of working memory. It was used to control for individual differences in working memory which might otherwise influence performance on the tasks requiring inhibitory control. The testing procedure from Fourth Edition of the Wechler Adult Intelligence Scales (Wechsler, 2008) was followed as set out in the testing manual. Participants repeated back sequences of numbers said by the examiner, either in their original order (DS forwards), reverse order (DS backwards), or numerical order (DS sequencing). A composite of the scores was then used to control for individual differences in working memory (cf. Brewin & Smart, 2005).

Sustained attention to response task (SART; Manly at al., 1999). The SART was used as the baseline measure of mind wandering to rule out group differences in mind wandering frequency. The SART is a simple go/no-go task on which errors are commonly used as a behavioural proxy for off-task thinking. It has been validated as a measure of individual differences in mind wandering frequency (Robertson, Manly, Andrade, Baddeley & Yiend, 1997). Participants were seated in front of a standard laptop screen. Over about 5 minutes, participants were presented with a series of 200 single digits. Each digit was displayed for 250ms, followed by a mask period in which a cross is displayed centrally on the screen. Participants responded to each presented digit with a key press, but were instructed not to respond to the number 3. Key press reaction times, and errors of commission (i.e. key presses in response to non-target digits) were recorded. Practice trials were administered before the main trial block, and participants were instructed to focus equally on responding quickly and accurately.

Dundee Stress State Questionnaire: Thinking Content Scale (DSSQ-TC; Matthews et al., 1999). The DSSQ-TC was given immediately after the baseline SART to provide self-report corroboration of the behavioural measure. The Thinking

Content scale of the DSSQ is a 16-item measure assessing thought content during a recent task. Two eight-item factors tap task-related interference (e.g. 'I thought about how I should work more carefully') and task-unrelated thought (e.g. 'I thought about something that happened earlier today'). Administration of the DSSQ-TC immediately followed the SART in the baseline phase of the study, and questionnaire items were keyed to participants' experiences during the SART. See Appendix D.

Mind wandering visual analogue scales (VAS). Mind wandering during the narration tasks was measured using simple VAS. This method was chosen over repeated administration of the DSSQ-TC in order to reduce testing burden on participants. A 20cm line was presented, marked at 2mm intervals and anchored at 0 ('Never') and 100 ('Always'). Participants marked the line in response to the instruction 'How much did your mind wander during that task?'. See Appendix D.

Happiness and sadness visual analogue scales (VAS). Simple VAS were used for the present-moment ratings of PA and NA. Two 20cm lines, marked at 2mm intervals, anchored at 0 and 100, were presented before each memory narration. On these separate scales, participants indicated their present affective state in response to the question 'How much [happiness/sadness] are you feeling right now?' After each memory narration, participants completed similar scales, worded as follows: 'How much [happiness/sadness] did you experience on average during that task?' Participants therefore completed eight happiness VAS and eight sadness VAS in total during the study. This measure was chosen above a longer questionnaire to reduce the testing burden of frequent PA and NA reporting. See Appendix D.

Data analysis strategy. Two-tailed statistical tests were carried out with alpha set to .05. Dependent variables were mind wandering, happiness increase and sadness repair. Baseline data (Hypotheses One, Two and Three) were analysed using

a series of repeated measures ANOVAs, with distraction condition as a within-subjects factor (control, distraction). These analyses were repeated entering mean-centred BDI-II score as a covariate, to examine if depression severity moderated the pattern of results.

Training data (Hypotheses Four, Five and Six) were analysed using mixed ANOVA, with distraction condition (control, distraction) and time (before training, after training) as within-subjects factors and training (no-go, go) as a between-subjects factor. The critical term here is the interactions involving time (i.e. assessing training effects), so for the sake of brevity only these are reported. These analyses were then repeated with BDI-II score as a mean centred covariate to examine the potential moderating effect of depression severity.

Results

In total, 49 participants completed the study. All participants were included in the analysis of baseline (i.e. pre-training) data (hypotheses 1, 3 and 5). For 4 participants, a high proportion of errors (more than 20%) on the no-go training or go-only control task indicated poor task understanding. These participants were excluded from the analysis of training effects below.

Change scores were used for the dependent variables of happiness and sadness response during memory narrations. These were calculated by subtracting pre-narration ratings of present-moment affect from participants' ratings of affect experienced during the memory.

In the results section below, preliminary data inspection, data cleaning and descriptive characteristics of the baseline variables are discussed first. Second, validity of the mood inductions and training tasks are considered. Third, bivariate relationships between independent and dependent variables are analysed. Finally, multivariate analysis testing the six study hypotheses is presented.

Data Inspection

Preliminary data inspection revealed significant deviations of normality for four independent variables (BDI-II score, mind wandering during the SART, DSSQ-TC task-related interference subscale, DSSQ-TC task-irrelevant interference subscale) and two dependent variables (mind wandering during memory narrations and sadness change during memory narrations). For BDI-II score, mind wandering during the SART, both DSSQ-TC subscales and mind wandering during narrations, square root transformations brought their distributions closer to normality. Transformed values for these variables were therefore used in all statistical tests reported below. The distribution of sadness change scores remained markedly leptokurtic following attempted square root and log transformations. Untransformed sadness change values were therefore used in the analysis of hypotheses five and six below and these findings must be interpreted cautiously. All sample means and standard deviations reported below give untransformed values. Descriptive data for all baseline variables are given in Table 1.

Table 1

Descriptive data for mood, working memory, mind wandering and inhibitory control variables at baseline

	All participants[a]		Training group[b]		Control group[c]	
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*
BDI-II	7.04	8.54	5.88	7.92	8.16	9.12
SHAPS	21.51	5.29	21.96	6.27	21.08	4.23
Digit span[d]	29.82	6.12	28.79	4.95	30.80	7.02
SART						
RT of correct trials	348.29	68.17	342.33	65.77	354.02	71.27
Errors of commission	9.08	4.50	9.25	4.42	8.92	4.65
Mind wandering[e]	27.31	21.41	27.88	21.50	26.76	21.75
DSSQ-TC						
Task-related interference	18.82	5.11	18.79	4.75	18.84	5.54
Task-irrelevant interference	11.71	4.54	11.75	4.67	11.68	4.50
Stop-signal task RT	273.94	90.23	257.50	106.12	289.72	70.43

Note. SD values are one SD from the mean. RT = reaction time.

[a]$N = 49$. [b]$n = 24$. [c]$n = 25$. [d]Composite of forwards, backwards and sequencing span scores. [e]Self-report rating following SART completion.

A series of independent-samples *t*-tests was used to check for baseline group differences on the variables listed in Table 1. No significant group differences were

revealed (highest $t = 1.81$, lowest $p = .08$). Depression severity was not confounded by age, $r(49) = -.15$, $p = .32$. Although females are considerably more likely to become clinically depressed (e.g. Kuehner, 2003; Nolen-Hoeksema, 1987), an independent-samples *t*-test indicated depression severity was not confounded by female gender in the study sample, $t(1,47) = .17$, $p = .87$. These variables were therefore not controlled for during data analysis.

Prior to hypothesis testing, bivariate relationships between baseline variables and dependent variables were examined using correlations (see Table 2). This was done to establish the convergent validity of the dependent variables (brief cognitive and affective VAS scales) with the more established baseline mood and mind wandering measures. Of note is the absence of a significant association between the behavioural measure of mind wandering (SART errors of commission) and the self-report rating of mind wandering (VAS) during the same period. Notably, the self-report measure of mind wandering during the first pleasant narration was not significantly associated with any of the baseline measures of mind wandering (SART errors of commission, self-report mind wandering during the SART, DSSQ-TC). This suggests that the mind wandering dependent variable must be interpreted cautiously in the later analysis, as it may not reflect the same aspect of off-task experience as the baseline behavioural and self-report measures. Interestingly anhedonia, but not overall depression, predicted errors of commission during the SART. Consistent with previous research, participants experienced greater happiness increase during the first memory narration when their minds wandered less. Depression and anhedonia were predictive of mind wandering during the first memory narration, but not happiness or sadness response. Depression and anhedonia were also more strongly associated with task-irrelevant thoughts during the SART than with task-related interference.

Table 2

Pearson correlations between baseline variables

Variables	1	2	3	4	5	6	7	8	9	10
1. BDI-II	-									
2. SHAPS	.58***	-								
3. Digit span[a]	.09	.05	-							
4. SART errors of commission	.10	.29*	-.06	-						
5. SART mind wandering[b]	.19	.22	.39**	.07	-					
6. DSSQ-TC task-related interference	.29*	.14	.20	.26	.25	-				
7. DSSQ-TC task-irrelevant interference	.57***	.50***	.23	.18	.52***	.38**	-			
8. Narration mind wandering	.41**	.41**	.004	.18	-.05	.22	.13	-		
9. Narration happiness change	-.20	-.11	.26	-.04	.21	.04	-.05	-.31*	-	
10. Narration sadness change	-.20	.02	-.14	.08	-.11	-.23	-.22	-.05	.02	-

Note. $N = 49$. BDI-II = Beck Depression Inventory II. SHAPS = Snaith-Hamilton Anhedonia Pleasure Scale. SART = Sustained attention to response task. VAS = visual analogue scale. DSSQ-TC = Dundee Stress States Questionnaire, Thinking Content subscale. Narration variables refer to first narration only (standard condition without distraction, pre-training).

[a]Composite of forwards, backwards and sequencing. [b]Self-report rating following SART completion.

*$p < .05$. **$p < .01$. ***$p < .001$.

Mood induction validation. To confirm the validity of the positive mood induction procedure, paired-sample *t*-tests were carried out to compare happiness and sadness before and after the first (non-interference) pleasant memory narration. As predicted, participants reported that they had experienced significantly greater pleasure during the narration compared to their pre-narration baseline, $t(1,49) = -3.08$, $p = .003$. Sadness validation was carried out on square root transformed data due to significant negative skew. The mood induction procedure significantly reduced sadness, $t(1,49) = 6.16$, $p < .01$. These results indicate that the pleasant mood induction procedure had the anticipated effects of happiness increase and sadness decrease.

Hypothesis Testing

Table 3 shows the mind wandering, happiness and sadness responses to the mood inductions, before and after training.

Negative distraction effects.

Hypothesis one. Partially supporting hypothesis one, analysis revealed a significant effect of distraction on mind wandering, $F(1,48) = 5.69$, $p = .02$, $\eta_p^2 = .11$, with participants reporting more mind wandering in the distraction than in the control condition.

There was a main effect of BDI-II score in the moderation analysis, $F(1,48) = 5.39$, $p = .03$, $\eta_p^2 = .10$, with mind wandering increasing with depression symptoms. Inconsistent with predictions, there was no significant interaction between distraction and BDI-II score, $F(1,47) = 2.07$, $p = .16$, $\eta_p^2 = .04$. More depressed individuals therefore experienced greater mind wandering but not an exacerbated effect of the distraction on mind wandering.

Table 3

Cognitive and affective responses to the mood inductions

		All participants[a]		Training group[b]		Control group[c]	
Condition	Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*
				Pre-training			
Standard							
	MW	9.73	13.03	9.13	13.00	10.32	13.29
	Happiness	8.20	18.66	10.83	19.34	5.68	18.01
	Sadness	-10.96	18.04	-7.29	19.20	-14.48	16.48
Distraction							
	MW	15.63	16.86	13.12	15.30	18.04	18.22
	Happiness	7.02	20.75	11.96	22.01	2.28	18.68
	Sadness	-.67	12.91	1.17	11.57	-2.44	14.09
				Post-training			
Standard							
	MW	11.73	15.65	14.43	18.69	9.38	12.35
	Happiness	10.25	14.17	9.38	16.49	11.04	11.98
	Sadness	-5.51	11.38	-3.19	6.45	-7.13	14.40
Distraction							
	MW	15.20	21.54	12.29	19.38	17.75	23.38
	Happiness	9.91	16.52	12.81	19.71	7.26	12.83
	Sadness	-1.53	7.08	-1.48	5.65	-1.39	8.38

Note. SD values are one SD from the mean. MW = mind wandering. Happiness and sadness values are change scores over the mood inductions.

[a]Pre-training $N = 49$; post-training $n = 45$. [b]Pre-training $n = 24$; post-training $n = 21$. [c]Pre-training $n = 25$; post-training $n = 24$.

Hypothesis two. There was no main effect of distraction on happiness change, $F(1,48) = .15$, $p = .70$, $\eta_p^2 = .003$. Hypothesis two was therefore not supported.

Covariate analysis revealed no significant main effect of depression, $F(1,47) = .18$, $p = .67$, $\eta_p^2 = .004$. The interaction between distraction condition and depression approached significance, $F(1,47) = 3.28$, $p = .08$, $\eta_p^2 = .07$, with correlations indicating that depression scores were negatively (but not significantly) associated with happiness change during the standard narration, $r(49) = -.20$, $p = .17$, but that a trivial positive association existed during the distractor narration, $r(49) = .08$, $p = .58$. Participants with higher depression scores therefore gained less happiness from narrating a pleasant memory under standard conditions, but surprisingly this difference disappeared when negative distraction was applied.

Hypothesis three. There was a significant main effect of interference on sadness change, $F(1,48) = 12.38$, $p = .001$, $\eta_p^2 = .21$, with participants reporting a greater reduction in sadness when narrating pleasant memories without distraction than with distraction. Hypothesis three was therefore supported.

The addition of depression as a covariate showed a significant main effect of depression, $F(1,48) = 12.38$, $p = .01$, $\eta_p^2 = .12$. Contrary to predictions, the interaction between depression and distraction was not significant, $F(1,47) = .17$, $p = .68$, $\eta_p^2 = .004$. Participants reporting more depression symptoms experienced greater reductions in sadness during pleasant memory narrations, but negative distraction did not change this relationship.

Training effects.

No-go training validation. For 4 participants, a high proportion of errors (more than 20%) on the no-go training or go-only control task indicated poor task understanding, markedly poor inhibitory control ability or both. To prevent confounding of any training effects, these participants were excluded from the analysis of post-task data below. Training adherence for retained participants was acceptable, indicated by mean error rates of 4% or below across all conditions of the

task (comparable with other no-go studies, e.g. Liddle, Kiehl & Smith, 2001). Performance on each task (error rate and RT) was compared to check for systematic differences. Error rates on neutral trials did not differ significantly between the groups, $t(1,43) = -1.45$, $p = .16$. The training group made significantly more errors on negative trials than did the control group, $t(1,43) = -4.89$, $p < .01$, due to the added possibility of errors of commission for training group participants asked to inhibit responses on negative trials. Performance on neutral word trials was compared between the no-go and go-only groups Neutral trials were selected because the no-go group did not respond to negative words and hence did not contribute RT data on these trials. Independent-samples *t*-tests showed that the no-go group responded significantly more slowly on neutral trials than did the go-only control group, $t(1,43) = -5.16$, $p < .01$. This discrepancy is likely to be due to added processing demands of the no-go task.

Hypothesis four. With mind wandering as the dependent variable there was no main effect of time, $F(1,43) = 0.17$, $p = .68$, $\eta_p^2 = .004$, no time by distraction interaction, $F(1,43) = 1.10$, $p = .30$, $\eta_p^2 = .03$, no time by training group interaction, $F(1,43) = 0.49$, $p = .49$, $\eta_p^2 = .01$, and no time by training group by distraction interaction, $F(1,43) = 0.64$, $p = .43$, $\eta_p^2 = .02$, indicating no effect of the training task.

This analysis was repeated entering mean-centred BDI-II score as a covariate. There was no interaction between depression severity and any of the analyses involving time (greatest $F = 0.65$; smallest $p = .43$). Hypothesis four was therefore not supported, i.e. training did not significantly alter mind wandering during the memory recall and there was no moderation of training effects by depression severity.

Hypothesis five. In the analysis of happiness change data, one participant was a multivariate outlier and was therefore excluded. There was no main effect of time, $F(1,42) = 0.46$, $p = .50$, $\eta_p^2 = .01$, no time by distraction interaction, $F(1,42) = 0.01$,

p = .92, η_p^2 = .0002, no time by training group interaction, $F(1,42) = 0.94$, p = .34, η_p^2 = .02, and no time by training group by distraction interaction, $F(1,42) = 0.01$, p = .94, η_p^2 = .0002. Hypothesis five was therefore not supported.

Baseline depression was then added as a covariate. There was a significant three-way interaction between distraction, time and depression, $F(1,40) = 4.56$, p = .04, η_p^2 = .10. To investigate the interaction, values for the difference in happiness response between standard and distraction narrations were calculated at each time point. This was done such that a negative score meant that happiness change was smaller during distraction. These scores were then correlated with baseline depression scores. Before training, there was a trend for increased depression to be associated with a greater happiness increase when distraction was applied, $r(44)$ = .26, p = .08, whereas after training the association was reversed, $r(44) = -.24$, p = .18. Both the training and control interventions appear to have inhibited depression's potentiating effect upon negative distraction. None of the other interaction terms involving depression and time was significant, (greatest F = 2.98; smallest p = .09).

Hypothesis six. In the analysis with sadness change as the dependent variable, there was no main effect of time, $F(1,43) = 2.65$, p = .11, η_p^2 = .06, no time by training group interaction, $F(1,43) = 1.03$, p = .32, η_p^2 = .02, and no time by training group by distraction interaction, $F(1,43) = 0.19$, p = .66, η_p^2 = .004. The interaction between distraction and time approached significance, $F(1,43) = 3.84$, p = .06, η_p^2 = .08. To investigate this interaction, difference scores for participants' sadness response with and without distraction were calculated at each time point. The greater the difference score, the more participants' sadness repair during narrations was attenuated by distraction. Paired-sample t-tests showed that these scores differed at trend significance level pre- and post-training, $t(1,44) = 1.95$, p = .06, with

participants' difference scores greater at pre-training, $M = 11.38$, $SD = 20.15$, than at post-training, $M = 3.98$, $SD = 12.80$. This finding could suggest that both the no-go training and the go-only control task may have reduced the impact of negative distraction. Alternatively, participants in both groups may have habituated to the distracting stimuli over the course of the testing session. The absence of group main or interaction effects meant that hypothesis six was not supported.

The addition of BDI-II score as a covariate showed a significant main effect of depression, $F(1,41) = 4.85$, $p = .03$, $\eta_p^2 = .11$, with more depressed participants surprisingly experiencing a greater decrease in sadness during pleasant memory narrations overall. There were no significant interaction effects involving depression and time (greatest $F = 1.82$; smallest $p = .19$), indicating that there was no moderation of training effects by depression severity.

Discussion

This study aimed to explore the proposition that mind wandering is a cognitive process that maintains anhedonia. It had four specific aims. It attempted to show causally that negative distraction is linked to increased off-task thought and that it impairs affective responses to positive idiosyncratic material. It sought to determine whether increased depression severity strengthens this effect. It also aimed to demonstrate proof-of-concept of inhibitory control training's effect on cognitive and affective responses to pleasant material, and whether training effects were more marked with greater depression severity.

The study's first two aims, relating to the impact of negative distraction, were considered in Hypotheses One, Two and Three. These hypotheses were tested using data from the first two mood inductions (i.e. pre-training). Negative auditory distraction was used during the second mood induction to stimulate mind wandering. It was predicted that the distraction would increase self-reported off-task thinking,

relative to the first induction (Hypothesis One). The results of the study supported this prediction, suggesting that the distraction indeed increased mind wandering. It was also hypothesised that the addition of distraction would result in the second mood induction having a smaller beneficial effect on PA and NA (Hypotheses Two and Three). The predicted effect was found for NA but not PA. Negative distraction reduced the level of sadness repair participants received from engaging with idiosyncratic pleasant material. These results add to the research demonstrating a link between mind wandering and low mood (e.g. Smallwood & O'Connor, 2009; Smallwood, O'Connor & Obonsawin, 2007), but are not consistent with a particular link between mind wandering and anhedonia.

When participants then underwent the first mood induction they reported greater pleasure response when their minds wandered less from pleasant material. It was therefore surprising that participants' PA response during the second induction was not adversely affected by negative distraction and the associated increase in mind wandering. How might the absence of an effect of distraction and mind wandering on PA be explained? The simplest possibility relates to the differing baseline levels of happiness and sadness in the study's relatively euthymic sample. It may be that the distracting material was insufficiently negative to impact happiness response, whereas absolute sadness levels were close to floor and thus more sensitive to the distraction condition. It may also be that the negative words were insufficiently distracting to participants who were recounting a highly meaningful memory out loud. According to perceptual load theory (Lavie, 2010), a distractor will not be perceived if task demands leave insufficient spare perceptual capacity.

A third possibility is that the negative distraction failed to stimulate mind wandering as it is normally understood in the literature. On the 'stimulus-independence' and 'task-relatedness' dimensions proposed by Stawarczyk, Majerus,

Maj, Van der Linden and D'Argembeau (2011), mind wandering is classified as task-unrelated and stimulus-independent. Established procedures such as the SART deliberately require limited cognitive resources, *reducing* task load on the basis that this will allow greater capacity for generation and pursuit of thoughts unrelated to the current task (Manley et al., 1999; Robertson et al., 1997; Smallwood & Schooler, 2006). There is a similar rationale behind the use of monotonous vigilance tasks to induce comparable mental events such as involuntary autobiographical memories (e.g. Kvavilashvili & Schlagman, 2011). The auditory distraction differs from these paradigms, in that it aims to induce mind wandering by *increasing* task load. Furthermore, playing negative distracting words seems most likely *a priori* to generate cognitive interference that is task-unrelated but stimulus-*dependent*, according to the Stawarczyk et al. (2011) dimensions. In essence, it may be that mind wandering reported during the auditory distraction task is not the same as that generated by the typical low-load paradigms and – crucially – is therefore not the same as that reported by participants during the baseline tasks or first mood induction.

There are two ways, based on competing theories of mind wandering, that this hypothesised unplanned effect of the auditory distraction could account for the finding that additional distraction-induced mind wandering did not impair positive affective response to pleasant material. One hypothesis is that mind wandering reflects a failure of executive control to keep task-unrelated thought out of awareness (McVay & Kane, 2010). As task demands increase, according to this account, executive control processes are proactively initiated which incidentally defend against mind wandering. Increasing the processing load in the distraction condition would therefore have reduced stimulus-independent off-task thinking during the narrations. The perceptual decoupling hypothesis, by contrast, proposes that mind

wandering occurs when attention is coupled to an internal process and decouples from external stimuli, in effect 'insulating' mind wandering (Smallwood, 2010). By this account, the intermittent external stimuli of the auditory distraction may have reduced internally-generated mind wandering by interrupting this decoupling process. Either increased task demands, or disrupting perceptual decoupling, could therefore have led to the observed reduction in internally-generated mind wandering (reducing positive affective interference) and an increase in stimulus-bound negative thoughts (with greater impact on negative affect).

The study's second aim was to examine the moderating effect of depression severity on the distraction effects tested in Hypotheses One, Two and Three. It was expected that the adverse effect of the negative distraction on mind wandering would be moderated by depression. The potentiating effect of depression on mind wandering has been demonstrated in a number of previous studies (Smallwood, Fitzgerald, Miles & Phillips, 2009). In fact, negative distraction did not increase mind wandering more for people with lower mood in this study. As noted above, the distraction may have confounded mind wandering so this effect is hard to interpret. The unexpected finding may also be attributed to the nature of the positive mood induction, in which a stream of internally-generated memory narration, presumably highly salient to competing positive schema, could have meant that external and stimulus-dependent negative distraction did not activate more negative material in more depressed participants.

It was also predicted that the adverse effect of the negative distraction on affective response to the mood inductions would be moderated by depression severity. The affective predictions were based partly on classic schema theory of depression (Beck, 1976), whereby negative external material activates negative cognitive schema, and partly on the considerable evidence of deficits in the

inhibition of mood-congruent material in depression (for example, from negative affective priming and directed forgetting studies; Joormann, 2004, 2006; Power, Dalgliesh, Claudio, Tata & Kentish, 2000). Contrary to predictions, the data did not show clear moderation effects of depression on the relationship between happiness change and mind wandering. Although more depressed participants gained less happiness from narrating a pleasant memory, there was only a trend interaction whereby this suppressive effect of lower mood on happiness change was not present when distraction was applied. By contrast, more depressed participants experienced *greater* sadness reduction (i.e. more beneficial effect on mood) from memory narrations, but this relationship was not altered by distraction.

There are a number of possible reasons why current study did not replicate the failure of more depressed people to experience mood repair from pleasant autobiographical memories which has been documented in some studies (e.g. Joormann & Siemer, 2004; Joormann et al., 2007). First, it may be that sadness was close to floor level for the study's relatively euthymic participants. This would mean that, in effect, the study's sample replicated the control group (which did show mood repair from mood-incongruent memories) from the studies by Joormann and colleagues, rather than the dysphoric group. The absence of a negative mood induction before positive memory recall (as used in the studies by Joormann and colleagues) may also have contributed to this floor effect. A further possibility is that the instructions and verbal procedure for the narrations required participants to focus on the rich sensory details of their memories. It has been shown that such a concrete mode of processing memory data (as opposed to ruminative and abstracted reflection) facilitates emotional benefit from pleasant memory recall, for depressed and non-depressed groups (Werner-Seidler & Moulds, 2012).

In summary of the study's second aim, none of the predictions concerning moderation effects on mind wandering and mood repair for more depressed individuals was supported. This is likely to be due to the stimulus-dependent nature of the mind wandering manipulation, the low levels of depression severity in the sample, and the concrete processing required by the mood induction procedure.

The third aim of the study was to examine whether an affective no-go task was effective at training participants' inhibitory control over negative auditory distraction. It was hypothesised that participants in the training group would show an attenuated cost of distraction in terms of mind wandering, happiness change and sadness change (Hypotheses Four, Five and Six respectively). There was no evidence that associations between mind wandering and affective response were influenced by training inhibitory control of negative material. Participants trained to inhibit motor responses to negative material did not respond to negative auditory distraction differently from the control group who responded to these stimuli. The data were therefore inconsistent with the prediction of spill-over effects from motor to cognitive inhibition, based on stop-signal designs training response to food stimuli (e.g. Houben, 2011; Houben & Jansen, 2011; Muraven & Baumeister, 2000). Weak interactions between distraction and time (but not group) suggest that both tasks may have had slight effects on how distraction influenced happiness and sadness response, but these effects cannot be clarified in the current design due to the absence of a no-training control group.

One reason for these null findings could be that the stimulus-response associations under modification were more subtle and diffuse in the current study than the food-based studies. Another likely explanation is that the no-go training (lasting approximately ten minutes) was simply not extensive enough. By way of comparison, a recent study demonstrating improved attention performance in

dysphoric participants (Owens, Koster & Derakshan, 2013) did so using a more demanding *n*-back task, administered over eight half-hour sessions. Alternatively, the training could have targeted the wrong aspect of inhibitory control. Studies in which participants were instructed to ignore or forget irrelevant information (e.g. Joormann & Gotlib, 2008; Joormann, Hertel, Brozovich & Gotlib, 2005; Levens & Gotlib, 2010) have shown that depression and rumination were particularly associated with difficulties in removing irrelevant negative material from awareness. The present study's no-go training, by contrast, targeted participants' ability to prevent this material entering awareness at all. More promising results have been found by studies seeking to train forgetting in depressed individuals (Joormann, LeMoult, Hertel, & Gotlib, 2009).

The fourth aim of the study was to consider whether any inhibitory control training effects were moderated by depression severity. None of the training analyses with depression as a covariate indicated a training effect moderated by depression. There was a weak trend for both training and control interventions to reduce the effect of depression on PA response to distraction, but this was of marginal statistical significance and hard to interpret given the absence of group effects. Testing this moderation hypothesis must await an efficacious manipulation of inhibitory control in the affective domain.

Some additional limitations of the study should be noted. The low level of depression in the sample means that the moderating effects of these symptoms must be interpreted with caution. The study relied on a simple self-report measure of mind wandering during mood induction. In the analysis of training effects, the study was insufficiently powered to detect the required 2×2×2 interactions. A *post hoc* power calculation indicated that obtained power to detect the time × distraction × group interaction was .30 in the ANOVA used to test hypothesis 2 above (where the effect

size was greatest). A sample of 140 would have been needed to increase power to .80; the required sample would have been greater still in the analysis of happiness and sadness response. A further limitation of the study is the potential for unwanted longitudinal effects in the testing session. Participants reported that the negative distraction during the final narration was less off-putting because they knew what to expect. Although a habituation effect would probably operate equally on both groups, it may have made training effects harder to detect. There is also a risk that self-generated inductions threatened internal validity in the study by introducing within- and between-subjects variation in affective content. Pre-recording narrations would allow independent ratings of memories' affective content and allow these differences to be controlled for.

There are a number of ways in which future research might further explore the proposition that mind wandering is a cognitive maintenance process of anhedonia. In light of the limitations noted above, the specific aims of this study could be better tested through adjustments such as a larger, more dysphoric sample, more extensive inhibitory control training and alterations to the second distraction (such as a different voice recording) to reduce habituation effects.

As discussed above, the distraction procedure in the present study may not have stimulated internally-driven mind wandering as intended. Administering a post-distraction measure which distinguishes between task-related and task-irrelevant interference, such as the DSSQ-TC, would be an obvious way to clear up this point. Reducing perceptual load concurrent with the distraction (e.g. by changing the mood induction to silent memory rehearsal) would also help clarify whether the absence of a distraction cost in PA was due to a lack of cognitive resources to process the negative words.

An important wider issue for future research will be to clarify the role of stimulus dependence in determining the effects of task-irrelevant interference on present-moment emotional experience. This is of particular relevance to depression, where internally-generated distraction is likely to be qualitatively different (e.g. more negative or self-critical) as well as more frequent.

The hypothesised relationship between anhedonia and mind wandering could also be investigated using alternative designs. Other interventions to reduce mind wandering (such as mindful breathing exercises; Mrazek et al., 2012) could be used in place of the no-go training. As noted above, there is some support for training targeting the removal of irrelevant material from awareness, rather than initial inhibition. Future research could valuably compare training aimed at these different aspects of inhibitory control. It would also be valuable to clarify how mind wandering relates to the anticipatory and consummatory aspects of pleasure disruption in anhedonia. It is plausible that mind wandering could be beneficial to pre-event savouring yet inhibitory to enjoyment in the moment, and future research dissociating these aspects of anhedonia with the same sample would therefore be useful.

References

American Psychiatric Association (1994). *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*. Washington, DC: American Psychiatric Association.

Baer, R. A., Smith, G. T., Hopkins, J., Krietemeyer, J., & Toney, L. (2006).Using self-report assessment methods to explore facets of mindfulness. *Assessment, 13*, 27-45.

Beck, A. T. (2005). The current state of cognitive therapy: A 40-year retrospective. *Archives of General Psychiatry, 62*, 953-959.

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). Manual for Beck Depression Inventory II (BDI-II). San Antonio, TX: Psychology Corporation.

Berkman, E. T., Burklund, L., & Lieberman, M. D. (2009). Inhibitory spillover: Intentional motor inhibition produces incidental limbic inhibition via right inferior frontal cortex. *Neuroimage, 47,* 705-712.

Berkman, E. T., Falk, E. B., & Lieberman, M. D. (2011). In the trenches of real-world self-control: Neural correlates of breaking the link between craving and smoking. *Psychological Science, 22,* 498-506.

Billieux, J., Gay, P., Rochat, L., & Van der Linden, M. (2010).The role of urgency and its underlying psychological mechanisms in problematic behaviours. *Behaviour Research and Therapy, 48,* 1085-1096.

Bradley, M. M., Codispoti, M., Cuthbert, B. N., & Lang, P. J. (2001). Emotion and motivation I: Defensive and appetitive reactions in picture processing. *Emotion, 1*, 276-298.

Bradley, M.M., & Lang, P.J. (1999). Affective norms for English words (ANEW): Instruction manual and affective ratings. The Center for Research in Psychophysiology: University of Florida.

Brewin, C. R., & Smart, L. (2005).Working memory capacity and suppression of intrusive thoughts. *Journal of Behavior Therapy and Experimental Psychiatry*, *36*, 61-68.

Brown, T. A. (2007). Temporal course and structural relationships among dimensions of temperament and DSM-IV anxiety and mood disorder constructs. *Journal of Abnormal Psychology, 116,* 313-328.

Bylsma, L. M., Morris, B. H., & Rottenberg, J. (2008) A meta-analysis of emotional reactivity in major depressive disorder. *Clinical Psychology Review, 28*, 676-691.

Bylsma, L. M., Taylor-Clift, A., & Rottenberg, J. (2011). Emotional reactivity to daily events in major and minor depression. *Journal of Abnormal Psychology*,*120*, 155.

Clark, L. A. (2005). Temperament as a unifying basis for personality and psychopathology. *Journal of Abnormal Psychology, 114*, 505.

Clark, L. A., & Watson D. (1991). Tripartite model of anxiety and depression: Psychometric evidence and taxonomic implications. *Journal of Abnormal Psychology, 100*, 316-336.

Cohen, J. R. & Lieberman, M. D. (2010). The common neural basis of exerting self-control in multiple domains. In Y. Trope, R. Hassin, & K. N. Ochsner (eds.) *Self-control in society, mind, and brain* (pp. 141-160). New York: Oxford University Press.

Depue, B. E., Curran, T., & Banich, M. T. (2007). Prefrontal regions orchestrate suppression of emotional memories via a two-phase process. *Science, 317*, 215-219.

Ditzen, B., Neumann, I. D., Bodenmann, G., von Dawans, B., Turner, R. A., Ehlert, U., & Heinrichs, M. (2007). Effects of different kinds of couple interaction

on cortisol and heart rate responses to stress in women. *Psychoneuroendocrinology, 32*, 565-574.

Dunn, B. D. (2012). Helping depressed clients reconnect to positive emotion experience: Current insights and future directions. *Clinical Psychology & Psychotherapy, 19*, 326-40.

First, M.B., Spitzer, R. L., Gibbons, M., & Williams, J.B.W. (1996). Structured Clinical Interview for DSM-IV Axis I Disorders. American Psychiatric Press, Washington, DC.

Geschwind, N., Peeters, F., Drukker, M., van Os, J., & Wichers, M. (2011). Mindfulness training increases momentary positive emotions and reward experience in adults vulnerable to depression: A randomized controlled trial. *Journal of Consulting and Clinical Psychology, 79*, 618-628.

Goeleven, E., De Raedt, R., Baert, S., & Koster, E. H. (2006).Deficient inhibition of emotional information in depression. *Journal of Affective Disorders, 93*, 149-157.

Hasher, L., Lustig, C., & Zacks, R. T. (2007). Inhibitory mechanisms and the control of attention. In A. Conway, C. Jarrold, M. Kane, A. Miyake, A., & J. Towse (eds.), *Variation in working memory* (pp. 227-249). New York: Oxford University Press.

Hertel, P. T., & Gerstle, M. (2003).Depressive Deficits in Forgetting. *Psychological Science, 14*, 573-578.

Hofmann, W., Schmeichel, B. J., & Baddeley, A. D. (2012). Executive functions and self-regulation. *Trends in Cognitive Sciences, 16*, 174-180.

Houben, K. (2011). Overcoming the urge to splurge: influencing eating behavior by manipulating inhibitory control. *Journal of Behavior Therapy and Experimental Psychiatry, 42*, 384-388.

Houben, K., & Jansen, A. (2011). Training inhibitory control: A recipe for resisting sweet temptations. *Appetite, 56,* 345-349.

Joormann, J. (2004). Attentional bias in dysphoria: The role of inhibitory processes. *Cognition and Emotion*, *18*, 125–147.

Joormann, J. (2006). Differential effects of rumination and dysphoria on the inhibition of irrelevant emotional material: Evidence from a negative priming task. *Cognitive Therapy and Research, 30*, 149-160.

Joormann, J., & Gotlib, I. H. (2007). Selective attention to emotional faces following recovery from depression. *Journal of Abnormal Psychology, 116*, 80-85.

Joormann, J., & Gotlib, I. H. (2008). Updating the contents of working memory in depression: Interference from irrelevant negative material. *Journal of Abnormal Psychology*, *117*, 182-192.

Joormann, J., Hertel, P. T., Brozovich, F., & Gotlib, I. H. (2005). Remembering the good, forgetting the bad: Intentional forgetting of emotional material in depression. *Journal of Abnormal Psychology, 114*, 640.

Joormann, J., LeMoult, J., Hertel, P. T., & Gotlib, I. H. (2009). Training forgetting of negative material in depression. *Journal of Abnormal Psychology*, *118*, 34-43.

Joormann, J., & Siemer, M. (2004). Memory accessibility, mood regulation, and dysphoria: Difficulties in repairing sad mood with happy memories? *Journal of Abnormal Psychology*, *113*(2), 179-188.

Joormann, J., Siemer, M., & Gotlib, I. H. (2007). Mood regulation in depression: Differential effects of distraction and recall of happy memories on sad mood. *Journal of Abnormal Psychology, 116*, 484-490.

Killingsworth, M. A., & Gilbert, D. T. (2010). A wandering mind is an unhappy mind. *Science, 330*, 932-932.

Kreibig, S. D. (2010). Autonomic nervous system activity in emotion: A review. *Biological Psychology, 84,* 394-421.

Kroenke, K., Spitzer, R. L., & Williams, J. B. (2001). The PHQ‐9. *Journal of General Internal Medicine, 16,* 606-613.

Kuehner, C. (2003). Gender differences in unipolar depression: An update of epidemiological findings and possible explanations. *Acta Psychiatrica Scandinavica, 108,* 163-174.

Kuyken, W., Moulds, M.L. (2009). Remembering as an observer: How is autobiographical memory retrieval vantage perspective linked to depression? *Memory, 17,* 624-634.

Kvavilashvili , L., & Schlagman, S. (2011). Involuntary autobiographical memories in dysphoric mood: A laboratory study. *Memory, 19,* 331-345.

Lavie, N. (2010). Attention, distraction, and cognitive control under load. *Current Directions in Psychological Science, 19,* 143-148.

Levens, S. M., & Gotlib, I. H. (2010). Updating positive and negative stimuli in working memory in depression. *Journal of Experimental Psychology. General, 139,* 654-664.

Liddle, P. F., Kiehl, K. A., & Smith, A. M. (2001). Event-related fMRI study of response inhibition. *Human Brain Mapping, 12,* 100-109.

Loas, G., Salinas, E., Guelfi, J. D., & Samuel-Lajeunesse, B. (1992). Physical anhedonia in major depressive disorder. *Journal of Affective Disorders, 25,* 139-146.

Leventhal, A. M., Chasson, G. S., Tapia, E., Miller, E. K., & Pettit, J. W. (2006). Measuring hedonic capacity in depression: A psychometric analysis of three anhedonia scales. *Journal of Clinical Psychology, 62,* 1545-1558.

MacLeod, A., & Byrne, A. (1996). Anxiety, depression, and the anticipation of future positive and negative experiences. *Journal of Abnormal Psychology, 105*, 286-289.

Manly, T., Robertson, I. H., Galloway, M., & Hawkins, K. (1999). The absent mind: Further investigations of sustained attention to response. *Neuropsychologia, 37*, 661–670.

Martell, C., Dimidjian, S., & Herman-Dunn, R. (2010). *Behavioral activation for depression*: *A clinician's guide.* New York: Guilford.

Matthews, G., Joyner, L., Gililand, K., Campbell, S. E., & Faulconner, S. (1999). Validation of a comprehensive stress state questionnaire: Towards a state 'Big three'? In I. Mervielde, I. J. Deary, F. De Fruyt, & F. Ostendorf (eds.), *Handbook of coping: Theory, research and applications* (pp. 333-350). Tilburg, NL: Tilburg University Press.

McVay, J. C., & Kane, M. J. (2010). Does mind wandering reflect executive function or executive failure? Comment on Smallwood and Schooler (2006) and Watkins (2008). *Psychological Bulletin, 136*, 188-197.

Mineka, S., Watson, D., & Clark, L. A. (1998). Comorbidity of anxiety and unipolar mood disorders. *Annual Review of Psychology, 49*, 377-412.

Morris, B. H., Bylsma, L. M., & Rottenberg, J. (2009). Does emotion predict the course of major depressive disorder? A review of prospective studies. *British Journal of Clinical Psychology, 48*, 255-273.

Mrazek, M. D., Smallwood, J., & Schooler, J. W. (2012). Mindfulness and mind-wandering: Finding convergence through opposing constructs. *Emotion*, *12*, 442-448.

Muraven, M., & Baumeister, R. F. (2000). Self-regulation and depletion of limited resources: Does self-control resemble a muscle? *Psychological Bulletin, 126,* 247-259.

Nolen-Hoeksema, S. (1987). Sex differences in unipolar depression: Evidence and theory. *Psychological Bulletin, 101*, 259-282.

Osman. A., Downs, W. R., Barrios, F. X., Kopper, B. A., Gutierrez, P. M., & Chiros, C. E. (1997). Factor structure and psychometric characteristics of the Beck Depression Inventory-II. *Journal of Psychopathology and Behavioral Assessment*, *19*, 359-376.

Owens, M., Koster, E. H., & Derakshan, N. (2013). Improving attention control in dysphoria through cognitive training: Transfer effects on working memory capacity and filtering efficiency. *Psychophysiology*, *50*, 297-307.

Robertson, I. H., Manly, T., Andrade, J., Baddeley, B. T., & Yiend, J. (1997). 'Oops!': Performance correlates of everyday attentional failures in traumatic brain injured and normal subjects. *Neuropsychologia*, *35*, 747-758.

Rottenberg, J., Gross, J. J., & Gotlib, I. H. (2005). Emotion context insensitivity in major depressive disorder. *Journal of Abnormal Psychology*, *114*, 627.

Power, M. J., Dalgleish, T., Claudio, V., Tata, P., & Kentish, J. (2000). The directed forgetting task: Application to emotionally valent material. *Journal of Affective Disorders*, *57*, 147-157.

Shankman, S. A., Nelson, B. D., Harrow, M., & Faull, R. (2010). Does physical anhedonia play a role in depression? A 20-year longitudinal study. *Journal of Affective Disorders, 120*, 170-176.

Siegle, G. J., Ingram, R. E., & Matt, G. E. (2002). Affective interference: An explanation for negative attention biases in dysphoria? *Cognitive Therapy and Research*, *26*, 73-87.

Smallwood, J. (2010). Why the global availability of mind wandering necessitates resource competition: Reply to McVay and Kane (2010). *Psychological Bulletin, 136,* 202-207.

Smallwood, J., Fitzgerald, A., Miles, L. K., & Phillips, L. H. (2009). Shifting moods, wandering minds: Negative moods lead the mind to wander. *Emotion, 9,* 271-276.

Smallwood, J., O'Connor, R. C., Sudbery, M. V., & Obonsawin, M. (2007). Mind-wandering and dysphoria. *Cognition and Emotion, 21,* 816-842.

Smallwood, J., & Schooler, J. (2006). The restless mind. *Psychological Bulletin, 132,* 946-958.

Snaith, R. P., Hamilton, M., Morley, S., Humayan, A., Hargreaves, D., & Trigwell, P. (1995). A scale for the assessment of hedonic tone: The Snaith-Hamilton Pleasure Scale. *The British Journal of Psychiatry, 167,* 99-103.

Stawarczyk, D., Majerus, S., Maj, M., Van der Linden, M., D'Argembeau, A. (2011) Mind-wandering: Phenomenology and function as assessed with a novel experience sampling method. *Acta Psychologica, 136,* 370-381.

Stewart, M., Edwards, C., Barker, C., Dunn., B. (submitted). Savouring the moment: Affective forecasts and actual emotion experience to real-world positive events in depression and their relationship to dispositional mindfulness.

Strunk, D. R., & Adler, A. D. (2009). Cognitive biases in three prediction tasks: A test of the cognitive model of depression. *Behaviour Research and Therapy, 47,* 34-40.

Treadway, M. T., &Zald, D. H. (2011). Reconsidering anhedonia in depression: Lessons from translational neuroscience. *Neuroscience and Biobehavioural Reviews, 35,* 537-555.

Verbruggen, F., & Logan, G. D. (2008a). Response inhibition in the stop-signal paradigm. *Trends in Cognitive Sciences*, *12*, 418-424.

Verbruggen, F., & Logan, G. D. (2008b). Automatic and controlled response inhibition: Associative learning in the go/no-go and stop-signal paradigms. *Journal of Experimental Psychology: General*, *137*, 649-672.

Vrijkotte, T. G., van Doornen, L. J., & de Geus, E. J. (2000). Effects of work stress on ambulatory blood pressure, heart rate, and heart rate variability. *Hypertension*, *35*, 880-886.

Watkins, E. R. (2008). Constructive and unconstructive repetitive thought. *Psychological Bulletin*, *134*, 163-206.

Watson, D., Clark, L., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, *54*, 1063-1070.

Wechsler, D. (2008). *Wechsler Adult Intelligence Scales* (4th edn.). San Antonio, TX: Pearson.

Wenzlaff, R.M. (1993). The mental control of depression: Psychological obstacles to emotional well-being. In D.M Wegner & J.W. Pennebaker (eds.), *Handbook of mental control* (pp. 239-257). New Jersey: Prentice Hall.

Westermann, R., Spies, K., Stahl, G. and Hesse, F. W. (1996). Relative effectiveness and validity of mood induction procedures: A meta-analysis. *European Journal of Social Psychology*, *26*, 557-580.

Wichers, M., Peeters, F., Geschwind, N., Jacbos, N. Simons, C. J., Derom C., Thiery, E., Delespaul, P. H., & van Os, J. (2009). Unveiling patterns of affective responses in daily life may improve outcome prediction in depression: A momentary assessment study. *Journal of Affective Disorders*, *124*, 191-195.

World Health Organization (2008).*The ICD-10 Classification of Mental and Behavioural Disorders: Diagnostic Criteria for Research*. World Health Organization.

Appendix A: Ethical Approval

Re: ethics approval

Viding, Essi
Sent:15 October 2012 12:34
To: Pistrang, Nancy; Hickey, Joseph

Dear Nancy, Joseph, & Barney,

The CEHP RD Ethics Chair has approved your application. It appears that you have indicated a UCL number on the form. You do not need to register the application with UCL and the Ethics number on this document should be the one that is used in your information sheets, consent forms etc.

Researchers:Nancy Pistrang, Joseph Hickey, Barney Dunn
Number: CEHP/2012/029
Title: Can anhedonia be repaired by strengthening inhibitory control of negative material? A stop-signal training study

Please do make sure that the data you gather are stored anonymously.
Please remember, in general to observe the Code of ethics and conduct. Leicester: The British Psychological Society, March 2006, and in particular to follow the 'Guidelines for minimum standards of ethical approval in psychological research'. Leicester: The British Psychological Society, July 2004 when conducting your research.

Yours sincerely,
Essi Viding
CEHP RD Ethics Chair

Appendix B: Information Sheet

Information Sheet for Participants in Research Studies
You will be given a copy of this information sheet.

Title of Project: Pleasure response and attention.
This study has been approved by the UCL Division of Psychology and Language Sciences.
Research Ethics Committee as Project ID Number: CEHP/2012/029

Name, Address and Contact Details of Investigators:
Joe Hickey & Professor Nancy Pistrang
Department of Clinical, Education & Health Psychology, UCL, London, WC1E 6BT
Dr Barney Dunn
Department of Psychology, University of Exeter, Exeter, EX4 4QG
Email:

We would like to invite you to participate in this research study. You should only participate if you want to; choosing not to take part will not disadvantage you in any way. Before you decide whether you want to take part, please read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or you would like more information.

What is the study about?
This project is investigating inhibition and anhedonia, a symptom of depression which is characterised by reduced pleasure. We want to know more about how people get enjoyment from pleasurable things. In particular, we want to find out whether people enjoy things more if they are better able to block out irrelevant information. Learning about this will help our understanding of how depression interferes with people enjoying their lives.

What will I have to do?
Participants will first complete a questionnaire to determine if they are eligible for the study. Eligible participants will attend a single research session at UCL lasting about 1.5 - 2 hours. During the session, participants will complete questionnaires about mood and attention and do some computer-based tasks. Participants will also be asked to talk about some favourite memories and hear some recordings of critical words. Participants will be audio recorded while talking about the memories. During the computer tasks we will measure your heart rate and changes in electrical activity in your skin, which is a painless procedure.

What are the benefits from taking part?
There are no direct benefits from taking part in the study, but you will be contributing to scientific knowledge and you may find the research session interesting. Study participants will be reimbursed for attending the research session at the rate of £6 per hour. UCL undergraduate students can elect to receive course credit instead of payment.

What are the risks from taking part?
All of the tasks we will ask you to complete have been used safely in previous research. There is a small chance that hearing the recordings of critical words may

cause slight discomfort for some people. There are no other anticipated risks of taking part in the study.

How will my information be stored?
All data will be collected and stored anonymously, in accordance with the Data Protection Act 1998. The audio recordings of memory descriptions will be destroyed once they have been transcribed.

Do I have to take part?
It is up to you to decide whether or not to take part. If you choose not to participate, you won't incur any penalties or lose any benefits to which you might have been entitled. If you do decide to take part, you will be given this information sheet to keep and asked to sign a consent form. Even after agreeing to take part, you can still withdraw at any time and without giving a reason.

How can I find out more?
Please contact Joe Hickey by email or post (contact details above).

Appendix C: Consent Form

Informed Consent Form for Participants in Research Studies

Title of Project: Pleasure response and attention.
This study has been approved by the UCL Division of Psychology and Language Sciences Research Ethics Committee as Project ID Number: CEHP/2012/029

Participant's Statement

I …….

Agree that I have…

- ❑ Read the information sheet and/or the project has been explained to me orally.
- ❑ Had the opportunity to ask questions and discuss the study.
- ❑ Received satisfactory answers to all my questions or have been advised of an individual to contact for answers to pertinent questions about the research and my rights as a participant and whom to contact in the event of a research-related injury.

I understand that…

- ❑ I am free to withdraw from the study without penalty if I so wish, and I consent to the processing of my personal information for the purposes of this study only and that it will not be used for any other purpose. I understand that such information will be treated as strictly confidential and handled in accordance with the provisions of the Data Protection Act 1998.
- ❑ My participation will be audio recorded, and I am aware of, and consent to, use of these recordings for the purposes of this research.
- ❑ The information I have submitted will be published as a report and I will be sent a copy. Confidentiality and anonymity will be maintained, and it will not be possible to identify me from any publications.
- ❑ I am being paid for my assistance in this research and that some of my personal details will be passed to UCL Finance for administration purposes.

I agree to be contacted in the future by UCL researchers who would like to invite me to participate in related studies.

- ❑ Yes
- ❑ No

Signed: Date:

Investigator's Statement

I ……..
confirm that I have carefully explained the purpose of the study to the participant and outlined any reasonably foreseeable risks or benefits (where applicable).

Signed: Date:

Appendix D: Testing Pack

Pleasure Response and Attention Study

Participant ID	
Date	
Start time	
Stop time	
Researcher	
Group (G/NG)	

Memory keyword				
Memory date				
Order				

***BIOPAC ON**

Consent	
Demographics	
Memory keywords	
BDI-II	
SHAPS	
Digit span	
SART	
SARTVAS	
DSSQ-TC	
VAS1	
Memory 1*****	
VAS2	
VAS3	
Memory 2*****	
VAS4	

Narration instructions
"Now I would like you to remember the memory in which [*memory event*] for the next two minutes. I want you to say it out loud like a story, starting from the beginning, working through in order until you reach the end. This will be audio recorded but I will leave the room while you speak, so you can focus completely on [*memory event*]. Tell the story from the first person, as if you are seeing it through your own eyes. Try to speak about the memory for the full two minutes, including all details you can remember about it. I will tell you when the two minutes are up."

Notes

G/NG		
VAS5		
Memory 3*****		
VAS6		
VAS7		
Memory 4*****		
VAS8		

Digit Span Forwards

[Item not reprinted to preserve copyright and test security.]

Digit Span Backwards

[Item not reprinted to preserve copyright and test security.]

Digit Span Sequencing

[Item not reprinted to preserve copyright and test security.]

Demographics

Name	
Date of birth	
Gender	
Marital status	
Education	
Occupation	
Nationality	
Ethnicity	*White* □ English/Welsh/Scottish/N Irish/British □ Irish □ Gypsy or Irish Traveller □ Any other White background, write in:
	Mixed / multiple ethnic groups □ White and Black Caribbean □ White and Black African □ White and Asian □ Any other Mixed background, write in:
	Asian / Asian British □ Indian □ Pakistani □ Chinese □ Any other Asian background, write in:
	Black / African / Caribbean / Black British □African □ Caribbean □ Any other Black / African / Caribbean background, write in:
	Other ethnic groups □ Arab □ Any other ethnic group, write in:

<table>
<tr><td rowspan="3">Current medication</td><td colspan="4">□ Yes □ No</td></tr>
<tr><td>Purpose</td><td>Name</td><td>Dose</td><td>Frequency</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>Neurological problems/injuries</td><td colspan="4">□ Yes □ No
Details:</td></tr>
<tr><td>Mental health problems</td><td colspan="4">□ Yes □ No
Details:

If no, closest:</td></tr>
</table>

BDI-II

[Questionnaire not reprinted to preserve copyright.]

SHAPS

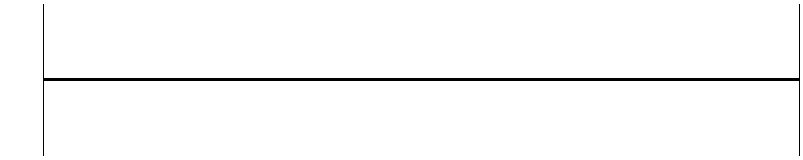
This questionnaire is designed to measure your experience of pleasure in the last few days. It is important to read each statement very carefully. Write the number in the blank to indicate how much you agree or disagree with each statement.

1	2	3	4
Definitely agree	**Agree**	**Disagree**	**Definitely disagree**

_____ 1. I would enjoy my favourite television or radio programme
_____ 2. I would enjoy being with family or close friends
_____ 3. I would find pleasure in my hobbies and pastimes
_____ 4. I would be able to enjoy my favourite meal
_____ 5. I would enjoy a warm bath or refreshing shower
_____ 6. I would find pleasure in the scent of flowers or a the smell of a fresh sea breeze or freshly baked bread
_____ 7. I would enjoy seeing other people's smiling faces
_____ 8. I would enjoy looking smart when I have made an effort with my appearance
_____ 9. I would enjoy reading a book, magazine or newspaper
_____ 10. I would enjoy a cup of tea or coffee or my favourite drink
_____ 11. I would find pleasure in small things, e.g. a bright sunny day, a telephone call from a friend
_____ 12. I would be able to enjoy a beautiful landscape or view
_____ 13. I would get pleasure from helping others
_____ 14. I would feel pleasure when I receive praise from other people

SARTVAS

During that task, how much did your mind wander to other things?



THINKING CONTENT

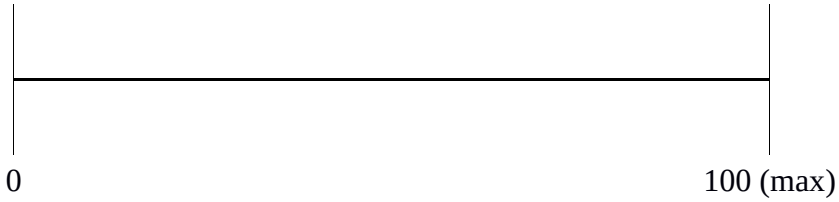
This set of questions concerns the kinds of thoughts that go through people's heads at particular times, for example while they are doing some task or activity. Below is a list of thoughts, some of which you might have had recently. Please indicate roughly how often you had each thought **DURING THE LAST TEN MINUTES** or so, by circling a number from the list below.

1= Never 2= Once 3= A few times 4= Often 5= Very often

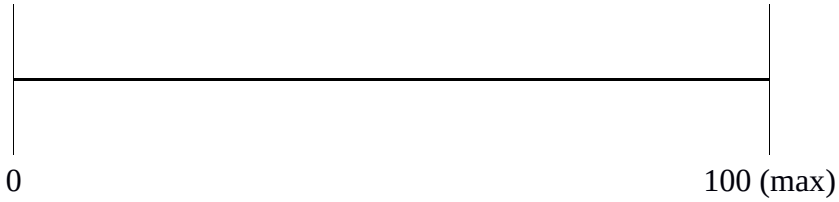
1.	I thought about how I should work more carefully.	1 2 3 4 5
2.	I thought about how much time I had left.	1 2 3 4 5
3.	I thought about how others have done on this task.	1 2 3 4 5
4.	I thought about the difficulty of the problems.	1 2 3 4 5
5.	I thought about my level of ability.	1 2 3 4 5
6.	I thought about the purpose of the experiment.	1 2 3 4 5
7.	I thought about how I would feel if I were told how I performed.	1 2 3 4 5
8.	I thought about how often I get confused.	1 2 3 4 5
9.	I thought about members of my family.	1 2 3 4 5
10.	I thought about something that made me feel guilty.	1 2 3 4 5
11.	I thought about personal worries.	1 2 3 4 5
12.	I thought about something that made me feel angry.	1 2 3 4 5
13.	I thought about something that happened earlier today.	1 2 3 4 5
14.	I thought about something that happened in the recent past (last few days, but not today).	1 2 3 4 5
15.	I thought about something that happened in the distant past	1 2 3 4 5
16.	I thought about something that might happen in the future.	1 2 3 4 5

VAS1

How much happiness are you feeling right now?

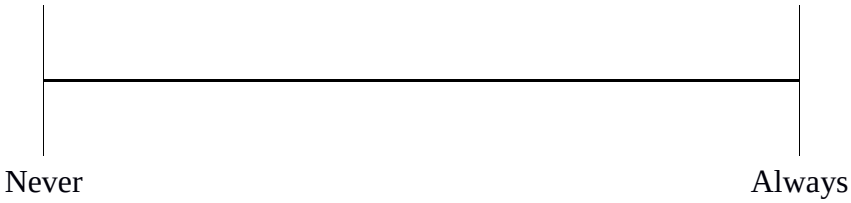


How much sadness are you feeling right now?

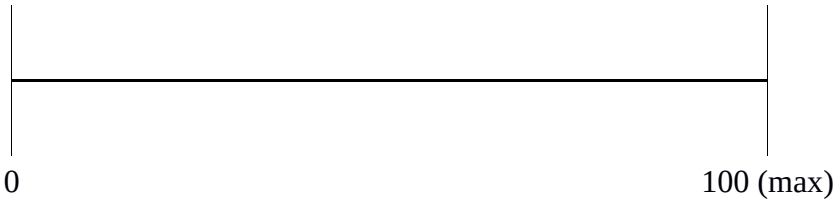


VAS2

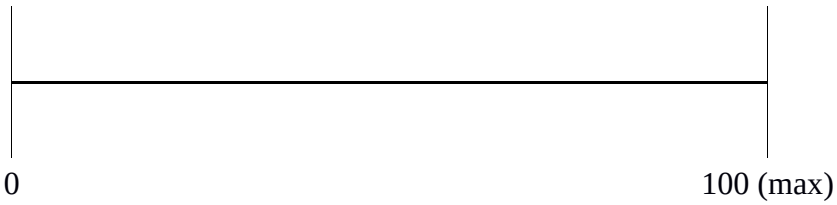
During that task, how much did your mind wander to other things?



How much happiness did you experience on average during that task?

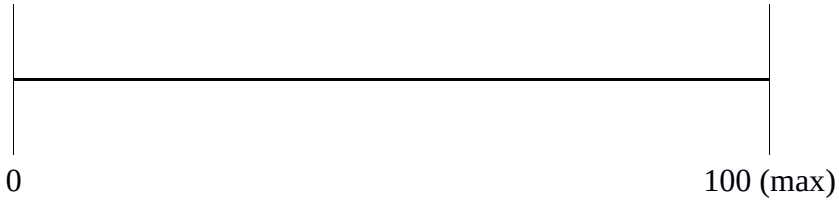


How much sadness did you experience on average during that task?

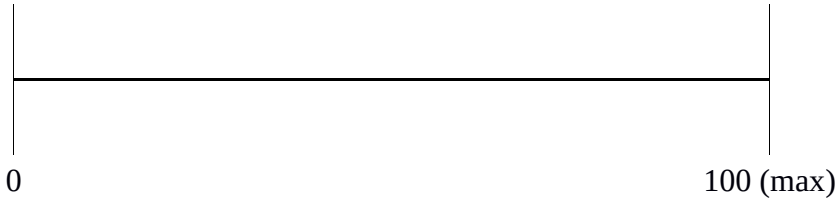


VAS3

How much happiness are you feeling right now?

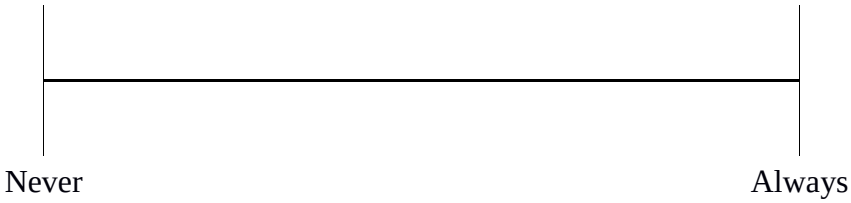


How much sadness are you feeling right now?

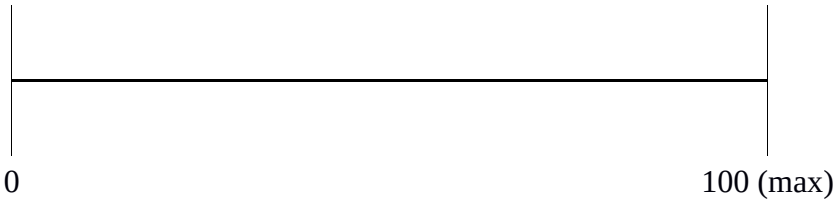


VAS4

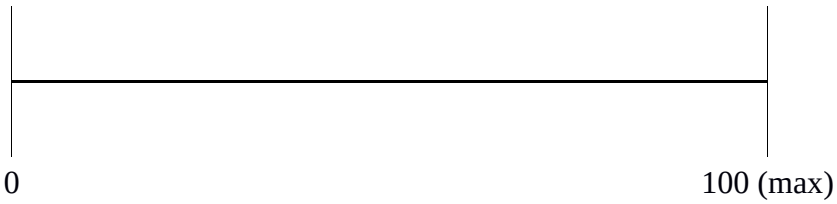
During that task, how much did your mind wander to other things?



How much happiness did you experience on average during that task?

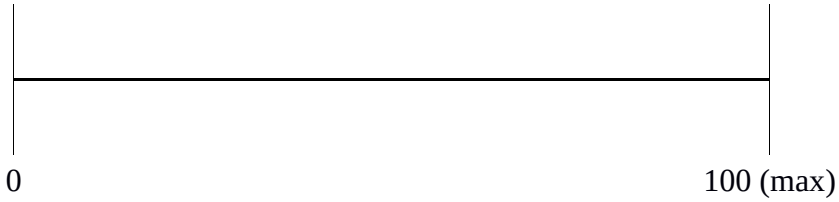


How much sadness did you experience on average during that task?

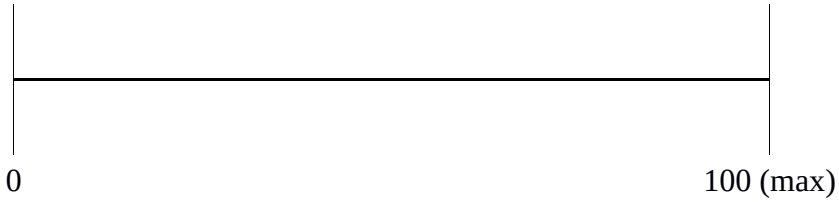


VAS5

How much happiness are you feeling right now?

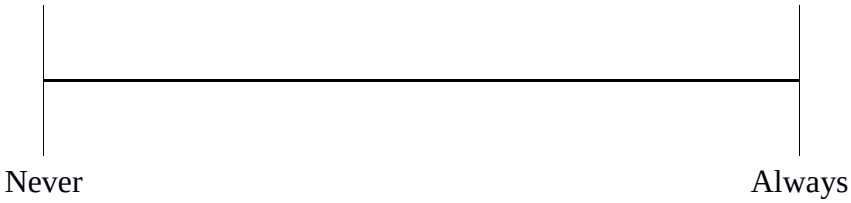


How much sadness are you feeling right now?

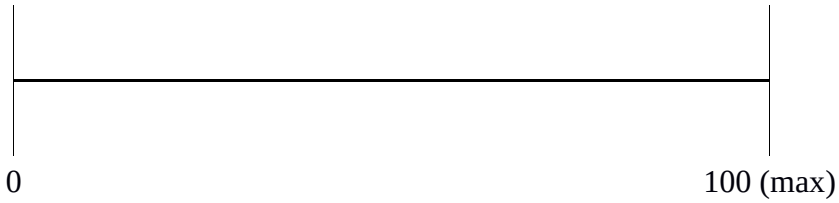


VAS6

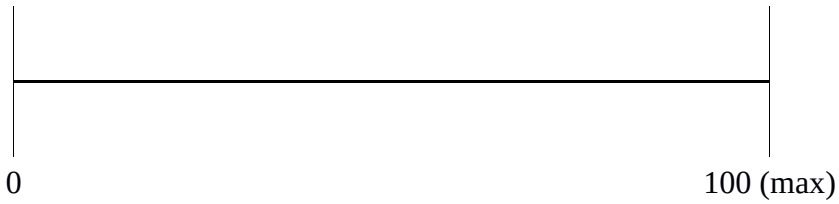
During that task, how much did your mind wander to other things?



How much happiness did you experience on average during that task?

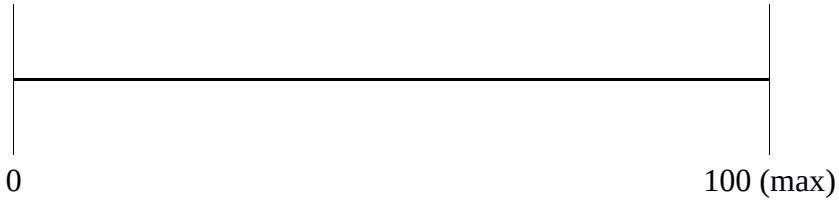


How much sadness did you experience on average during that task?

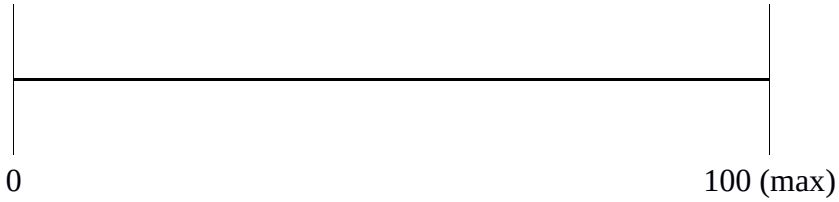


VAS7

How much happiness are you feeling right now?

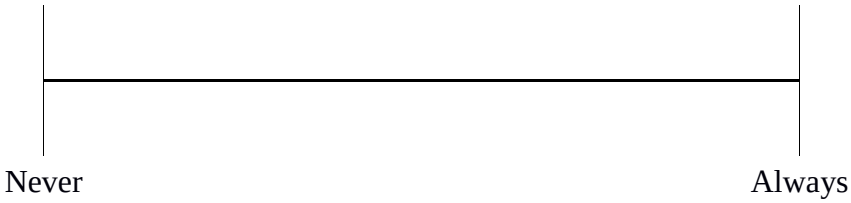


How much sadness are you feeling right now?

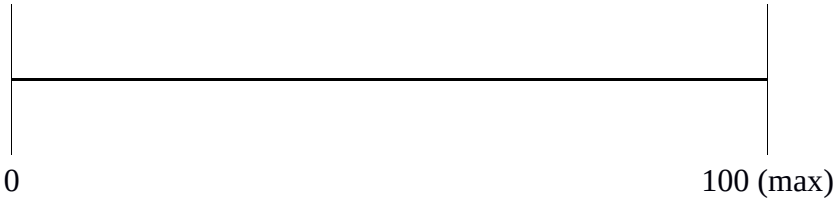


VAS8

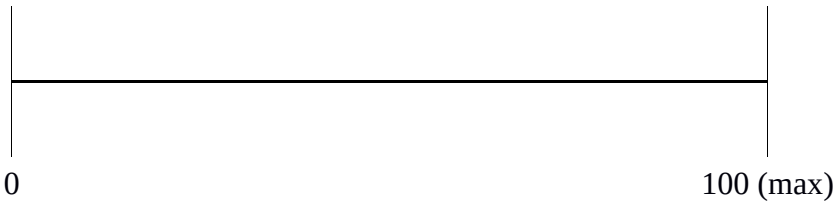
During that task, how much did your mind wander to other things?



How much happiness did you experience on average during that task?



How much sadness did you experience on average during that task?



Part Three: Critical Appraisal

This critical appraisal explores three aspects of the thesis. First, I reflect on the research design process of the empirical study reported in Part 2. Second, the issue of measuring a transient mental event such as mind wandering will be explored. Finally, a future study based on an observation from the empirical testing is proposed.

Reflection on Research Design

The starting point for this section is the failure of the empirical study to find any of the inhibitory control training effects it investigated. Some specific reasons for this have been noted in the discussion section of the empirical paper. In particular, the training was probably too short and the mind wandering induction may have induced stimulus-dependent off-task thoughts rather than stimulating stimulus-independent intrusions as desired. Beside these reasons, it is possible that the null findings reflect a type II error, given the study's low power. These problems reflect a more general shortcoming of the design: the study sought simultaneously to establish a relationship between two variables and manipulate that relationship.

In order to establish the presence of training effects in the current study, a number of elements of the design needed to work in concert. First, negative auditory distraction had to stimulate mind wandering. Second, mind wandering had to interfere with affective benefits of the mood induction. There was some evidence in the results to support both of these steps but it was far from conclusive. Third, a brief inhibitory control task had to successfully train response inhibition to negative words on screen. This step was not itself verified in the study. Fourth, the enhanced inhibitory effect had to extend to presentation of the negative stimuli in a different modality. Fifth, participants receiving the training had to show different responses to the control group when the distraction was repeated. There was no evidence for the fourth or fifth steps; even had there been it would have been hard to interpret given the uncertain effects of the mind wandering intervention.

Combining these steps into a single design meant that null findings were hard to interpret and hence not very informative about the study's research questions. A more focused design may have been a wiser approach; most of the steps described above could have been the subject of studies in their own right. For example, the mind wandering manipulation should have been more extensively piloted. This would have allowed its effects to be more precisely understood, particularly concerning the type of off-task thinking it prompted. The piloting that was undertaken was only concerned with establishing the face validity and acceptability of the negative distraction. From the data so far it is an open question whether the procedure primarily generates off-task thinking that is independent from external stimuli, as intended. A more considered approach to looking for training effects in a separate study would also have been advisable. For example, a longer training period would have been suitable for a proof-of-concept study; the brief training task we used was more suitable for a real-world translational study of a proven effect. It would also have been more precise to carry out some validation of the training task besides searching for its effects in participants' affective responses (step three above). A surprise recall test of the task stimuli (cf. Herbert & Sütterlin, 2011) would have helped to ascertain whether any cognitive transfer effects had occurred as a result of increased stopping practice in the training group.

The fact that these decisions were not taken is due in part to a degree of over-ambition at the design phase. It is also due to the protracted nature of the design phase in this case. It was originally planned to carry out a quite different study of intrusive memory in borderline personality disorder. For logistical reasons (chiefly the lack of access to a suitable clinical sample) this project was adapted, becoming an investigation of the role of memory vantage point in depression. This project was thought to be insufficiently novel and a new one devised, examining the links

between mind wandering and involuntary memory in depression. The literature review reflects this stage of the project's evolution. The largely correlational nature of this project was then judged to have too little clinical impact and a further change was made, to consider the links between anhedonia and inhibitory control of negative material and attempt to manipulate mind wandering more directly. Originally this project was to have a lengthy training protocol using a demanding *n*-back training task given daily for two weeks. For reasons of feasibility this training was scaled back and the one-off brief no-go procedure chosen instead.

With such a gestation, a point was reached where proceeding to data collection by slimming down the study seemed particularly important. This sense of urgency may have interfered with the ability to evaluate the design on its merits, particularly when considering the likelihood of finding training effects in this way with this sample. It is unlikely that the final design would have been arrived at from scratch, had studying response inhibition in anhedonia been the original aim of the project.

A final factor affecting the viability of the study was the difficulty encountered in recruiting a sufficiently dysphoric sample for investigating depression effects. It was intended to selectively recruit a dysphoric sample. Unfortunately the pace of recruitment was too slow when participants were pre-screened. This approach was therefore dropped in favour of recruiting a general community sample. As is apparent from the data in the empirical paper, levels of depression in the sample were ultimately low. It was intended that the protocol would be workable in event that a depressed sample could not be recruited. This may also have been a necessary rather than a realistic assumption. The very small effect sizes observed in all of the depression moderation analyses may be attributable, at

least in part, to the fact that the sample included very few participants with significant depressive symptoms.

Measuring Mind Wandering

When analysing the results of the study, one of the issues was determining the type of off-task thinking that the negative distraction was likely to produce. As discussed above, this partly reflects the fact that piloting this part of the procedure was constrained by time. At the same time, this problem is related to the more general difficulty of measuring a transient mental phenomenon such as mind wandering. This section of the critical appraisal first outlines current measurement approaches to mind wandering. The impact of recent developments in the theoretical conception of mind wandering is considered. Finally some ideas for improving measurement are advanced, including some derived from the study of involuntary autobiographical memories.

Current measurement approaches. There are two measurement strategies prevalent in the mind wandering literature (for a review, see Smallwood & Schooler, 2006). The first is behavioural: mind wandering is inferred from increased response latency and performance failures on tasks which require continuous attention. The most commonly-used example is the sustained attention to response task (SART; Manly, Robertson, Galloway & Hawkins, 1999), in which participants must respond to a sequence of non-target digits and withhold their response to an infrequent target digit. Word-by-word reading paradigms, able to detect mindless reading from reading speed and comprehension performance, have also been developed (e.g. Franklin, Smallwood & Schooler, 2011). The second measurement approach is thought sampling: asking people directly about their mental activity. Here the mind wandering may either be probe-caught or self-caught (Smallwood & Schooler, 2006). Mind wandering is probe-caught when participants are asked mid-activity to report

or record it (e.g. Killingsworth & Gilbert, 2010). Thought content may be assigned as off-task by participants themselves, or this judgement may be made by the experimenter. Self-caught detection requires participants proactively to report off-task thinking, either during a task or afterwards in a questionnaire (e.g. Smallwood et al., 2004; the approach used in the empirical paper of this thesis).

Limitations. Although these measurement strategies have yielded important insight into mind wandering in recent years, they have some drawbacks. A downside of self-caught monitoring is that people's awareness of off-task thinking or their ability to remember it may confound mind wandering measurement. For this reason it is not often used to measure the absolute frequency of mind wandering. Although behavioural paradigms such as the SART offer rigorous experimental control, their ecological validity may be open to question. Vigilance tasks may be a reasonable analogue to certain occupational settings (airport baggage screener, perhaps), but typically offer less stimulation than real-world settings where some kind of task focus is present.

A more general issue has been raised by Smallwood (2013a) in a recent review. He notes that mind wandering data are atypical in the cognitive science literature because the onset and offset of the mental event cannot be experimentally controlled, posing a challenge to standard research designs. The main implication of this is that experimental data (such as a probe-caught report of thought content) may pertain to the initiation of an episode of off-task thinking, its continuation, or its termination. Smallwood (2013a) has suggested a process-occurrence framework to help disentangle these conflicts.

The process-occurrence framework. Smallwood (2013a) argues for a distinction between the process of mind wandering (entailing maintenance mechanisms) and its occurrence (mechanisms governing onset). He proposes that the

framework helps clarify the competing theories of mind wandering because some focus on occurrence (current concerns, executive failure and meta-awareness) whereas a competing theory is more concerned with maintaining processes (perceptual decoupling). It is beyond the scope of this appraisal to evaluate the process-occurrence framework fully. The critical point for this discussion is a limitation of these hypotheses, noted by Smallwood (2013a): they explain how mind wandering might occur probabilistically, but do not explain how *specific* self-generated thoughts occur. The aim of the remainder of this section is to show how ideas from the literature review in Part 1 on this thesis can address this gap, by suggesting new ways of measuring mind wandering. Consistent with the process-occurrence framework, this discussion will focus first on mind wandering initiation and then on maintenance processes.

Mind wandering occurrence and memory. The literature review in Part 1 proposed that retrospective mind wandering and involuntary autobiographical memory may be seen as overlapping phenomena. While much more work is needed to support this approach, there is scope to consider applications of the memory literature to mind wandering. In his review, Smallwood (2013a) acknowledges that a possible mechanism for mind wandering initiation (i.e. occurrence) is that "memory systems and specifically the hippocampus provide the spark that ignites an internal train of thought" (p. 531). In the case of mind wandering to past events, the literature review of this thesis suggests specific ways in which events linked to initiation could be investigated. It was predicted that cue underload (when an environmental cue matches only one memory rather than many), cue multiplicity (multiple cues pointing to the same memory) and cue distinctiveness will increase the likelihood of the mind wandering to a given past event. Experimental designs which manipulate

these variables (for example, by using vigilance tasks with memory-salient stimuli) could begin to address the gap identified by Smallwood (2013a).

Mind wandering process and memory. Smallwood (2013a, 2013b) argues that perceptual decoupling (when cognitive resources are engaged by self-generated information rather than external stimuli) is responsible for maintaining mind wandering by insulating an internally-focused stream of thought. He argues that this theory of mind wandering is distinct because it concerns how off-task thoughts are maintained, rather than how they begin. He proposes that the same cognitive processes that ensure the continuity of both externally-focused thinking (e.g. working memory, Levinson, Smallwood & Davidson, 2012) support internally-focused thought once perceptual decoupling has occurred. Again, this theory does not address mind wandering content, in particular how this may evolve over the course of a mind wandering episode.

A relevant perspective from the memory literature comes from studies of so-called involuntary memory chains (Mace, 2007). These occur when an involuntary memory is cued by a preceding involuntary memory rather than an external event. Memories in a chain may be connected by general-event associations (e.g. two memories about the same night out) or conceptual associations (e.g. two memories of telling a joke). A number of studies have found that for involuntary memories, conceptual associations outnumber event associations by about eight to one (Mace, 2007).

The study of involuntary memory chains has three implications for understanding the processes that maintain a mind wandering episode, at least when it is retrospective. First, the chaining concept suggests that the distinction made between initiation and maintenance of mind wandering made by Smallwood (2013a) might be too absolute. That is, the ‘process’ element of the process-occurrence

framework could actually contain repeated ‘occurrence’ iterations, where the mind remains off-task but focus is captured by a succession of internally-generated thoughts.

Second, chaining may be particularly relevant to the study of off-task thinking in depression. It is accepted that negative repetitive thought in depression (rumination) is a cyclical, repetitive process (e.g. Watkins, 2008). If the content of retrospective rumination is partly determined by conceptually-associated memory chains, this could help to explain how repetitive thought strengthens mood-cognition links (the amplification hypothesis: Watkins, 2008). For example, one memory of failure is likely to generate another, rather than a mood-incongruent memory linked to the first by events. Experiencing a sequence of conceptually-associated negative memories might also make depressed people more likely to enter an abstract, conceptual processing mode which is known to influence emotional reactivity (Watkins, Moberly & Moulds, 2008).

Finally, the memory chains concept suggests that mind wandering research could usefully measure connections between mind wandering events, rather than considering off-task thoughts as discrete events. Studies of naturalistic involuntary memories have used diaries which collect information about the cognitive events immediately preceding the memory (e.g. Mace, Clevinger & Martin, 2008). Experience sampling mind wandering protocols (e.g. Killingsworth & Gilbert, 2010) could be augmented to gather this information. In the laboratory, thought probes could be modified to investigate subjective connectedness of off-task thoughts. Additionally, whole-session analysis of mind wandering from multiple thought probes content could be undertaken, with a view to determining the degree of conceptual linkage.

Affective Forecasting of Autobiographical Memory

The final section of this critical appraisal describes a proposed study of affective forecasting of autobiographical memory in depression. This idea develops an anecdotal finding from the experimental procedure used in the study reported in Part 2. During the testing sessions for the empirical study, participants were asked to nominate four pleasant memories. They were told that they could choose recollections of any time or place, so long as the events took place over a single day and they retained sufficient information to tell the story for two minutes. The types of memories chosen ranged from significant life events (e.g. honeymoons or graduation) to more material pleasures (e.g. buying a new laptop). Later in the testing session, participants narrated their memories out loud as part of a mood induction procedure. Participants frequently reported that narrating a memory did not make them feel as they had expected. Most commonly they reported a discrepancy in degree of affective response, such that the narration was more or less pleasurable than they had expected. Some participants also reported valence discrepancies, when recalling the memory in detail provoked different emotions to those expected (most commonly, more negative affect). The proposal below places these discrepancies in the context of the existing literature on affective forecasting, recall biases and autobiographical memory in depression. It then suggests how studying these errors as they apply to memory events could help understanding of daily affective experience in depression.

Affective forecasting biases. Non-depressed people overestimate the impact of future events on their emotional experience. These errors have been shown in a range of contexts, and are found for positive and negative emotional reactions (for a review, see Wilson & Gilbert, 2005). There is evidence that these patterns are altered in depression. In absolute terms, depressed people tend to anticipate less pleasure

than controls (e.g. Strunk & Adler, 2009). The picture is less clear when the relative accuracy of forecasting is considered. Some studies have found greater overestimates of happiness in depressed groups (for a review see Dunn, 2012), but a recent study of predicted and actual reactions to Valentine's day found robust evidence of a dysphoric forecasting bias (Hoerger, Quirk, Chapman & Duberstein, 2012).

Underestimating pleasure from future events is thought to have an unhelpful maintaining function in depression (for example by promoting inactivity) and is targeted for remediation in behavioural experiments or activity scheduling (e.g. Beck, 1995; Martell, Dimidjian, & Herman-Dunn, 2010). A reduced optimism bias for remembering could drive reduced engagement with pleasant autobiographical material. To date, forecasting errors for memory events and how these might be altered in depression have not been examined. In other words, it is not known whether depressed people underestimate how much they will enjoy remembering something pleasant from their past, or underestimate the sadness they will feel when remembering a negative event.

Recall biases. Compared to predicting affective responses to an objective event (such as winning a prize), forecasting for mnemonic events in depression is complicated by recall biases. Recall biases for negative material in depression are well-established (e.g. Gotlib, 1983; Lloyd & Lishman, 1975). The functions of recall biases for memories in depression are not well understood, but their clinical relevance may lie in the affective impact at the moment of recall. In everyday recall outside the laboratory, depressed people's memories are more often about negative events, and the remembering has a greater negative impact on mood (Watson, Berntsen, Kuyken & Watkins, 2012). There is recent evidence that negative recall biases persist even without reference to a specific event (Wenze, Gunthers & German, 2013). Recall biases could influence forecasting errors by causing negative

information to be over-represented in the recall of a pleasant memory. Controlling for mood state at the time of recall might help to mitigate how much these biases confound potential affective forecasting effects

Reduced autobiographical memory specificity. As well as biases in affective forecasting and affective recall, there is also evidence of qualitative differences in the autobiographical memories of depressed people. When autobiographical recall is generated voluntarily from cue words, there is reliable evidence that depressed people produce memories that are less specific and detailed than non-depressed controls (e.g. Wessels, Meeren, Peeters, Arntz & Merckelbach, 2001). Williams et al. (2007) have proposed that this phenomenon is caused by the truncation of memory search processes by capture and rumination, functional avoidance of emotional material and executive function deficits. The proposed study of mnemonic affective forecasting would control for reduced specificity. Otherwise, it could be that depressed people's experienced pleasure may not live up to their predictions simply because they were not recalling the memory in sufficient detail.

Proposed study. Based on the literature briefly reviewed above, it may be hypothesised that: (i) depressed people will overestimate how much negative affect they experience when remembering a negative event; (ii) depressed people will underestimate how much positive affect experience they experience when remembering a positive event; and (iii) these biases will be reversed in a non-depressed control group. A laboratory-based design, allowing recall biases and memory specificity to be controlled, would be appropriate for an exploratory study. For example, participants would first report their current mood state. They could then be asked to nominate four autobiographical memories. They would rate the predicted affective valence, intensity and specific emotions during recall. Participants would then narrate each memory for a brief period, with instructions to

give a detailed story (to control for specificity variations). After recall, memory characteristics would be re-rated. Analysis would focus on group differences in forecasting errors.

Conclusion

This thesis has sought to develop mind wandering theory in the context of the memory literature and to investigate how the wandering mind may disrupt pleasurable experience in depression. The critical appraisal has noted some of the challenges encountered in pursing these aims, and some directions which further research might take. As the initiation, content and consequences of unplanned thought become better understood, clinicians can develop new ways of working with this ubiquitous part of mental life.

References

American Psychiatric Association (1994). *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*. Washington, DC: American Psychiatric Association.

Beck, J. S. (2011). *Cognitive behavior therapy: Basics and beyond*. New York: Guilford.

Dunn, B. D. (2012). Helping depressed clients reconnect to positive emotion experience: Current insights and future directions. *Clinical Psychology & Psychotherapy, 19,* 326-340.

Gotlib, I. H. (1983). Perception and recall of interpersonal feedback: Negative bias in depression. *Cognitive Therapy and Research, 7*, 399-412.

Herbert, C., & Sütterlin, S. (2011). Response inhibition and memory retrieval of emotional target words: Evidence from an emotional stop-signal task. *Journal of Behavioral and Brain Science, 1*, 153-159.

Hoerger, M., Quirk, S. W., Chapman, B. P., & Duberstein, P. R. (2012). Affective forecasting and self-rated symptoms of depression, anxiety, and hypomania: Evidence for a dysphoric forecasting bias. *Cognition and Emotion, 26,* 1098-1106.

Killingsworth, M. A., & Gilbert, D. T. (2010). A wandering mind is an unhappy mind. *Science, 330*, 932-932.

Levinson, D. B., Smallwood, J., & Davidson, R. J. (2012). The persistence of thought: evidence for a role of working memory in the maintenance of task-unrelated thinking. *Psychological Science, 23,* 375-380.

Lloyd, G. G., & Lishman, W. A. (1975). Effect of depression on the speed of recall of pleasant and unpleasant experiences. *Psychological Medicine, 5*, 173-180.

Mace, J. H. (2007) Involuntary memory: Concept and theory. In J. H. Mace (Ed.), *Involuntary memory.* Blackwell, Oxford.

Mace, J. H., Clevinger, A. M., & Martin, C. (2010). Involuntary memory chaining versus event cueing: Which is a better indicator of autobiographical memory organisation? *Memory, 18,* 845-854.

Manly, T., Robertson, I. H., Galloway, M., & Hawkins, K. (1999). The absent mind: Further investigations of sustained attention to response. *Neuropsychologia, 37,* 661–670.

Martell, C., Dimidjian, S., & Herman-Dunn, R. (2010). *Behavioral activation for depression*: *A clinician's guide.* New York: Guilford.

Strunk, D. R., & Adler, A. D. (2009). Cognitive biases in three prediction tasks: A test of the cognitive model of depression. *Behaviour Research and Therapy, 47,* 34-40.

Smallwood, J. (2013a). Distinguishing how from why the mind wanders: A process–occurrence framework for self-generated mental activity. *Psychological Bulletin, 139,* 519-535.

Smallwood, J. (2013b). Searching for the elements of thought: Reply to Franklin, Mrazek, Broadway, and Schooler (2013). *Psychological Bulletin, 139,* 542-547.

Smallwood, J., Davies, J. B., Heim, D., Finnigan, F., Sudberry, M., O'Connor, R., & Obonsawin, M. (2004). Subjective experience and the attentional lapse: Task engagement and disengagement during sustained attention. *Consciousness and Cognition, 13,* 657-690.

Smallwood, J., & Schooler, J. W. (2006). The restless mind. *Psychological Bulletin, 132,* 946-958.

Watkins, E. R. (2008). Constructive and unconstructive repetitive thought. *Psychological Bulletin, 134*, 163-206.

Watkins, E., Moberly, N. J., & Moulds, M. L. (2008). Processing mode causally influences emotional reactivity: Distinct effects of abstract versus concrete construal on emotional response. *Emotion, 8*, 364-378.

Watson, L. A., Berntsen, D., Kuyken, W., & Watkins, E. R. (2012). The characteristics of involuntary and voluntary autobiographical memories in depressed and never depressed individuals. *Consciousness and Cognition, 21*, 1382-1392.

Watson, L. A., Berntsen, D., Kuyken, W., & Watkins, E. R. (2013). Involuntary and voluntary autobiographical memory specificity as a function of depression. *Journal of Behaviour Therapy and Experimental Psychiatry*, 44, 7-13.

Wenze, S. J., Gunthert, K. C., & German, R. E. (2012). Biases in affective forecasting and recall in individuals with depression and anxiety symptoms. *Personality and Social Psychology Bulletin, 38*, 895-906.

Wessel, I., Meeren, M., Peeters, F., Arntz, A., & Merckelbach, H. (2001). Correlates of autobiographical memory specificity: The role of depression, anxiety and childhood trauma. *Behaviour Research and Therapy, 39*, 409-421.

Wheatley, J., Brewin, C. R., Patel, T., Hackmann, A., Wells, A., Fisher, P., & Myers, S. (2007). "I'll believe it when I can see it": Imagery rescripting of intrusive sensory memories in depression. *Journal of Behavior Therapy and Experimental Psychiatry, 38*, 371-385.

Williams, J. M. G., Barnhofer, T., Crane, C., Herman, D., Raes, F., Watkins, E., & Dalgleish, T. (2007). Autobiographical memory specificity and emotional disorder. *Psychological Bulletin, 133*, 122.

Wilson, T. D., & Gilbert, D. T. (2005). Affective forecasting: Knowing what to want. *Current Directions in Psychological Science, 14,* 131-134.