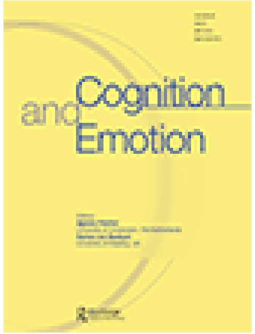

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Mind-wandering and dysphoria

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Mind-wandering shares a number of important similarities with thinking in depression. This experiment examines whether mind-wandering provides a useful marker of cognition in dysphoria during a word learning task. Dysphoria was associated with more *accessible* mind-wandering when attempting to encode verbal items. In addition, in the dysphoric population, periods when the mind wandered led to greater *decoupling* from task-relevant processing as indexed by slower response times, and greater *physiological arousal*, as indexed by faster heart rates. In the general population, periods of mind-wandering when attempting to encode information were associated with poor retrieval and high skin conductance. Finally, the extent to which mind-wandering was associated with poor retrieval was associated with an individuals' latency to retrieve specific autobiographical memories from outside the laboratory. These results provide strong evidence for the utility of mind-wandering as a marker for depressive thinking and suggest a number of important implications for therapy for depression.

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INTRODUCTION

Cognition in depression

Over the last hundred years it has become apparent that cognition plays an important role in the experience and maintenance of depression. For example, Freud (1917/1953) famously suggested that mourning was the process by which the mourner relinquished emotional ties to the lost object. One important account of cognition in depression in recent times is based on the work of Aaron Beck (Beck, 1976). In its earliest form the cognitive account of depression suggested that depressive thinking had two important dimensions. First, depressive cognitions were negative in tone and, second, they were the product of an automatic process (Beck, 1976).

Recently, the emphasis on negative thinking in dysphoria has been challenged (Champion & Power, 1995; Teasdale & Barnard, 1993). Alternative accounts stress that depression involves states of self discrepancy (Higgins, 1987) and depressive thinking often entails the repetitive processing of unattainable personal goals (Pyszczynski & Greenberg, 1987). By emphasising the importance of *self-discrepancy*, recent accounts of depression imply that the cognitive difficulties centre on a style of preoccupation with resolving personal problems, rather than the negative emotional tone of these thoughts per se (Champion & Power, 1995). More recent accounts of depression, therefore, suggest that they could involve preoccupation with attaining impossible positive, as well as avoiding inevitable negative goals.

Neither is it clear that depressive thinking is strictly automatic in nature. Wegner and Bargh (1998) suggest that an automatic process is one that can be conducted in an efficient manner without interference from other processes. In considering whether depressive thinking is automatic, it is necessary to distinguish between the trigger for the thought and the process involved in the maintenance or experience of the thought (Ingram & Kendall, 1987; Ingram & Wisnicki, 1991). In a comprehensive review it was suggested that the cognitive deficits in depression result from an automatic process that subsequently interfere with various aspects of "ongoing mental activity" (Hartlage, Alloy, Vazquez, & Dykman, 1993, p. 248). The fact that these cognitions pervasively impair everyday functioning suggests that they interfere with the performance of alternative activities. It seems, therefore, that while the triggers for depressive cognition occur automatically, once initiated depressive thoughts involve resources, which in other circumstances would be employed in the service of alternative executive goals.

Mind-wandering

If dysphoria is not necessarily associated with negative automatic thoughts as Beck (1976) suggested, it could involve a more general preoccupation with events that are important, but which are not necessarily present in the *here* and *now* (Teasdale, 1999). Everyday, we all experience our minds wandering away from our current activity as our attention is drawn to our private thoughts and feelings. *Mind-wandering* is a ubiquitous element of everyday cognitive processing, which shares an emphasis on the processing of information from beyond the here and now. Differences in the intensity and/or frequency with which the mind wanders, therefore, could provide an excellent marker of depression.

Mind-wandering or daydreaming (Singer, 1966) has been studied over the last thirty years, and has been defined in a variety of ways—for example, task unrelated thought (Smallwood, Baracaia, Lowe, & Obonsawin, 2003b; Smallwood, Obonsawin, & Heim, 2003a; Smallwood, O'Connor, Sudberry, & Ballantyre, 2004b; Smallwood et al., 2004a), task unrelated images and thought (Giambra, 1995) and stimulus independent thought (Antrobus, 1968; Teasdale, Proctor, Lloyd, & Baddeley, 1993: Teasdale et al., 1995a). All three terms capture the essential information-processing characteristics of mind-wandering: *a shift in the focus of attention away from the here and now towards one's private thoughts and feelings.* In the following sections of this paper we review empirical evidence that demonstrates that, similar to cognition in dysphoria, mind-wandering involves the decoupling of executive processes from task relevant information processes towards more general ongoing personal problems.

Mind-wandering as an executive processes

At first glance mind-wandering is a quintessential example of an executive process as it involves the most complex cognitive process of all—thinking. In a recent review it was suggested that when the mind wanders executive resources are decoupled from the current task context, and are directed instead to our own private thoughts and feelings (Smallwood & Schooler, in press). We will briefly summarise the evidence for this claim, before detailing why mind-wandering should prove a useful marker for depressive thinking.

One influence on executive processing is practice. As tasks become practiced they require less conscious attention to perform successfully (Anderson, 1983). Skilled performance is *functionally transparent* (Vera & Simon, 1993) because it does not involve the management of micro aspects of task performance in awareness. Under conditions of functional transparency resource competition indicates that *mind-wandering* will be *more frequent* because executive resources are not needed to manage the primary task.

Studies have suggested that as practice increases so does mind-wandering (Smallwood, Obonsawin, & Reid, 2003c; Teasdale, Segal, & Williams, 1995b). Tasks that lack the complex demands of *executive* processes, such as simple signal-detection-tasks (Giambra, 1995; Smallwood et al., 2003c; Smallwood et al., 2004a) and visuo-spatial tasks (Teasdale et al., 1995a) all show a reliable increase in mind-wandering as time on-task increase. By contrast, more complex tasks, such as a verbal fluency, the resource demands of which are impervious to practice, do not show an increase in mind-wandering with time on-task (Smallwood et al., 2003c). Taken together, these results indicate that mind-wandering often occurs in task contexts that are *functionally transparent*.

Not all mind-wandering occurs without consequence to task performance, however. When the mind wanders it leads to measurable deficits in task performance (Giambra, 1995; Smallwood et al., 2004a; Teasdale et al., 1995a). In a variety of tasks including go/no go (Smallwood, 2004a) and simple signal detection-tasks (Giambra, 1995) the experience of mind-wandering has been shown to lead to subtle deficits in task performance. Even in executive tasks, such as random number generation, mind-wandering has been shown to lead to deficits in task performance (Teasdale et al., 1995a) comparable in certain respects to the effects of divided attention in this paradigm (Baddeley, 1996). Mind-wandering, therefore, is often accompanied by an involuntary switch to performing the task on automatic pilot.

Mind-wandering and the decoupling of attention

Based on our own experiences mind-wandering involves a withdrawal of attention from the current "here and now" and a redirection towards our current concerns (Klinger, 1999). The lack of attentional supervision of the primary task during mind-wandering implies that attention is *decoupled* from the primary task (Smallwood & Schooler, in press; Smallwood et al., 2003a, 2003b, 2004a, 2004b). The fact that during mind-wandering our attention is decoupled from the task indicates that our representations of the task environment will be *less detailed* than during periods of time when our attention is focused on the task.

Evidence supports the suggestion that mind-wandering involves a superficial representation of the current environment. Self-reports of mind-wandering tend to occur in temporal periods when encoding of task-relevant information is poor (Seibert & Ellis, 1991; Smallwood et al., 2003a, 2003b). For example, manipulations that increase retrieval decrease mind-wandering (Smallwood et al., 2003a) while frequent mind-wandering is associated with poorer retrieval (Smallwood et al., 2003b). At a more detailed level the consequences of mind-wandering on retrieval resemble those of divisions of attention—decreasing the influence of conscious recollection while leaving the automatic influences due to stimulus exposure invariant (Smallwood et al., 2003b, 2004b; Smallwood, O'Connor, & Heim, 2005).

Mind-wandering also interferes with reading. During reading mind-wandering has been associated with impaired text comprehension (Schooler, McSpadden, Reichle, & Smallwood, 2005b; Schooler, Reichle, & Halpern, 2005a). Using a one word at a time text presentation mind-wandering has even been shown to increase the likelihood of missing meaningless yet syntactical sentences (e.g., The circus needed money to go the boys) hidden within simple 2nd grade text (Schooler et al., 2005a, 2005b). When the mind wanders, therefore, it seems, our attention is *decoupled* from the "here and now" and as a result we cannot create and maintain a detailed representation of the information provided by the external environment.

Mind-wandering and dysphoria

In principle, therefore, cognition in depression shows two important similarities with recent conceptualisations of mind-wandering: (1) both are implicated in shifting attention away from the *here and now*; and (2) both lead to the monopolising of executive processes by personally salient information (Smallwood & Schooler, in press). Consistent with the conceptual similarity between mind-wandering and depression, empirical evidence has documented a relationship between self-reports that their mind has wandered and scores on questionnaire measures of dysphoria. Positive correlations between mind-wandering frequency and levels of dysphoria have been documented across a wide range of tasks: word learning (Smallwood, Obonsawin, Baracaia, Reid, O'Connor, & Heim, 2003d; Smallwood et al., 2004b), sustained attention (Smallwood et al., 2004a) and simple word fragment completion (Smallwood et al., 2005).

A second reason to expect mind-wandering to be associated with depression is the success of therapies that provide training on maintaining attention on the here and now: *mindfulness-based cognitive therapy* (MBCT; Teasdale, 1999; Teasdale, Segal, Williams, Ridgeway, Soulsby, & Lau, 2000; Williams, Teasdale, Segal, & Soulsby, 2000a). MBCT is a form of therapy that focuses on changing the mode of attentional control by increasing the participants' "awareness of the present moment to moment experience": a state described as *mindful*[1] processing (Williams et al., 2000a, p. 151).

[1] Mindfulness can be considered a state of mind in which the individual is "paying attention in a particular way: on purpose, in the present moment and non-judgementally" (Kabat-Zinn, 1994, p. 4). By contrast, the mindless processing of information, the *conception/doing mode* (Teasdale, 1999) is "dominated by relatively impersonal detached thoughts about the self or emotion (as objects) about goal orientated strategies .... Such thinking will often be related to the past or future rather than to immediate experience" (Teasdale, 1999, p. 68).

Williams and colleagues' evidence suggests that MBCT significantly reduces the tendency for a recovered depressive to recall over-general memories for events that have occurred since the beginning of treatment (Williams et al., 2000a). It is a reasonable interpretation for the success of MBCT that it provides the patients with the skill to overcome the decoupling nature of mind-wandering and, in turn, allows them to form more detailed autobiographical memories.

Experimental aims

There were two broad aims for this investigation into the relationship between mind-wandering and dysphoria. The first aim was to examine whether the experience of dysphoria in nonclinical participants was associated with higher frequencies of mind-wandering. This question was addressed by attempting to answer two core questions. If depressive thinking is associated with mind-wandering, then off-task thinking in dysphoria should be more readily activated, i.e., more frequent, than in non-dysphoric individuals. In addition dysphoric individuals could show evidence for greater *decoupling* during mind-wandering than a non-dysphoric population. This would predict greater interference on concurrent behavioural measures in dysphoric relative to control individuals when verbal reports indicate they are off-task. It is also possible that mind-wandering during dysphoria is more emotional than in controls suggesting that theses episodes could entail greater physiological activation.

The second aim of this investigation was to explicitly examine the claim that a tendency towards frequent mind-wandering is associated with differences in the formation of autobiographical memories. If MBCT elicits its therapeutic effects on autobiographical memories for recently occurring events because the therapy enhances encoding (Williams et al., 2000a) then we might expect to see an association between the consequences of decoupling attention during the task and performance on a test of specificity of autobiographical memory. Put simply we expect the decoupling influences of mind-wandering on-task performance to be associated with one's effectiveness to retrieve specific autobiographical memories.

Methodological issues

The study of verbal reports is notoriously problematic in psychology (Nisbett & Wilson, 1977). Consistent with recommendations in the literature, an association between mind-wandering and either behavioural or physiological measures would enhance our confidence in the veracity of the self-reported information because these measures are less susceptible to demand characteristics (Schooler & Schreiber, 2004). Previous work has linked mind-wandering to *behavioural* measures of information processing (e.g., response time and word fragment completion; Smallwood et al., 2003a, 2003b, 2003c, 2003d, 2004a, 2004b) and psychophysiological markers of attention, heart rate (HR) and the skin conductance response (SCR; Smallwood et al., 2004a, 2004b). We briefly describe the rationale for our choice of behavioural and physiological measures employed in this study.

Retrieval. The most obvious way to test the whether mind-wandering is a state of *decoupled* attention is to examine whether participants can recall information that was presented when their attention was off-task. According to dual process accounts of memory it is necessary to distinguish between recollection based on detailed episodic memories and retrieval, which occurs unintentionally because we are simply familiar with the stimulus (see Jacoby, 1998). This experiment uses the same method as was employed elsewhere to measure the relationship between retrieval and mind-wandering (Smallwood et al., 2003b, Experiment 2; see also Smallwood et al., 2004b). Participants are exposed to a list of words under two different *instruction* conditions: (1) information that is to be *encoded* for subsequent retrieval; and (2) information that is to be *shadowed*, but not encoded. This design allows us to compare the influences on retrieval that are based on effortful encoding, with a baseline measure of "unintentional" encoding that results from simple exposure to information (see Jacoby, 1998).

Previous demonstrations of the influences of mind-wandering on retrieval of information have been documented using word fragment completion but not word recognition (Smallwood et al., 2003b, Experiments 2 and 3; Smallwood et al., 2004b; Smallwood et al., 2005). For example, Smallwood et al. (2003b, Experiment 2) employed a similar design to that employed in this study, and demonstrated that the decoupling effects of mind-wandering were observed using word fragment completion both in terms of a greater frequency of false alarms (Experiment 1) and a relative inability to retrieve information that was to be encoded but not shadowed (Experiment 2). In neither experiment did mind-wandering yield differences in retrieval using word recognition (Smallwood et al., 2003b, Experiments 1 and 2). In this experiment we, therefore, employ word fragment completion as an index of retrieval.

Response time. Psychology has employed response time as an indicator of the efficiency of information processing for over a hundred years. Broadly, rapid response times imply that task processing is proceeding in an efficient manner. Slower response times instead indicate inefficient psychological processing or, alternatively, indicate more complex information processing. In complex tasks like encoding, the experience of mind-wandering is often accompanied by longer response times. For example, when individuals encoded a list of verbal items presented at a rate of approximately one item every ten seconds, mind-wandering was associated with slower response times than periods when attention was directed towards the task (Smallwood et al., 2003b). Subsequent experiments employing a similar presentation rate identified that: (1) increases in response times were greater when encoding information relative to a baseline signal detection-task (Smallwood et al., 2004b, Experiment 1); and (2) higher frequencies of off-task experiences were associated with slower response times when attention was off-task (Smallwood et al., 2004b, Experiment 3).

Heart rate. Previous work documented that temporal increases in heart rate are associated with mind-wandering (Smallwood et al., 2004a, 2004b). In the context of both simple signal detection (Smallwood et al., 2004a) and in encoding tasks (Smallwood et al., 2004b) mind-wandering was associated with epochs when heart rate was faster. It was speculated that these increases in heart rate relate to the emotional engagement of the individual in the contents of mind-wandering (Smallwood et al., 2004a, 2004b).

Skin conductance response. Temporal fluctuations in the skin conductance response co-vary with regional variations in specific brain activity (Critchley, Elliot, Mathias, & Dolan, 2000; Patterson, Ungerleider, & Bandettini, 2002; Williams, Senior, David, Loughland, & Gordon, 2000b). A network of specific brain regions including the ventro-medial prefrontal cortex, the cerebellum and the visual cortices are correlated with the skin conductance response in a variety of different tasks including a checkerboard task (Williams et al., 2000b) a gambling task (Critchley et al., 2000) and during the resting state (Patterson et al., 2002). Taken together it was suggested that the skin conductance response appears to be a marker for a "network that is active during, but independent of the task being studied" (Patterson et al., 2002, p. 1797). The fact that the skin conductance response is associated with variations in attention independent of the task suggest that it could be a useful marker for mind-wandering.

Analytic strategy

In this task, the participant is asked to encode or shadow verbal information organised into blocks of stimuli. Each block is terminated by a thought probe. To examine whether mind-wandering in dysphoria is more accessible we compare the increase in off-task episodes as the task becomes practiced. To analyse the relationship between mind-wandering and behavioural and physiological measures, we retrospectively code the objective measure on the basis of the subsequent verbal report. This approach has been employed in the past (see Teasdale et al., 1993, 1995a; Smallwood et al., 2003b, 2004a, 2004b, 2005). These measures are averaged and analysed using a factor-based design as in standard psychological experiments. In this experiment, this design yields two within-participants factors: *Mental State* (on-task/mind-wandering) and *Instruction* (encoding/shadowing). We also include one between-participant factor: *Dysphoria Group* (high/low).

Categorising objective measures into task epochs when mind-wandering occurs allows us to test the veracity of verbal reports. The analysis we employ is based on the assumption that mind-wandering is a moment-to-moment shift in the focus of attention, away from the primary task towards one's current concerns. According to this viewpoint, mind-wandering is an example of a *temporal dissociation* in conscious processing (Schooler, 2002). To test the temporal view of mind-wandering we examine whether objective measures distinguish between epochs when verbal reports indicate attention is off-task and when attention is on-task. Because our analysis is not based on random assignment and, instead, is determined post hoc using classified verbal reports we cannot make clear statements of causality. Nonetheless, should our analysis of objective measures discriminate between periods when attention is on-task compared to mind-wandering this would confirm it involves a temporal dissociation and rule out either simple individual differences or demand characteristics accounts of our data.

METHOD

Participants

Participants were recruited from a University Psychology department ($N = 37$, 11 of whom were male and 26 female). The mean age of the sample was 25.6 ($SD = 7.6$) years of age and, on average, each participant had spent 17.5 ($SD = 1.8$) years in full-time education. All participants were paid £5 at the end of the experimental session.

Materials

Task stimuli. Stimuli for the study/shadowing task were selected from the ANEW word norms (Bradley & Lang, 1999). Approximately 250 stimuli were selected that were in the middle third of the distribution for each of the three affective dimensions presented in the list of norms.[2] These words were then randomly divided into 20 blocks of stimuli containing 12 ± 2 stimuli. The number of stimuli was varied in a quasi-random fashion to ensure that participants could not anticipate the end of the block. Block order was fully counterbalanced. Out of the stimuli presented during each block of study,

[2] In this experiment we were not concerned with the investigation of the consequences of the emotional quality of the stimuli to be studied.

four critical items were selected from each block at random. These critical items were transformed into word fragments by removing 25% of the letters from each word at random. During the retrieval, these word fragments were presented in a randomised list containing 80 items previously seen and 10 "new" items. The stimulus presentation package used for this experiment was the Experimental Run Time Systems.

Stimuli for the over-general memory task were selected from previous research (Williams, 2002; Williams & Broadbent, 1986). Five positive words (happy, safe, interested, successful and surprised) and five negative words (sorry, angry, clumsy, hurt and lonely) were administered alternately. The instructions required participants to recall a specific personal memory to each of 10 cue words. Participants were given 60 seconds to retrieve a memory in responses to each of these cues. Latency of memory recall was recorded using a stopwatch. If a participant was unable to recall a specific memory in the time available, a time of 60 seconds was recorded. In addition, if a participant retrieved a general memory, they were probed further to try to generate a specific event. Each participant was given three practice trials before beginning the task. Responses were coded by the researcher as to whether they qualified as a specific memory (see Williams & Broadbent, 1986).

Physiological measures. Five minutes before beginning the task the electrodes to record SCR and heart rate were attached to each participant. The electrodes for recording SCR were always attached to the non-dominant hand. All electrode attachment sites were cleaned with SkinPure (Nihon Kohden) prior to the attachment of electrodes. Ag–AgCl skin conductance electrodes (6 mm, Biopac Systems, Inc.) were attached to the palm side of the medial phalanx of the index and middle fingers of the non-dominant hand. The electrodes were secured with Velcro® straps. The electrolyte used was a commercially available preparation (KY® Lubricating Gel, Johnson & Johnson) with a conductivity similar to that of the 0.051 M NaCl solution recommended for use by Fowles, Christie, Edelberg, Grings, Lykken, and Venables (1981) and Golding (1992). The signal from the electrodes were amplified with a Biopac model SCR100 amplifier.

The ECG was recorded using a 3-lead setup. Three surface Ag–AgCl electrodes (8 mm, BiopacSystems, Inc.) were used, with one electrode placed on the palm side of the right and left wrists, and the third electrode placed on the anterior surface of the ankle ipsilateral to the dominant hand. The electrodes were secured with surgical tape (Blenderm™, 3M). The electrolyte used was Sigma Gel®(Parker Laboratories, Inc.). The signals from the electrodes were amplified with a Biopac model ECG100B amplifier, with a high-pass filter set at 1.0 Hz. The sampling rate for the ECG and the SCR channels was set at 500 Hz. Data acquisition and analysis were performed with Acknowledge® software (Biopac Systems, Inc.).

For the purpose of analysis we calculated (1) average beats per minute as a measure of heart rate and (2) maximal differences in amplitude as a measure of SCR. Both of these scores were calculated for the last thirty seconds of each block—the period directly prior to a verbal report.

Questionnaires. In addition to the over-general memory and encoding tasks, participants completed a battery of three questionnaires at the end of the session:

1. The Centre for Epidemiological Studies Depression Inventory (CES-D; Radloff, 1977) a validated tool for using in an undergraduate sample (Field, Diago, & Sanders, 2001).
2. The short form of the Response to Situations Questionnaire (RSQ).
3. Mood component of the Dundee Stress State Questionnaire (DSSQ; see Matthews, Gililand, Campbell, & Faulconner, 1999, for the validity and reliability of this instrument).

Both the CES-D and the RSQ have been employed in the study of the relationship between mind-wandering and dysphoria in the past (Smallwood et al., 2003c, 2004a, 2004b, 2005). The CES-D is measured on a 4-point Likert scale and contains items such as: "I was bothered by things which did not normally bother me". The short form of the Response to Situations Questionnaire is a 10-item measure of trait rumination that assesses the degree to which an individual tends to respond when they are feeling depressed. It contains items such as: "I think about how alone I feel" or "I think about how hard it is to concentrate". Each item is measured on a 4-point Likert scale.

Finally, we administered the mood component of the DSSQ, a self-report instrument designed to measure affective experience during a recently completed task. The Mood component of the DSSQ consists of 29 adjectives (such as happy, nervous or tired). The participant rates the extent to which each adjective describes how they felt while performing the task on a 4-point Likert scale. The mood scale contains three factors: Energetic Arousal, Tense Arousal and Hedonic Tone. Completion of this questionnaire allows the examination of the mood state of the participants during task completion, and was administered as an additional control measure.

Procedure

Upon arrival, participants were greeted by the researcher and seated in a comfortable seat in front of a computer. The researcher outlined the experimental procedure and invited each participant to read and sign an informed consent sheet. Ethical approval had been obtained for the University Psychology Department's Ethics committee. Subsequently, participants completed a short questionnaire recording demographic details (i.e., age, gender and length of full-time education). The order for the tasks was fully counterbalanced.

Over general memory task

The procedure for the over general memory task was based on that employed by Williams and Broadbent (1986).

Encoding task

Study phase. The participant was informed that their task was to remember words, which were presented sequentially on a computer screen. They were told that in some blocks they were going to be shown words they would have to try to remember (Encode) and in other blocks they were going to be shown some words that they would not have to recall (Shadow). In either case, they were to push the space bar as quickly as possible after the word disappeared from the screen. Response time was recorded by the computer. Finally, before beginning the study phase, participants were informed that throughout the course of this task they would be asked to report what was passing through their mind:

> When you see the word STOP appear on the screen, I would like you to stop what you are doing and tell me exactly what was passing through your mind as you saw the word STOP. I do not want you to tell me what you were thinking about during the trial, just what was passing through your mind when you saw the word STOP.

Retrieval phase. Memory retrieval was measured at the end of the study phase via a paper and pencil word fragment completion-task. Individual were instructed that some of these word fragments could be completed using words that were previously seen in the stimulus presentation phase and some would be completely new. They were informed that they should not complete any word fragments with stimuli that were either (1) new items or (2) items from the shadowing condition. Participants were allowed a maximum of ten minutes to complete the word fragment completion-task.

Questionnaire measures. The three questionnaires were administered in a battery following the completion of both experimental procedures. The order of questionnaires was counterbalanced with the exception that the mood questionnaire always preceded the measures of dysphoria and rumination.

Thought classification. Thoughts were recorded verbatim, onto a pad of paper, and later classified by the investigator and two judges' blind to the dysphoria status of the individual and the hypothesis of the experiment. Thoughts were classified into whether they were directed towards task completion (On-task) or were off-task (Mind-wandering).[3] The definition of Mind-wandering reflects thoughts that are broadly directed to the self but bear no relationship to the task in hand, or the current situation (see Smallwood et al., 2003c, for published criteria for making these judgements). Examples of Mind-wandering are: "I was thinking about what I was going to do this evening" or "I was thinking of a meeting I have just had". The total number of recorded thoughts per task is 10, and therefore, 20 thoughts per individual were recorded for analysis. Interrater reliability was calculated as described by Smallwood et al. (2003a, 2003b, 2004a, 2004b). The total number of thoughts for which the raters agreed was divided by total number of thoughts. Interrater agreement was 91%.

RESULTS

Dysphoria. To examine the relationship between self-reported dysphoria and the cognitive tasks employed in this experiment we divided the sample into two groups on the basis of a median split on CES-D scores. The Low Dysphoria Group contained 19 individuals with CES-D scores of 31 or lower, 8 of whom were male. In the Low Dysphoria Group the mean CES-D score was 25.9 ($SD = 3.4$), mean RSQ score was 18.0 ($SD = 4.5$), mean age was 25.6 ($SD = 6.8$) years and the mean length of full time education was 17.8 ($SD = 1.8$) years. The High Dysphoria Group contained 18 individuals with CES-D scores of 32 and above, 3 of whom were male. In the High Dysphoria Group the mean CES-D score was 39.8 ($SD = 8.2$) years of age,[4] mean RSQ score was 22.0 ($SD = 5.0$), mean age was 25.44 years ($SD = 8.6$) and on average participants in this group had spent 17.0 ($SD = 1.0$) years in full-time education. There were no significant differences between the High Dysphoria and Low Dysphoria groups in terms of demographic characteristics ($p > .1$). The High Dysphoria Group reported higher RSQ scores than

[3] In this experiment we opted not to classify thinking in terms of the extent to which it was concerned with the appraisal of the self/task as in previous work (Smallwood et al., 2003a, 2003b). There were two reasons for this. First, previous research has implicated task unrelated thinking, but not task appraisal in the experience of dysphoria (Smallwood et al., 2003a, 2003b). Second, a detailed examination of both verbal reports and retrospective questionnaire data suggests that only the experience of task-unrelated thinking makes a measurable contribution to concurrent encoding (Smallwood et al., 2003a, 2003b).

[4] It is worth noting that research using the CES-D has suggested that scores of 40 or above on the CES-D are indicative of subsequent clinical depression (Field, Diago, & Sanders, 2001).

TABLE 1
The mood scores reported during the experimental procedures in the individuals high and low on dysphoria. High scores on the energetic and tense arousal dimensions reflect high scores on that particular component (e.g., high levels of tension). High scores on hedonic tone reflect a positive mood, while low scores reflect a negative mood

	Mood component		
	Energetic arousal	*Tense arousal**	*Hedonic tone***
Low dysphoria	5.5 (.29)	3.9 (.25)	6.6 (.28)
High dysphoria	4.9 (.30)	4.6 (.25)	5.30 (.29)

*Group differences $p < .05$. **Group differences $p < .01$.

the low dysphoria group, $t(36) = -2.5$, $p < .05$. Analysis of each dimension of the mood questionnaire (see Table 1) indicated that the dysphoric participants reported higher levels of tension, $F(1, 32) = 4.05$, $p = .05$, and a lower hedonic tone during the experimental procedure, $F(1, 32) = 11.15$, $p < .01$. No group differences were observed in the energetic arousal reported by the participants ($p > .2$).

Mind-wandering

Dysphoria and the accessibility of mind-wandering.[5] To examine the accessibility of mind-wandering during dysphoria we employed a $2 \times 2 \times 2$ mixed ANOVA with repeated measures for each Instruction condition (*Encode* and *Shadow*) and Practice (1st Half vs. 2nd Half). Dysphoria Group (High and Low) was included as a between-participants variable. The ANOVA indicated a main effect of Practice, $F(1, 36) = 4.37$, $p < .05$, indicating that overall Mind-wandering was more likely in the second half of the task, Mind-wandering 1st Half = .19 (.03), 2nd Half = .26 (.03). In addition, a Instruction × Practice × Dysphoria Group interaction was observed, $F(1, 36) = 6.35$, $p < .01$. To follow up this interaction we conducted two separate 2×2 ANOVAs on frequency of Mind-wandering under each Instruction condition (*Shadow* and *Encoding*). The subsequent ANOVA indicated a 2-way Interaction under the instruction to Encode information, Practice × Dysphoria Group; $F(1, 34) = 4.80$, $p < .05$, see Table 2. To follow up this interaction we subtracted the likelihood of experiencing Mind-wandering in the first half of the Study Task from the second half of the Study Task. This index reflected the increase in Mind-wandering as the task

[5] Of the 37 individuals, 1 individual reported no examples of mind-wandering during either task, therefore that individual could not be included in the analysis of the effects of mind-wandering on either behaviour or physiology. The data for this individual was, therefore, included in the analysis of the distribution of Mind-wandering only.

TABLE 2
Frequency of mind-wandering under the instructions to Shadow or Encode information

	*Encode**		*Shadowing***	
	Blocks 1–5	*Blocks 6–10*	*Blocks 1–5*	*Blocks 6–10*
Low dysphoria	.22 (.05)	.19 (.05)	.17 (.05)	.28 (.05)
High dysphoria	.19 (.05)	.28 (.06)	.22 (.05)	.27 (.05)

*Between group increase in mind-wandering ($p < .05$). **Main effect of practice on-task ($p < .05$).

proceeds and was compared across depression groups using a paired t-test. When asked to Encode information, the High Dysphoria Group showed an increase in Mind-wandering, relative to the Low Dysphoria Group, $t(34) = 2.31$, $p < .05$. In contrast, under the instruction to shadow information the ANOVA indicated a trend that implies an effect of practice on the distribution of Mind-wandering only, $F(1, 36) = 3.5$, $p = .07$, indicating that irrespective of dysphoria group mind-wandering was more frequent in the second half of the shadowing task, Mind-wandering 1st half = .19 (.03), 2nd half = .28 (.03). Overall, this analysis indicates that dysphoria is associated with mind-wandering with increased accessibility leading dysphoric individuals to report off-task episodes in situations when other individuals are able to maintain task focus (e.g., Encoding).

Performance on-task

Response time. To contrast the effect of mind-wandering and dysphoria on response time, we averaged the response times over the last thirty seconds of each block. These scores were averaged to reflect response time under the four within-participant factors of our design. The data in these cells was contrasted using an ANOVA with repeated measures on two factors: Instructions (*Shadow* and *Study*) and Mental State (Mind-wandering vs. On-task). Dysphoria Group was included as a between-participant factor. The initial ANOVA indicated a marginal 3-way interaction between Instruction × Mental State × Dysphoria Group, $F(1, 35) = 3.75$, $p = .058$. To follow up this interaction we conducted two separate ANOVAs for each Mental State (Mind-wandering/On-task). No effects of either instructions or group were observed for the blocks in which thinking was directed towards the task, for all comparisons $p > .2$. An Instruction × Dysphoria interaction was observed during the experience of Mind-wandering, $F(1, 34) = 4.93$, $p < .05$. We followed up the Instruction × Dysphoria interaction by subtracting the response time during Mind-wandering under the instruction to Shadow information from the response time during Mind-wandering under the instruction to Encode information. These indices were distributed as follows:

Low Dysphoria, $M = 29$ ms ($SD = 22$) and High Dysphoria, $M = -41$ ms ($SD = 22$). This differences was reliable, $F(1, 34) = 4.93$, $p < .05$. Considering response time as a measure of psychological efficiency, this result indicates that dysphoria is associated with greater decoupling during mind-wandering because it leads to slower response times when off-task under instructions to encode information.

Word fragment completion. Across the entire sample, the likelihood of incorrectly completing a "new" word fragment was 0.20 ($SD = 0.2$). Pearson correlations indicated no relationship between overall frequency of Mind-wandering, Dysphoria or Rumination with the likelihood of completing a new word fragment, for all comparisons $p > .3$.

As for the response time analysis, we averaged the number of word fragments completed from each block. These were summated to reflect the two factors being investigated, in the same fashion as for response time (Mental State and Instruction). The ANOVA on the number of completed word fragments indicated three noteworthy effects. First, an effect of Instructions approached significance, $F(1, 35) = 3.85$, $p = .06$, indicating more word fragments were completed with information presented under the instruction to Encode ($M = 1.33$, $SD = 0.1$) than when asked to Shadow Information ($M = 0.81$, $SD = 0.1$). Second, a main effect of Mental State was observed, $F(1, 35) = 11.43$, $p < .01$, indicating that when On-task a higher number of word fragments were completed ($M = 1.3$, $SD = 0.1$) than when Mind-wandering, ($M = 0.81$, $SD = 0.1$). Finally, both main effects were qualified by an Instruction $\times$ Mental State interaction, $F(1, 35) = 8.25$, $p < .001$; see Figure 1. The 2-way interaction was followed up by contrasting the effects of Mental State on the number of word fragments completed using information observed under each Instruction condition. The ANOVA indicated a reliable difference with Mind-wandering under the instruction to Encode information, $F(1, 35) = 15.3$, $p < .0001$,[6] but not for the instruction to shadow information, $F(1, 35) = 3.0$, $p = .09$. We explicitly tested these differences by calculating the difference between retrieval with and without Mind-wandering by calculating the differences separately for information observed under the condition to Encode and Shadow information. A mixed ANOVA demonstrated a reliable difference between conditions, $F(1, 35) = 8.25$, $p < .01$, indicating significantly greater differences in retrieval when Mind-wandering was reported under the Instruction to Encode information,

[6] It is worth noting that in the analysis for the stimuli processed under the instruction to study information a reliable effect of Dysphoria Group was observed, $F(1, 35) = 5.03$, $p < .05$, indicating that fewer word fragments were correctly completed by individuals in the High Dysphoria Group ($M = 0.98$, $SD = 0.12$) than in the Low Dysphoria Group ($M = 1.36$, $SD = 0.12$).

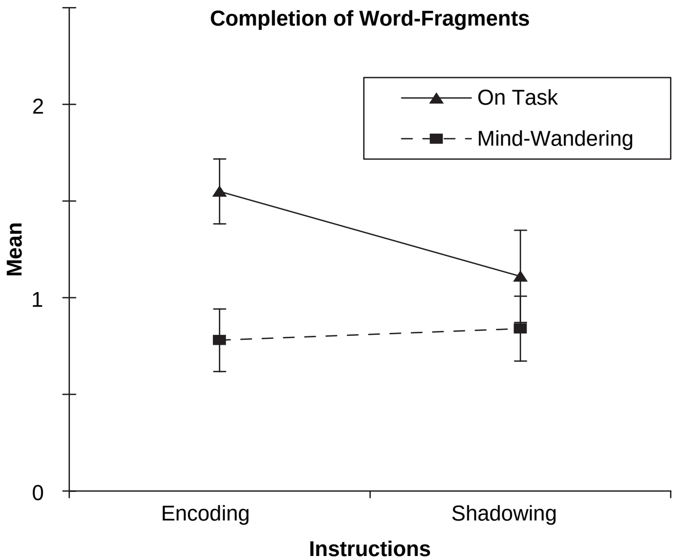

Figure 1. Mean word fragments completed at the end of the task. Encoding and Shadowing refers to the instructions under which the stimuli were processed. On-task/Mind-wandering refers to the mental state reported at the end of the block.

than Shadow information. No effects of dysphoria or any of the subsequent interactions were observed (for all comparisons $p > .1$). The word fragment retrieval data indicated that overall, mind-wandering was associated with a significant reduction in the effectiveness with which participants encoded the information. Mind-wandering did not alter the likelihood of unintentionally retrieving information to which participants were simply exposed (Shadow).

Physiological variables

Heart rate. Average heart rate was calculated for the last 30 seconds before a thought probe and averaged to reflect the four cells in our design. We contrasted the data using a mixed ANOVA as for the behavioural data. This ANOVA revealed three significant differences. First, a main effect of Mental State was reported, $F(1, 34) = 6.97$, $p < .01$, indicating that overall a higher heart rate accompanied the experience of Mind-wandering (Mind-wandering $M = 79.7$ BPM, $SD = 1.8$) than accompanied task-focused thinking (On-task $M = 77.6$ BPM, $SD = 2.1$). Second, an Instruction $\times$ Dysphoria Group interaction[7] was observed, $F(1, 34) = 6.75$, $p < .01$, see Table 3. Finally, a reliable Instruction $\times$ Mental State $\times$ Dysphoria Group interaction was observed, $F(1, 34) = 5.2$, $p < .05$, see Table 3. We followed

[7] It is likely that this 2-way interaction is an artefact of the subsequent 3-way interaction.

TABLE 3

Mean response time, mean heart rate and mean number of word fragments completed while under instructions to encode or shadowing verbal information. Mind-wandering/On-task refers to the mental state reported at the end of the block

		Behavioural measures				*Physiological measures*			
		Mean response time (ms)		*Mean completed word fragments*		*Mean heart rate (BPM)*		*Mean SCR (Micro Siemens)*	
		Mind-wandering	*On-task*	*Mind-wandering*	*On-task*	*Mind-wandering*	*On-task*	*Mind-wandering*	*On-task*
Low dysphoria	Encode	527 (26)	500 (38)	1.80[b] (.25)	1.58 (1.03)	75.8[c] (2.3)	79.0 (3.0)	1.87 (.27)	1.63 (.23)
	Shadowing	556 (27)	493 (46)	1.35[b] (.28)	1.07 (.15)	84.0[c] (3.3)	77.4 (2.7)	1.58 (.21)	1.64 (.25)
High dysphoria	Encode	553 (27)	541 (39)	0.70[b] (.26)	0.95 (.11)	81.3[c] (2.5)	76.8 (3.2)	1.90 (.29)	1.54 (.24)
	Shadowing	513 (27)	548 (48)	0.75[b] (.30)	0.64 (.16)	78.1[c] (3.2)	77.2 (4.5)	1.28 (.22)	1.43 (.27)

NB. The maximum frequency of correct word fragments was 4. [a]Dysphoria × Instruction interaction in response time ($p < .05$). [b]Main effect of Dysphoria Group on correctly reported word fragments ($p < .05$). [c]Dysphoria × Instructions interaction in heart rate ($p < .05$).

up this 3-way interaction by contrasting each Mental State separately under each Instruction. The ANOVA on heart rate recorded under the instructions to Encode information indicated a Mental State × Dysphoria interaction, $F(1, 34) = 5.82$, $p < .05$, see Table 3. To follow up this interaction we subtracted Heart Rate during task-focused thinking from Heart rate when off-task. This index was distributed as follows Low Dysphoria $M = -3.21$, $SD = 11.5$ and High Dysphoria $M = 4.5$, $SD = 6.5$. Independent *t*-tests indicated a reliable effect of Dysphoria Group for this index, $t(34) = -2.41$, $p = .02$, implying that when asked to Encode information dysphoria status was associated with higher heart rate during Mind-wandering. In contrast, when asked to Shadow information ANOVA yielded a main effect of Mental State, $F(1, 34) = 4.53$, $p < .05$, indicating that irrespective of dysphoria level heart rate was higher while experiencing Mind-wandering ($M = 80.95$ BPM, $SD = 2.6$) than when On-task ($M = 77.3$ BPM, $SD = 1.98$). No reliable effects of dysphoria or the possible interaction was observed for heart rate recorded under the instruction to shadow information ($p > .14$ for all comparisons). The analysis of heart rate indicated that, in general, high heart rate accompanied mind-wandering, and, moreover, that consistent with the notion that dysphoric individuals have more emotional mind-wandering episodes, off-task experiences under the instruction to encode information was associated with a higher heart rate.

Skin conductance response. The maximal changes in SCR were averaged to reflect the average SCR scores for the four cells of our design and were compared using a mixed ANOVA. This yielded two reliable differences. First, an effect of Instruction was observed, $F(1, 32) = 10.20$, $p < .01$, indicating higher SCR under the instruction to Encode information (Mean SCR = 1.7, $SD = .18$) than under the instructions to Shadow the stimuli ($M = 1.5$, $SD = .15$). Second, a reliable Instructions × Mental State interaction was observed, $F(1, 32) = 7.20$, $p < .01$, see Figure 2. To follow up this interaction we contrasted the association between Mind-wandering and SCR separately for each Instruction condition. A significant variation was observed when asked to Encode information, $F(1, 31) = 5.9$, $p < .05$, but not Shadow information, $F(1, 31) = .44$, $p > .53$. No effect of Dysphoria Group nor the subsequent interactions was observed for any comparison of SCR (for all comparisons $p < .4$). The analysis indicated that, in general, greater increases in SCR occurred in the period when the mind wandered from the task to encode information.

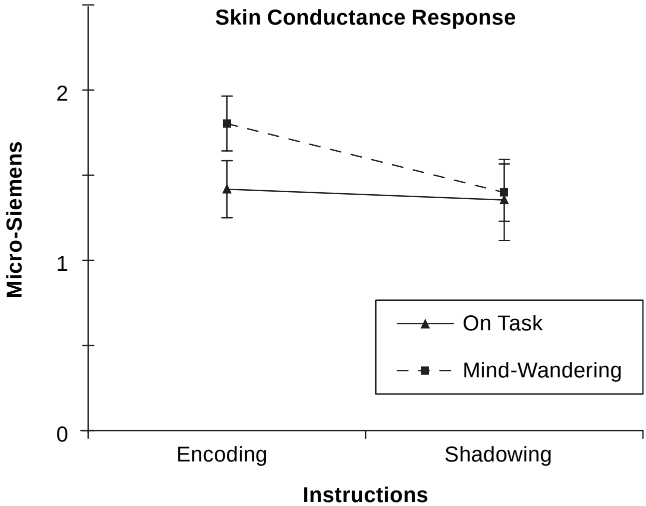

Figure 2. Mean skin conductance response (Micro Siemens) recorded under the instructions to either Encode or Shadow information. On-task/Mind-wandering refers to the mental state reported at the end of the block.

Autobiographical memory

Three individuals failed to complete the autobiographical memory test and so the following analysis was performed on a total of 34 individuals. No individual failed to produce a specific memory on any of the 10 trials. The effects of dysphoria on latency of specific memory were examined using a 2×2 ANOVA with repeated measures on Valence of memory (*Positive* and *Negative*) and with Dysphoria Group included as a between-participant factor. This analysis did not yield any main effects or subsequent interactions (for all comparisons $p > .15$). However, Pearson product–moment correlations pointed to a positive association between the participants' score correlations on both CES-D and RSQ and the latency of recalling specific negative memories (p-values approached significance in the expected direction; CES-D $r = .29$, $p = .09$ and RSQ $r = .32$, $p = .06$). No relationship was observed for the recall of positive memories (for all comparisons $p > .20$).

We employed Pearson product–moment correlations to examine whether the extent to which attention was decoupled from the current situation during mind-wandering was associated with latency to report a specific autobiographical memory. Overall, retrieval from the encoding task was negatively associated with latency of specific positive memories ($r = -.47$, $p < .01$) and overall latencies ($r = -.45$, $p < .01$). By contrast, no reliable association was observed between latency of negative memories and the

TABLE 4
The relation (1) between the effects of mind-wandering on the retrieval of word fragments under different instructions (Encoding and Shadow) and (2) the latency of specific autobiographical memories

	Encode				*Shadowing*			
	Mind-wandering		*On-task*		*Mind-wandering*		*On-task*	
	z	*p*	*z*	*p*	*z*	*p*	*z*	*p*
Positive	**−0.36***	**−.35***	−0.25	−.24	−0.12	−.09	−0.02	.00
Negative	−0.03	.11	−0.31	−.31	−0.29	−.20	−0.15	−.09
Overall	−0.29	−.21	**−0.35***	**−.35***	−0.25	−.18	−0.09	−.04

*Correlations significant at the $p < .05$ level.

quantity of information retrieved in the verbal encoding task ($r = -.20$, $p = .25$). The association between latency of negative memories and retrieval from the shadowing task approached significance ($r = -.29$, $p = .09$) but no reliable association was observed with latency of positive autobiographical memories ($r = -.09$, $p = .5$) nor overall memory latency ($r = -.20$, $p = .20$). We examined the association between the number of items recalled across the two conditions: Instruction (*Encode* and *Shadow)* and Mental state (*Mind-wandering* and *On-task*). The specific associations between the latency of autobiographical memory and memory retrieval on the encoding task are presented in Table 4, in which we present both the zero-order correlations and partial correlations (controlling for CESD and RSQ scores).

Two clear conclusions are apparent from the data in Table 4. First, performance on the autobiographical memory test was associated with the extent to which attention was decoupled during mind-wandering when asked to Encode but not Shadow the items. Second, the retrieval of information was associated with latency of positive memories, while retrieval during task focus was associated with latency of negative memories. These relationships were independent of the dysphoria and rumination levels of the individual (see Table 4).

DISCUSSION

The results of this experiment present strong indirect evidence that dysphoria is associated with both accessible and intense mind-wandering. First, consistent with the notion that dysphoric individuals are characterised by self relevant experiences that are more accessible (Power & Dalgleish, 1997; Teasdale, 1999), the distribution of mind-wandering suggests that when instructed to Encode information the attention of dysphoric participants was more likely to turn to their *current concerns* as the task proceeded. Second, when processing these concerns the dysphoric individuals' ability to maintain exogenous attention as measured by their response time was impaired. Physiologically, dysphoric individuals had significantly faster heart rates than non-dysphoric individuals when their mind wandered from the task. One important aspect of the results of this experiment is the correspondence between the verbal, behavioural and physiological analysis, which taken together provide compelling evidence that mind-wandering during dysphoria is characterised by greater *accessibility* and *decoupling* from the external environment.

By contrast, mind-wandering was associated with differences on two measures employed in this study, independent of the level of dysphoria of the participant: (1) the impairment in retrieval of information while off-task under the instruction to Encode information and (2) the elevation in SCR during mind-wandering under the same conditions (see Figures 1 and 2). It is unclear why the association between mind-wandering on retrieval and SCR were not contingent upon dysphoria, although we can dismiss the absence of a role for dysphoria in these two phenomena on the basis of methodological issues such as a paucity of statistical power.

It is possible that SCR and retrieval were unaffected by the level of dysphoria because the relationships in question are a consequence of the resources entailed in the primary task (cf. Wegner, 1994) and are, therefore, not specific consequences to the intensity or accessibility of the thoughts themselves. This interpretation is strengthened by the reliability of the association between mind-wandering and retrieval regardless of dysphoria status (e.g., Smallwood et al., 2003a, 2003b, 2004b; see also Schooler et al., 2005a, 2005b). One possibility is that cognitive load associated with the encoding task selectively impairs the participants' ability to *monitor* their attention for the presence of off-task episodes, ultimately leading to a rebound in the intensity of mind-wandering (Smallwood & Schooler, in press).

The fact that neither the SCR nor retrieval from memory during mind-wandering were contingent on dysphoria does not mean that these variables are unrelated. Analysis of the distribution of mind-wandering in this experiment suggest that as the task proceeds dysphoric individuals experience more mind-wandering when asked to encode information. Therefore, while dysphoric individuals did not experience qualitatively different consequences of mind-wandering on, for example, memory retrieval, they are likely to mind-wander more frequently under these circumstances. The net result of the higher frequency of mind-wandering in dysphoria when encoding information means that the rise in SCR and impairment of encoding will be *quantitatively* larger in dysphoric individuals.

Finally, the study presented in this paper sheds important light on the relationship between mind-wandering and the formation of autobiographical memories. It is clear from our own experiences and a growing body of evidence that mind-wandering is associated with the formation of less-detailed episodic memories (Schooler et al., 2005a, 2005b; Smallwood & Schooler, in press; Smallwood et al., 2003a, 2003b, 2003c, 2004b, 2005). Similarly, MBCT, which trains individuals to reduce mind-wandering, improves the detail in recent autobiographical memories of recovered depressives (Williams et al., 2001).

In this experiment we explicitly tested whether the extent to which attention becomes decoupled from the external task during mind-wandering was associated with the participants' efficiency at retrieving specific autobiographical memories formed in the real world. The results indicated that even when dysphoria and rumination are controlled for (see Table 4) the extent to which mind-wandering was associated with impaired encoding in the laboratory was predictive of the speed with which individuals retrieved specific episodic memories from the real world. This provides a useful validity check on our measure of the decoupling consequences of mind-wandering because it generalises the results to memories that were formed outside of the laboratory. Moreover, this is the first empirical demonstration of how MBCT could improve the specificity of recent autobiographical memories (Williams et al., 2001) because it reduces the time that individuals spend decoupled from the external environment. On theoretical grounds it seems a compelling argument that less-specific autobiographical memories go hand-in-hand with a tendency to experience strong decoupling of attention from the current environmental context when the mind wanders. In the future we anticipate that understanding the relationship between decoupling and autobiographical memories will be important in helping reduce the duration of depressive episodes.

Limitations and future directions

A note of caution is warranted in interpreting these results. The findings are based on data that is classified post-hoc on the basis of verbal reports, and so it would be useful to replicate the relationships presented in this paper using a design which manipulates the frequency of mind-wandering. While the association between mind-wandering and dysphoria is robust across different task contexts (see Smallwood et al., 2003c, 2004a, 2004b, 2005) and is observable in the analysis of the psychophysiological and behavioural measures employed in this paper, at present we can only speculate on the direction of causality for the relationships presented in this paper because we cannot randomly assign participants to a mind-wandering condition. To address the issue of causality, it is hoped that in the future research will be able to shed light on this issue by examining the consequences of manipulations that could modulate the association between mind-wandering and dysphoria. A study of the relative contribution of positive and negative mood in conjunction with the psycho physiological markers employed in this experiment would help illuminate whether a dysphoric mood causes high frequencies of off-task experiences. Alternatively, it would be worth while employing the methodology presented in this paper to follow a depressed cohort as they receive MBCT. This study would provide useful information on whether meditative techniques actually reduce the frequency of mind-wandering under laboratory conditions. Both of these studies would shed light on the direction of causality in the relationship between mind-wandering and dysphoria.

The research outlined in this paper has considerable implications for the choice of therapeutic interventions in the treatment of depression. Traditional cognitive therapy is concerned with training the individuals to challenge their existing beliefs using the Socratic method (e.g., Beck, 1976). For this approach to be successful, it is necessary for the patient to gather reliable evidence about how the world actually is. Because research indicates an association between mind-wandering and dysphoria, it is possible that low moods are actually associated with substantial impairment in one's ability to create a reliable model of the environment. Recent therapeutic interventions, such as MBCT provide the individual with training on how to reduce the time spent in a state of preoccupation. MBCT, therefore, in principle, provides the patient with the necessary skills to combat the decoupling influences of mind-wandering on information processing. By reducing the time spent *decoupled* mindfulness training could provide the individual with the skills to attend to the external world, ultimately empowering the individual to successfully process the "blizzard" of events which they are required to decode on a day-to-day basis and so remain non-depressed (Beck, 1976).

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