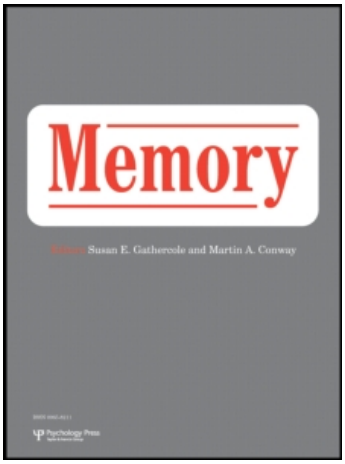

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Motivation, depression, and naturalistic time-based prospective remembering

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Motivation, depression, and naturalistic time-based prospective remembering

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This study investigated the effect of a motivational manipulation on naturalistic time-based prospective memory (PM) task performance. The association between depression and PM task performance was also investigated. First-year psychology students were required to send mobile phone text messages (SMSs) at a specific time 3 days and 6 days after an initial meeting. During the delay period participants recorded details of the retrieval whenever they remembered the SMS task. Participants given the incentive of extra course credit (motivation condition) outperformed their counterparts on the PM tasks, and showed a greater increase in the reported frequency of self-initiated retrievals on target days. Depression was negatively correlated with PM task performance. The findings suggest that motivational instructions impact the controlled processes underlying PM.

Keywords: Prospective memory; Motivation; Depression; Retrieval.

Prospective memory (PM) is memory for actions to be performed in the future (Einstein & McDaniel, 1990). PM is different from retrospective memory (RM, which is remembering information from the past), in the sense that, with PM, individuals need to instigate the remembering for themselves, rather than being instructed by an external agent to remember (Einstein, McDaniel, Richardson, Guynn, & Cunfer, 1995; Harris & Menzies, 1999). PM for intended actions is thought to be triggered by certain strategies or cues. Einstein and McDaniel (1990) distinguished event-based PM and time-based PM according to the type of cue individuals rely on to retrieve the intention. Event-based PM tasks are to be carried out in response to a certain event, and time-based tasks are to be carried out after a certain amount of time or at a particular time. Time-based PM tasks have been claimed to require more attentional resources than event-based tasks, because of the absence of a specific environmentally supported cue (Einstein et al., 2005). Sellen, Louie, Harris, and Wilkins (1997) suggested that reliance on environmental cues in the event-based task decreased the need to periodically bring the intention to mind, which is essential for successful execution of time-based tasks.

If time-based PM requires attentional resources, could PM performance be improved by motivational manipulations? Past research has shown positive effects of "task importance" instructions on PM in laboratory studies, especially in time-based tasks. Kvavilashvili (1987) demonstrated that PM can be enhanced by a motivational manipulation. Participants had to remember to carry out a simple action (to re-connect the phone) after finishing working on a cognitive task and before moving to another room where the experimenter waited for them to administer another task. Half of the participants were simply told to carry out the action and the other half received additional instructions stressing the importance of

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this action (head of the department waiting for an important call). Kliegel, Martin, McDaniel, and Einstein (2001) reported that in a time-based task (pressing a key every 2 minutes) participants who were told that the PM task was more important than the concurrent task showed better PM performance than participants given the opposite instructions. They also found that this motivational instruction generated more clock-monitoring behaviour and more interference with the concurrent task.

How could motivation influence retrieval of time-based PM? There are at least two possible mechanisms: (a) increased controlled processing that engages self-initiated monitoring, or (b) a strong association between the target time and intention is initially formed, and then automatically retrieved. Consistent with the first view, Kliegel et al. (2001) suggested that motivation improves PM to the degree that a PM task requires the strategic allocation of attentional resources throughout the delay period from encoding to execution of an intention. An index of this self-initiated process is time-monitoring behaviour during the delay period. This monitoring behaviour was reported to be positively related to the accuracy of PM responses (Kliegel et al., 2005), and to have a specific *J*-shaped pattern in that the checking frequency initially decreases and then increases approaching the target time (Einstein et al., 1995). Such monitoring behaviour is consistent with the test-wait-test-exit (TWTE) model of time-based PM (Harris & Wilkins, 1982), which posits that individuals engage in an iterative cycle of testing and waiting for the appropriate time to execute their intention until the correct time, at which execution occurs and the intention exits from memory. It was assumed in subsequent studies that this monitoring is a deliberate self-initiated process requiring strategic attentional resources (Einstein et al., 1995; Kvavilashvili & Fisher, 2007; Park, Hertzog, Kidder, Morrell, & Mayhorn, 1997).

The second view, that the influence of motivation on PM is mediated by automatic processes, is consistent with the random walk model (Wilkins, 1979, cited in Harris, 1984). The random walk model postulates that, after forming a certain trace of intention in memory, our conscious thoughts move around in a random manner throughout the delay interval. If our current thought accidentally ''wanders'' into the area of the original trace of intention through associative processes initiated by incidental cues, the PM task will be retrieved and executed.

The nature of retrievals of intended actions during the delay period may determine whether controlled or automatic processes mediate the motivation effect on PM performance. In laboratory PM tasks the delay period is normally limited to a number of minutes; thus an intention might never be out of awareness (Kvavilashvili & Fisher, 2007; Sellen et al., 1997). Therefore the scope for retrieval of the intention triggered by incidental cues or self-initiated planning is limited in existing laboratory PM paradigms (McDaniel & Einstein, 2007). A naturalistic study conducted during participants' everyday lives over a long delay period should provide a better analogue of the effects of motivation on natural PM. Only a few studies have examined long-delay naturalistic PM. Meacham and Singer (1977) found an effect of motivation on PM, but this effect was mediated by the use of memory aids. The use of memory aids transforms a time-based PM task into an event-based task (e.g., mobile alarm) or a RM task (e.g., reminder by another person). Kvavilashvili and Fisher (2007) did not find a motivation effect on PM in the task to telephone the experimenter 6 days later. However, their motivation manipulation of instructing participants that their data would be discarded if they did not telephone on time may have had little personal relevance to the participants.

A further variable of interest in this study was depression. Past research has reported negative associations between depression and time-based PM. Kliegel et al. (2005) found that inducing a sad mood resulted in decreased performance in a laboratory PM task. Rude, Hertel, Jarrold, Covich, and Hedlund (1999) also found that clinically depressed adults demonstrated poorer PM with impaired time-monitoring behaviour. Thus we expected that depressed individuals would show a deficit in time-based PM.

The present study aimed (a) to extend the findings of the positive effect of motivation on PM from the laboratory to a naturalistic setting, (b) to investigate the nature of the mechanisms underlying time-based PM performance through examination of the extent to which the intention is retrieved during the delay period, and what triggers those retrievals, and (c) to examine the relationship between depression and time-based PM in a naturalistic setting. Building on the naturalistic time-based PM approach developed by Kvavilashvili and Fisher (2007), students were

asked to send two text messages (SMSs) to the experimenter. They needed to maintain these intentions over 6 days, concurrently with their naturally occurring daily activities. Half of the students received the motivational instruction of a promise of extra course credit for successful PM performance. It was hypothesised that there would be a positive effect of motivation on the time-based naturalistic PM task and a negative relationship between PM and depression. To analyse what contrasting mechanisms underlie the possible motivation effect on PM, participants kept a structured diary throughout the delay period to record all instances of retrieval with details such as the time, the type of trigger, and the ongoing activity. In accordance with Kvavilashvili and Fisher (2007), it was hypothesised that there would be a positive relationship between retrieval frequency and PM performance, and that retrieval frequency over days would resemble a J-shaped pattern for each PM task. We also investigated whether the expected motivation effect would be associated with self-initiated retrievals, suggesting the operation of controlled processes. Finally, we expected to replicate Kvavilashvili and Fisher's (2007) findings that retrievals would be more likely to occur during concurrent activities that required little concentration.

METHOD

Participants and design

A total of 40 psychology undergraduate students took part in the study. Of these, 22 were female and 18 were male. The ages of the participants ranged from 17 to 46 years ($M = 20.00$, $SD = 5.12$).

Participants were initially selected on the basis of their depression score on the Depression Anxiety Stress Scales 21 (DASS-21; Lovibond & Lovibond, 1995), which was part of a screening questionnaire package that 611 Psychology 1A students at the University of New South Wales completed as part of course credit. The selection criterion was scoring either greater than 10 (High DASS) or less than 5 (Low DASS) on the Depression Subscale of the DASS-21. According to Lovibond and Lovibond (1995), a score of higher than 20 on the original DASS (equivalent to 10 on the shorter DASS-21) is rated as severe and a score of less than 10 on the DASS (equivalent to 5 in DASS-21) is rated as normal. Through telephone or e-mail contact with 47 students, 42 agreed to participate; 20 High DASS (10 male, 10 female) and 20 Low DASS students (8 male, 12 female) actually participated. Participants in each of the High DASS and Low DASS groups were randomly assigned to either the motivational or control manipulation condition in the naturalistic time-based PM task. During the second experimental session, participants once again completed the DASS-21. Despite a high correlation ($r = .72$; $p < .05$) between initial (screened) scores and the more current scores, many participants no longer met the categorisation of either High or Low DASS; therefore, correlational analyses with the more current DASS scores were employed to examine the depression hypotheses. In summary, the manipulated independent variable was motivation, and the individual difference variable was depression, operationalised by scores on the Depression Subscale of the second DASS-21 measurement. The dependent variables were PM on-time performance and retrieval reports.

Materials

The DASS-21 Depression Subscale. The DASS-21 is a short version of the DASS, a self-report instrument designed to measure the three related negative emotional states: depression, anxiety, and stress. The Depression Subscale assesses seven depressive symptoms: dysphoria, hopelessness, devaluation of life, self-deprecation, lack of interest, anhedonia, and inertia. Participants were asked to use the 4-point severity/frequency scale to rate the extent to which they had experienced each symptom over the past week. The DASS is designed to emphasise states rather than traits, but is not directly applicable to the measurement of participants' momentary emotional state (Lovibond & Lovibond, 1995). The instructions state: ''Please read each statement and circle a number 0, 1, 2 or 3 which indicates how much the statement applied to you *over the past week*.'' The DASS was based on a dimensional rather than a categorical conception of psychological disorder; however, Lovibond and Lovibond (1995) proposed recommended cutoffs for conventional severity labels: 0–9 normal, 10–20 moderate, 21+ severe. For information on reliability and validity, see Henry and Crawford (2005).

The diary. A pocket-size diary was provided to all participants to record their thoughts (retrievals)

about the intention to send an SMS to the experimenter. The diary had six entry columns. The first column was for the date and time of the retrieval. In the second column participants recorded what they were doing when they remembered the PM task, and in the third column participants rated their concentration level on what they were doing on a 7-point scale. In the fourth column participants wrote the cues or triggering thoughts that prompted the retrievals, and then in the next column categorised the triggers. Specifically participants were instructed to choose from the following categories: "①out of the blue" if the intention popped into their mind for no apparent reason (i.e., spontaneous), "②external cue" if the intention was triggered by something in their environment (e.g., clock), "③internal cue" if the intention was triggered by their own thoughts other than the PM task (e.g., psychology lecture; internal and external cue are types of incidental cues), and "④self-initiated" if the intention was triggered by deliberate self-initiated planning for their future (e.g., plan to do today). The last column was for the time that the entries were recorded. Participants were instructed to keep the diaries with them for the entire week, so that they could note as soon as they experienced a retrieval. They were instructed that the diaries should be kept out of sight and not be carried in a place they normally use, such as in a clothes pocket with other items, lest it cue the intention. All these instructions about the diary were also written in the first page of the diary. All participants were informed to start the diary-keeping the day after the initial meeting. They were also instructed to record only those rehearsals that occurred between 9:00 am and 9:00 pm, so that the diary was kept by all participants for approximately the same number of waking hours each day.

Procedure

The initial session was held on two consecutive Thursdays at the time participants selected between 12:00 pm and 5:00 pm. After signing a consent form participants were informed, in groups of two to seven, that their task was to send an SMS to the experimenter at 8:40 pm on Sunday and at 8:20 pm on Wednesday. The motivated group was told that if they sent those two SMSs within 10 minutes of the designated time they would be given an extra 30 minutes of course credit for their participation, in addition to the 1.5 hours credit they had signed up for. The control group was not told about the extra credit. It was emphasised that external memory aids such as making notes in personal diaries, setting an alarm in their mobile phones, or asking someone to remind them of the task, should not be used. The study diaries were then provided and the experimenter explained how to keep the diary. The times that participants sent the SMSs were recorded in the experimenter's phone.

In the second session on the following Thursday, at the same time, all participants returned their diaries. They also completed the DASS-21 again. The period of time the DASS-21 questions referred to (over the past week) corresponded to the time participants were engaged in the naturalistic time-based PM task. Participants were asked to write down the strategies they used to remember the SMS task. They were also asked to rate how much they were motivated to undertake the SMS task on a 4-point scale (0 = not motivated at all, 1 = hardly motivated, 2 = moderately motivated, 3 = very motivated). They then performed a computer task, which measured working memory. The working memory score was utilised as a covariate in analyses of PM performance to check whether motivation effects were mediated by individual differences in working memory capacity. As working memory did not appear to play this role, the analyses are not reported here. At the end of the experiment all the participants were given 2 hours' credit including the extra half hour, regardless of their performance or instructions. Participants were then debriefed regarding the general purpose of the experiment.

RESULTS

All 40 participants returned the diary; however, 2 participants reported (in answer to the "strategies" question) that they used external memory aids. One had set an alarm in his phone and the other had asked her sister to remind her about the SMS task. In addition, two participants did not appear to understand the instructions for the subsequent working memory computer task. Also discarded were the data of one participant whose frequency of rehearsals (40) was above two standard deviations of the group mean for the 36 participants ($M = 13.36$, $SD = 7.34$).

The data of 35 participants (20 female, 15 male) were analysed. A total of 20 participants

were given the motivational instruction, and 15 participants were given the control instruction. Participants' post-experimental self-rating about how much they were motivated to complete the SMS task was not significantly different between motivated ($M = 2.25$, $SD = .64$) and control groups ($M = 2.07$, $SD = .59$); $F(1, 33) = 0.75$, $MSE = 0.38$, $p = .39$.

SMS task performance

Only 2 participants (6%) did not send SMSs on both Sunday and Wednesday; 11 participants (31%) completed only one of the two PM tasks; 22 participants (63%) sent SMSs both on Sunday and Wednesday whether they were on time or late. However, the appropriate measure of time-based PM is in terms of the number of *on-time* responses: participants were instructed to send the SMS within 10 minutes of the designated time (following Kvavilashvili & Fisher, 2007), and the motivated participants were explicitly promised extra course credit on this basis. A total of 13 participants (37%) completed neither task on time, 13 participants (37%) completed only one PM task on time, and 9 participants (26%) completed both tasks on time. Naturalistic time-based PM performance was thus indexed by the percentage of on-time responses out of the two occasions (Sunday, Wednesday), thus generating a limited response range of 0%, 50%, or 100%. Although this variable could be construed as more categorical than continuous, wherever possible parallel chi-square analyses were conducted, and these yielded similar results to those reported here. PM task performance was higher for motivated participants ($M = 57.50\%$, $SD = 40.64$) than for control participants ($M = 26.67\%$, $SD = 32.00$); $t(33) = 2.43$, $p < .05$. DASS depression scores were negatively correlated with PM performance ($r = -.37$, $p < .05$). It should be noted that DASS also yields Anxiety and Stress subscale scores; neither of these variables correlated with PM performance, but the subscales all intercorrelated.

Frequency of retrievals

A total of 35 participants recorded a total of 441 retrievals with a range of 4–26 and a mean of 12.60 ($SD = 5.83$) for the 6-day period. In a regression analysis using PM performance as the criterion and the number of reported retrievals as a predictor, the retrieval frequency *in total* did not predict PM performance ($B = 0.97$, $r = .14$, $p = .42$); however, the retrieval frequency *on target days* positively predicted PM performance ($B = 4.45$, $r = .36$, $p < .05$).

Figure 1 displays the mean number of retrievals per day on average as a function of motivation and days. A 2×3 (motivation $\times$ days) mixed ANOVA with motivation as an independent variable (motivated, control) and days (Day 1, Day 2, Day 3) as a repeated variable was conducted for each SMS task. For both sets of analyses, there were no main or interaction effects for motivation or days, except for a significant quadratic trend for the first SMS task ($F = 6.86$, $p < .05$). Separate analysis for motivated and control participants for the first SMS task confirmed that motivated participants showed a J-shaped pattern across days with retrievals first decreasing and then increasing, as revealed by a significant quadratic trend ($F = 4.64$, $p < .05$), whereas control participants showed no significant trends across days. For the second SMS task, a separate analysis of motivated participants revealed that retrievals showed a linear increase ($F = 4.65$, $p < .05$) across days, whereas control participants did not show any significant pattern across days.

There was no correlation between the DASS depression scores and the number of total retrievals ($r = -.17$, $p = .34$), or target day retrievals ($r = -.28$, $p = .10$).

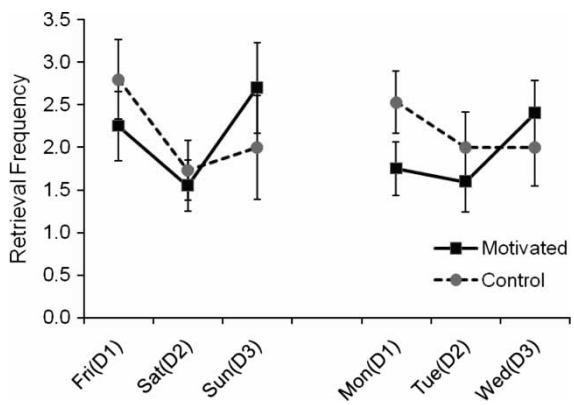

Figure 1. Means ($\pm SEM$) of retrieval frequencies per day as a function of motivation and days (Fri, Sat, Sun*, Mon, Tue, Wed*). *Sunday and Wednesday were the target PM task days (D = day).

Types of reported triggers of retrievals

Participants were required to record both a description of the retrieval trigger as well as the category of the retrieval trigger. Prior to analysis, one experimenter (JJ) checked the accuracy of participants' categorisation against the descriptions, and found that 34 of the 441 retrievals required reclassification. A sample of these reclassifications was checked by another experimenter (JC) who was unaware of the participants' group identity. There was 100% agreement. Of the retrievals, 22% were reported to have occurred spontaneously, 39% were triggered by external cues, 17% were triggered by participants' own internal thoughts, and 23% were triggered by self-initiated planning. The random walk model does not differentiate between the effects of internal and external cues on PM performance (Wilkins, 1979, cited in Harris, 1984); the central role of such incidental cues in the random walk model can be contrasted with the central role of self-initiated cues in the TWTE model (Harris & Wilkins, 1982; see Kvavilashvili & Fisher, 2007). Thus, external and internal cues were combined into a single ''incidental cue'' category for further analysis.

With average daily retrieval as the dependent variable, a $2 \times 2 \times 3$ (motivation $\times$ target/non-target day $\times$ type of triggers) mixed ANOVA was conducted with motivation as an independent variable (motivated, control) and day (target day, non-target day) and type of triggers (spontaneous, incidental, self-initiated) as repeated measures. There was a main effect of triggers ($F = 19.47$, $p < .05$) and a motivation $\times$ day interaction ($F = 6.10$, $p < .05$). There were no other main or interaction effects. Further *t*-tests showed that the number of average daily retrievals triggered by incidental cues (i.e., combined external and internal cues; $M = 1.17$, $SD = .58$) were greater than that for self-initiated retrievals ($M = 0.48$, $SD = .52$); $t(34) = 5.45$, $p < .001$, and greater than that for spontaneous retrievals ($M = 0.45$, $SD = .43$); $t(34) = 6.23$, $p < .001$, with no difference between the latter two types of retrievals. It was also shown that motivated participants increased the number of self-initiated retrievals per day significantly from non target days to target days, $t(19) = 2.34$, $p < .05$, whereas control participants did not (see Table 1).

TABLE 1
Retrievals for trigger categories

	Average daily retrievals reported	
Trigger categories/ group	*Non-target days*	*Target days*
Self-initiated	0.26 (0.38)	0.78 (1.20)
Motivated	0.57 (0.44)	0.50 (0.57)
Control	0.39 (0.43)	0.66 (0.98)
Total		
Incidental	1.00 (0.61)	1.28 (1.07)
Motivated	1.37 (0.59)	1.07 (1.03)
Control	1.16 (0.62)	1.19 (1.04)
Total		
Spontaneous	0.53 (0.68)	0.50 (0.56)
Motivated	0.33 (0.28)	0.43 (0.42)
Control	0.44 (0.55)	0.47 (0.50)
Total		

Mean (*SD*) number of reported retrievals on non-target days (averaged across the 4 days) and target days (averaged across the 2 days) as a function of trigger categories and motivation.

Ratings of concentration on ongoing tasks

For the analysis of participants' self-reported concentration levels on ongoing tasks during retrievals, Scale points 1, 2, and 3 were categorised as ''low concentration'', and Points 5, 6, and 7 were categorised as ''high concentration''; Scale point 4 responses (15% of total) were not included. A 2×2 (Motivation $\times$ Concentration) mixed ANOVA, with the between-participants variables of motivation and the within-participants variable of concentration levels (low, high), revealed that the retrievals with ''low concentration'' were reported more frequently ($M = 6.80$, $SD = 6.05$) than retrievals with ''high concentration'' on ongoing tasks ($M = 3.91$, $SD = 2.95$); $F(1, 33) = 5.18$, $MSE = 30.29$, $p < .05$, $\eta_p^2 = .14$. No other effects were significant.

DISCUSSION

As expected, the motivation manipulation led to better on-time PM performance, and the number of retrievals on target days predicted PM performance. Motivated participants tended to display more rehearsals on target days than on non-target days, whereas control participants did not show this pattern. Overall, incidentally triggered retrievals were the most frequent type of retrieval during the delay period. As predicted, retrievals

tended to occur during low-concentration concurrent activities. A measure of depression taken during the study was negatively associated with PM performance.

Naturalistic time-based PM and motivation

The current study utilised methodology based on Kvavilashvili and Fisher (2007; Study 1), who reported a 100% "any time" response rate, and a 59% "on-time" response rate (making a telephone call to the experimenter). The comparable performance for at least one SMS task completion in the current study was 94% and 63% respectively, which suggests some equivalence in outcomes. We proposed that Kvavilashvili and Fisher's motivational manipulation, which yielded no difference in PM performance, may have had insufficient personal significance for participants. Thus, in the current study participants were led to believe that their PM performance could result in increased research participation credit, which had implications for their course marks or for their time management. An alternative explanation for the finding of a motivation effect in this study, and not in Kvavilashvili and Fisher's study, is that two PM tasks allowed a greater range of responding and thus potentially a more sensitive measure of time-based PM performance than did one PM task.

The nature of the retrievals may elucidate the mechanisms underlying the motivation effect. The number of self-initiated or incidental retrievals was not different between the motivated and control groups, but motivated participants showed significantly greater increases than control participants in the frequency of self-initiated retrievals on target days relative to non-target days. This suggests that the motivation effect was mediated by controlled processes rather than automatic processes, and is consistent with previous findings that monitoring behaviour is positively related to the accuracy of PM responses (Einstein et al., 1995; Kliegel et al., 2005). In the present study, the frequency of retrievals on target days was positively related to PM performance. Motivated participants showed a J-shaped pattern in the first task and a linear increase in the second task across days. This pattern of results is more congruent with the TWTE model than the random walk model: If thoughts came to mind randomly or were solely triggered by incidental cues, it is unlikely that there would be a systematic increase in retrievals with proximity to the target time (see also Sellen et al., 1997).

How could motivation influence the naturalistic time-based PM performance? One possibility is that motivated participants may have formed more elaborate strategies to complete the task than did control participants during the encoding phase. This possible mechanism is supported by the answers of participants in the motivation condition to the post-experimental question about strategies they had used to remember the task. Unlike expected answers such as "tried hard to remember" or "kept reminding myself to do it", some answers were very specific, for example, "I thought what I would be doing at the time of the task, watching 'Grey's Anatomy'." This kind of specific encoding, "when situation X arises, I will perform the task", suggests that PM, as distinct from RM, requires a process of planning strategies about how to remember. Motivation may have facilitated this kind of effortful cognitive processing. It should also be acknowledged that the result of this process is to transform a time-based PM task into an event-based PM task (Graf & Grondin, 2006).

A second candidate for mechanisms underlying the motivational effect on PM is greater levels of sub-threshold activation of the PM representation, and increased accessibility to cues as a result. According to the adaptive control of thoughts model (Anderson, 1993) the representation of an intention maintains sub-threshold activation as a goal node. This constant activation leads to the retrieval sensitivity framework, such that an intention formation increases the likelihood of noticing relevant cues. This notion was supported by the finding that semantic priming of target categories prior to encoding increased the number of successfully executed intentions (Mäntylä, 1993). Compared to strategy planning, which is a controlled process, this sub-threshold activation is an automatic intrinsic property of intentions (Goschke & Kuhl, 1993).

It should be noted that although there was a motivational effect on PM performance, there was no difference in self-ratings about how much they were motivated. Compared to control participants, motivated participants may have had an increased level of activation and accessibility of the PM representation. If so, motivated participants should have noticed more external and internal cues. However, the number of incidentally triggered retrievals was not different between motivated and control participants. Spontaneous

triggers could be thought of as incidental triggers where the participants are unaware of the internal or external cues that associatively elicited retrieval. Kvavilashvili and Fisher (2007) suggested that the number of spontaneous retrievals can be used as a measure of the activation level of everyday long-term intentions, which periodically rise above the threshold into consciousness. However, in this study there was no difference in the number of spontaneous retrievals between motivated and control participants.

The third candidate is that motivation results in more self-initiated retrievals. These voluntary retrievals (and thus rehearsals) may have enhanced PM performance. Gollwitzer (1999) argued that rehearsing an intention in a way that ties the intention to specific situational cues increases the likelihood of enactment at the appropriate time. Freeman and Ellis (2003) argued that rehearsals may improve PM performance either by reviving its resting level of activation, or by prompting additional planning processes of execution. In this study, self-initiated retrievals and diary keeping may have strengthened the PM trace. Although total frequency of self-initiated retrievals was not greater for motivated participants, motivated but not control participants significantly increased the frequency of self-initiated retrievals per day from non-target to target days. This suggests that motivation facilitated or optimised controlled processes. In summary, the motivational effect on PM performance appears to be mediated more by strategic controlled processes (elaborate strategies and self-initiated retrievals) rather than by automatic processes (greater activation).

One alternative explanation of the motivational effect found in this study is that motivated participants may have used memory aids despite the instructions that they should not do so. Memory-aid use transforms a time-based PM task into an event-based task (e.g., mobile alarm) or a RM task (e.g., reminded by another person). With no restriction on the use of memory-aids, Meacham and Singer (1977) found that the motivational effect was mediated by the use of external cues. Strategies in real life, such as placing a to-be-remembered object by a door or writing a note on one's hand, are intended to turn an otherwise self-initiated time-based PM task into a less-demanding event-based task (Marsh & Hicks, 1998). Motivation in this study appeared to influence time-based PM performance without the use of such explicit memory aids, although the "Grey's Anatomy" type of strategy makes this conclusion questionable. Nevertheless, it should be acknowledged that the method of measuring retrievals using the diary is subject to falsification, under-recording, and misattribution. Evidence contrary to falsification is that systematic relationships between retrieval frequencies and performance were found. This suggests that falsification was not a dominant process, because falsification is likely to be random. If participants under-recorded (2.1 per day), they were not under-recording as much as the participants in Kvavilashvili and Fisher's (2007) study (1.2 and 1.9 per day across experiments). Inaccuracy may occur in the form of misattribution of the nature of retrieval triggers; however, there may be little that we can do about this issue given the introspective nature of the process. It should be acknowledged that the retrieval recording itself is a prospective memory task, and it is possible that during times of high concentration a retrieval occurrence is less likely to be recorded at the time the retrieval takes place. Although participants were able to record retrievals at a later time if they were not recorded immediately, this would impose an additional prospective memory, as well as retrospective memory, demand. If the recording of retrieval occurrences during high concentration times is more likely to be delayed, this could lead to an underestimation of retrieval occurrences during high concentration. Furthermore, it is possible that some participants may not have complied with the request that the diary be kept in a place that was not visible or routinely accessible. Thus, understanding the nature of the correlation between target-day retrieval and on-time SMS task performance will require further creative experimental focus.

Depression and naturalistic time-based PM

The current depression finding extends to naturalistic PM the previous laboratory findings of PM impairment in depressed individuals (Kliegel et al., 2005; Rude et al., 1999). As a mechanism underlying the impairment, Ellis and Ashbrook (1988) proposed that negative mood causes distracting task-irrelevant thoughts, and diverts cognitive resources away from PM. However, the failure to find a relationship between depression and retrieval frequency does not support this

proposition (although the target day correlation was suggestive).

Another possible mechanism underlying poor PM performance of depressed participants is nonspecific memory encoding. Williams et al. (2007) argued that depression is related to reduced memory specificity, which may lead to problems in imagining future events. They found that depressed individuals showed overgenerality (nonspecificity) in recalling past events and predicting future events. In the naturalistic PM task, currently depressed participants might have been less specific in planning strategies in the encoding phase, leading to worse PM performance.

It should be noted that impairments in currently depressed participants' time-based PM in this study and previous studies (Kliegel et al., 2005; Rude et al., 1999) were found only in timeliness (on-time response) rather than PM retention. That is, there was no difference in the number of SMS responses at any time on the target days (separate analyses not reported here). This suggests that depressed participants did not forget the intention, but struggled with its timely retrieval.

Conclusion

This study extended previous laboratory-based findings of the positive effect of motivation on time-based PM (Kliegel et al., 2001; Kvavilashvili, 1987) to the naturalistic environment. This finding suggests that motivation influences real-world time-based PM that has a long delay period and countless multi-dimensional ongoing tasks. Moreover, this study provides some evidence that depression is negatively associated with PM performance. Finally, this study supports Kvavilashvili and Fisher's (2007) conclusions that there is overlap in the automatic and controlled processes underlying PM performance on event- and time-based tasks, as revealed by the nature of the intention retrievals during the delay period. In this study, however, a timely increase in self-initiated retrievals was associated with better PM task performance by the motivated participants.

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