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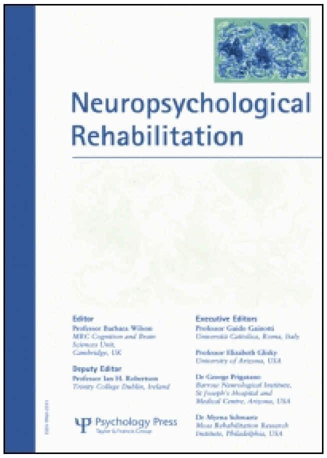

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Elaborated spaced-retrieval and prospective memory in mild Alzheimer's disease

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Prospective memory, or the timely remembering of a planned action, is conceptualised as a cognitive process demanding episodic memory and executive attention. Impairments in these skills are characteristic of the cognitive decline in early Alzheimer's disease, providing an expectation of prominent prospective memory difficulties in this population, and yet surprisingly, memory performance in early Alzheimer's disease has rarely been evaluated within a prospective memory framework. In a preliminary study we demonstrated that older adults with early Alzheimer's disease ($n = 14$), as compared to healthy older adults ($n = 14$), were significantly impaired in a simple experimental paradigm of prospective remembering (a text-reading task). In a subsequent intervention study, we investigated the efficacy of spaced-retrieval for improving the prospective remembering performance of older adults with early Alzheimer's disease ($n = 16$) compared to healthy older adults ($n = 16$) under two learning conditions: a spaced-retrieval technique alone or spaced-retrieval combined with elaborated encoding of task. The majority of

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the Alzheimer's disease group (63%) demonstrated benefit in prospective remembering in the combined condition as compared to spaced-retrieval alone. Participants with Alzheimer's disease who demonstrated better executive attention (Trail Making – set-shifting) and/or better retrospective memory (Hopkins Verbal Learning Test–Revised – recognition) were more successful in the combined learning condition.

INTRODUCTION

Memory loss is one of the most diagnostic features of Alzheimer's disease (AD) (Hodges, 2000), and in the early stage of the disease the memory impairment has been frequently characterised as primarily an encoding-storage deficit in episodic memory (Golby et al., 2005), contributing to significant difficulty in learning new information. In addition, recent research has increasingly recognised that executive attention changes occur early and can index even the pre-clinical phases of AD (Albert & Moss, 2002; Baddeley, Baddeley, Bucks, & Wilcock, 2001). These cognitive impairments form a potential substrate for major difficulties in prospective remembering in early dementia (Huppert & Beardsall, 1993; Maylor, Smith, Della Sala, & Logie, 2002).

Prospective memory, or prospective remembering, is defined as remembering to do something in the future, without prompting in the form of explicit instructions to recall (Einstein & McDaniel, 1990; McDaniel & Einstein, 2000); for example, remembering to return a borrowed book to a friend. Prospective remembering requires not only remembering *what* should be remembered but also *when* to remember. As a consequence, it is frequently argued that in addition to demands on retrieval of episodic memory (Cherry et al., 2001), executive attention of working memory is recruited in tasks of prospective memory (e.g., Burgess, Quayle, & Frith, 2001; Groot, Wilson, Evans, & Watson, 2002; Martin, Kliegel, & McDaniel, 2003; McDaniel et al., 1999). The interaction of these cognitive processes provides the basis for the argument that prospective memory should be more sensitive to the cognitive decline in early dementia than episodic retrospective memory alone (Huppert, Johnson, & Nickson, 2000). Typically, neuropsychological assessment of memory disorder in early AD has focused on retrospective memory (recall of information from the past), relying on standard episodic memory tests of delayed free-recall and recognition of word lists or pictures (Storey, Slavin, & Kinsella, 2002). Nevertheless, competence in everyday activities requires the capacity to recall not only past information but, as importantly, to remember to perform intended actions (Sohlberg & Mateer, 2001), and yet indexing of prospective remembering has rarely been reflected in neuropsychological assessment procedures for evaluating AD.

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Early identification of AD is important as disease-modifying pharmacological treatment of dementia is currently under active development; however, pursuit of early diagnosis also demands concurrent attention to development of effective psychosocial support and management strategies (Brodaty, Draper, & Low, 2003). Neuropsychological interventions with demonstrated efficacy are increasingly needed as patients and families are seeking practical advice at a stage when it is feasible to design neuropsychological interventions that engage the remaining capabilities of persons with AD and prolong independent functioning (Bird, 2001; Camp, 2001; Clare et al., 2002, 2004).

Spaced-retrieval represents a simple strategy to assist learning and memory of new information (Camp, 2001; Landauer & Bjork, 1978). The approach differs from simple repetition by requiring active attempts to recall specific information over progressively lengthened intervals. The goal of intervention is to assist people to remember important information for very long periods and Camp and colleagues (Camp, 2001) introduced the technique as an intervention for people with dementia. Spaced-retrieval can be considered a learning technique within the broad approach of errorless learning (Clare et al., 2002; Wilson, Baddeley, Evans, & Shiel, 1994). Camp, Bird, and Cherry (2000) have summarised explanations provided for the basis of spaced-retrieval to include: (1) Spaced-retrieval is a behavioural technique based on a shaping procedure that has been demonstrated to be generally effective in memory rehabilitation (Bjork, 1988; Wilson et al., 1994); (2) spaced-retrieval involves practice of information, incorporating active attempts at recall which has been demonstrated to be more effective than passive approaches to learning (Bird, 2001; Landauer & Bjork, 1978); (3) spaced-retrieval depends on gradually spacing the attempts at active recall and this has been shown to be more useful than massed repetition (Toppino, 1991); and, (4) spaced-retrieval has been argued to be based on implicit memory which is considered to be relatively spared in AD as opposed to the significantly impaired explicit memory system (Camp, Foss, O'Hanlon, & Stevens, 1996; Hodges, 2000). The success of spaced-retrieval as a technique for learning in AD potentially reflects the combination of all these explanatory processes. Spaced-retrieval has been demonstrated to be useful in the management of behavioural problems in institutional settings (Bird, 2001; Camp et al., 2000), and McKitrick, Camp, and Black (1992) have provided encouraging support for the successful use of spaced-retrieval as a prospective memory intervention for four persons with AD, providing the basis for further investigation of the utility of spaced-retrieval as a learning technique in prospective remembering and dementia.

Bäckman (1992, 1996) provides an argument that can be used to improve the application of spaced-retrieval to early AD. Bäckman argues that in early AD maximal response to intervention procedures will be achieved when dual cognitive support is provided from elaborated encoding and support at retrieval,

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and Bird and Luszcz (1991, 1993) have provided experimental support for this argument when investigating capacity for new learning in AD. Intuitively, this converges with the previous argument that the neuropsychological impairment in early AD may reflect an interaction between episodic memory and executive attention, thereby demanding a complex approach to intervention.

From this rationale, our research aim was to develop a broader understanding of memory ability in early AD, specifically by investigating prospective memory. Within this context, we aimed to evaluate whether a supported learning paradigm, spaced-retrieval, could substantially improve performance in AD for an experimental task of prospective memory, especially when combined with elaborated encoding. To address these questions we undertook two studies. In a preliminary Study 1 we compared baseline (unsupported) prospective memory performance between participants with mild AD and healthy older controls. In a subsequent intervention, Study 2, we compared performance of participants with mild AD and healthy older adults on a prospective memory task under two supported learning conditions – spaced-retrieval alone or elaborated encoding combined with spaced-retrieval.

GENERAL METHOD

Participants

In Study 1, the sample consisted of participants with mild AD ($n = 14$) and healthy older adult participants ($n = 14$). The AD group (9 female, 5 male) were recruited through memory clinics in several Melbourne hospitals, based on clinical diagnosis by the memory clinic team of probable AD according to the NINCDS-ADRDA criteria (National Institute of Neurological and Communicative Diseases and Stroke/Alzheimer's Disease and Related Disorders Association; McKahnn et al., 1984) without a confounding secondary diagnosis after a comprehensive assessment including interviews with patient and family, laboratory and radiological studies, and neurological, psychiatric and neuropsychological examination; severity of dementia (Mini Mental State Examination, MMSE, score, Folstein, Folstein, & McHugh, 1975) fell in the mild range (MMSE range 19–28). The control group (9 female, 5 male, MMSE range 26–30) were identified through relatives and friends of the AD participants. Selection criteria included: (1) fluency in English, and (2) absence of significant visual or auditory impairment or neurological co-morbidity. There were no significant differences between groups in age, years of education or predicted IQ (National Adult Reading Test, NART, score, Nelson & Willison, 1991) (see Table 1).

Using similar recruitment methods, the sample in Study 2 consisted of a further mild AD group (11 female, 5 male, MMSE range 19–27, $n = 16$)

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TABLE 1
Demographic characteristics for healthy older adults and AD participant groups

Measures	*M*	*SD*	*M*	*SD*
Study 1	*Healthy older group* ($n = 14$)		*AD group* ($n = 14$)	
MMSE	28.86	1.46	22.21	3.28
Age (years)	75.71	4.15	79.07	6.15
Education (years)	11.57	3.03	11.00	3.51
NART IQ	111.01	6.68	104.07	12.51
Study 2	*Healthy older group* ($n = 16$)		*AD group* ($n = 16$)	
MMSE	28.75	1.73	23.25	2.96
Age (years)	79.25	6.48	80.49	6.73
Education (years)	11.56	2.19	10.88	2.80
NART IQ	111.57	7.82	103.13	9.43
HVLT-R (DI)	9.56	2.45	5.00	2.78
Trail Making Test (B-A)	91.31	55.76	161.44	61.76
Digit Span (total score)	9.28	1.99	7.15	1.54

and healthy older adult control group (11 female, 5 male, MMSE range 26–30, $n = 16$). There were no significant differences between groups in age or years of education (see Table 1); however, there was a significant difference in predicted IQ; NART score, $t(30) = 2.76$, $p < .05$. Other research groups (Baddeley et al., 2001; Stebbins, Gilley, Wilson, & Bernard, 1990) have similarly found that the NART may not be as robust to cognitive impairment of AD as previously thought and even though mild AD groups may be matched to control groups on years of education, predicted IQ as measured through NART scores of the AD groups can be lower; this has been interpreted as the sensitivity of the vocabulary test to cognitive impairment even in early dementia. Nevertheless, in the current study the difference in predicted IQ was accounted for in the analyses.

Ethics approval was obtained from the Human Ethics Committee, La Trobe University and from the Ethics Committees of the participating hospitals. Prior to each study, information about the study was provided to each potential participant and all participants who agreed to participate provided written consent. As the patients with AD were diagnosed with mild dementia, all patients were considered by the memory clinic team to be competent to provide their own consent although in all cases information about the research and participation was also discussed with their families and friends.

Assessment

Experimental measure of prospective memory – Study 1 and 2. The Text-Reading Task (adapted from Ellis, Kvavilashvili, & Milne, 1999;

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Kvavilashvili, 1998) provided an uncomplicated dual-task paradigm to determine ability to perform a prospective memory task while simultaneously engaged in an ongoing task. The demands of the task were designed to be simple and naturalistic which is of consideration when assessing participants with dementia. Participants read aloud a short 6-page story (ongoing task) within which a target word (prospective remembering cue) was embedded on multiple occasions, appearing twice on every page, and participants were requested to make a word substitution (prospective remembering) whenever the target word was encountered. Participants were informed by the examiner that the target word, which was the name of a central figure in the story, had caused confusion in early practice trials with the task and the requested substitution would simplify the narration. Prospective memory performance was based on a weighted score of 2 for correct timing and content of substitution, 1 for an error (corrected response, late response or inaccurate target response), and 0 for no response before the next target word; allowing a maximum possible score of 24 (prospective memory score represented as the proportion correct).

Neuropsychological measures – Study 2 only. To assess individual differences in components of cognitive skill considered critical to successful prospective memory, participants in Study 2 were administered (1) the Hopkins Verbal Learning Test – Revised (HVLT-R; Brandt, 1991; Shapiro, Benedict, Schretland, & Brandt, 1999); the recognition discrimination index (HVLT-R DI) provided a measure of retrospective memory; (2) The Trail Making Test (Trails A and B; Reitan & Wolfson, 1995); the derived score of Trails (B – A) provided a measure of set-shifting (executive attention of working memory); and (3) Wechsler Digit Span (Wechsler, 1997); the total span (forward and backward) represented working memory capacity.

STUDY 1

In our first study we aimed to establish baseline information about the performance of patients with mild AD as compared to healthy older adults on a prospective memory task, and, importantly, did not provide a supported learning environment other than simple repetition of task instructions to task criteria. We expected that under these conditions patients with mild AD would be significantly impaired in prospective remembering as compared to healthy older adults as a reflection of impairments in episodic retrospective memory and executive attention (Huppert & Beardsall, 1993; Maylor et al., 2002).

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Procedure

Participants were simply provided with task instructions until they could successfully recall the target word and repeat instructions to the experimenter. Participants performed the text-reading task immediately after task instructions. Following performance of the text-reading task, participants were questioned whether they could recall the task instructions.

Results and discussion

In this preliminary study, we found that the proportion of correct responses to prospective memory targets for the AD group was very impaired ($M = 0.10$, $SD = 0.27$) as compared to the healthy older adult group ($M = 0.73$, $SD = 0.34$), Mann Whitney U ($N = 28$) = 21, $p = .000$. The AD group performed close to floor-level on the task even though the episodic memory task load was minimal (1 target word to remember), the severity of dementia was mild, and they were all living at home (see Figure 1).

Confounding a clear interpretation of the failure in prospective memory is the impairment in initial levels of encoding and subsequent retrieval of task information in the AD group. Although repetition of task instructions was provided pre-test until criterion was reached, acquisition and retrieval of task information remained fragile and a significant proportion of the AD group could not recall the task information at completion of the task: 8 of the 14 participants with AD could not free-recall task instructions at

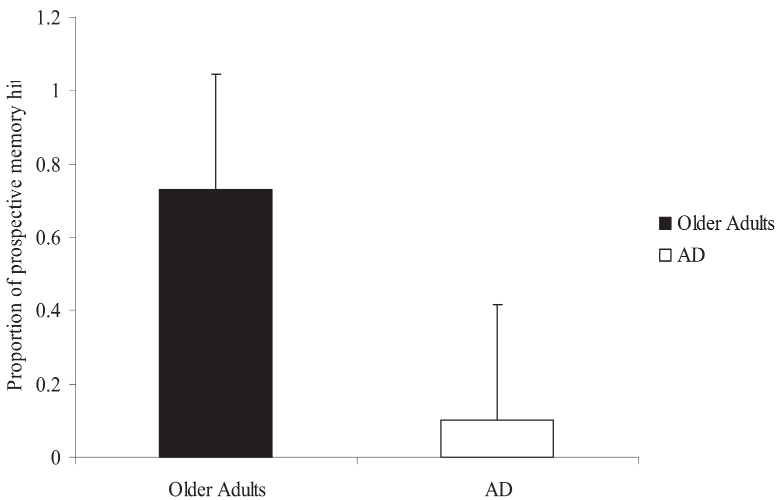

Figure 1. Study 1: Mean proportion of correct prospective memory responses by healthy older adults ($n = 14$) and older adults with AD ($n = 14$). Error bars are standard errors

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post-test although they had been able to repeat the instructions correctly immediately prior to the start of the task. In contrast, all 14 healthy adults could recall the instructions at post-test. Of the 6 participants with AD who were able to recall the instructions post-test, the mean proportion of correct prospective memory responses did increase to 0.27 but this success rate remained vastly inferior to the performance of the healthy older adult group.

To allow more detailed analysis of capacity for prospective memory in AD, a more secure encoding of the target stimulus to be remembered is required in the first instance. For example, Greene et al. (1996) in a study evaluating performance in tasks of episodic memory by 33 patients with mild AD and 30 controls, reported that when tasks equate initial acquisition of new information, removing the effect of the contribution of short-term memory to performance, patients with AD exhibit normal rates of forgetting (cf Kopelman, 1985). Perry, Watson, and Hodges (2000) similarly argued that once material has been acquired or learnt, patients with mild AD do not demonstrate accelerated forgetting from episodic long-term memory. In this respect, our next study explored the potential for spaced-retrieval to provide a supported learning technique for improving prospective memory performance in mild AD.

STUDY TWO

In Study 2 we investigated whether a strategy of supporting new learning, spaced-retrieval, could improve performance of persons with mild AD on a prospective memory task. We evaluated performance under two learning conditions – spaced-retrieval alone or elaborated encoding and spaced-retrieval. We expected that although there would continue to be a difference between participants with mild AD and healthy older adults in prospective memory performance (Maylor et al., 2002), we also expected that the difference between groups would be significantly less following the elaborated encoding spaced-retrieval condition than following the spaced-retrieval alone condition. A further aim of the study was to explore individual differences in performances on standard neuropsychological tests and determine which component cognitions correlated with prospective memory performance. We expected that neuropsychological measures of episodic retrospective memory (Cherry et al., 2001), and executive skills of working memory (Groot et al., 2002; Marsh & Hicks, 1998; Martin et al., 2003) would significantly contribute to variance in prospective memory.

Method

Design. The performance of a mild AD group was compared to a healthy older adult group in order to evaluate the potential for differential response to

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the intervention (learning condition) on the basis of neurological status (group). Due to the limited availability of patients with AD to participate in the study and to control the effect of factors such as variable individual profile of neuropsychological decline due to dementia, both experimental conditions were administered to each participant. The two learning conditions were separated by at least 30 minutes and the order of administration was counterbalanced in order to minimise the potential impact of any carry-over practice effect across conditions. However, any potential for this to occur was further investigated by evaluating the order-effect of the conditions on participants' performance.

Procedure. Participants were trained to remember and perform the prospective memory task under two learning conditions:

1. *Spaced-retrieval.* After provision of task instructions, participants were immediately asked to respond to the question, "What do you need to do in the reading task?" If unsure, participants were asked to simply respond, "I don't know". In accordance with the protocol adopted by Camp et al. (1996), the question was repeated at expanding intervals of 5 seconds, 10 seconds, 20 seconds, and 40 seconds up to 3 minutes. Any "I don't know" response led to instructions being re-stated and the previous delay interval reverted to – a correct response was necessary for progression to successive intervals. All participants were able to successfully repeat the instructions following a spaced-retrieval delay of 3 minutes immediately prior to commencing the prospective memory task.
2. *Elaborated encoding and spaced-retrieval.* Immediately prior to the experimental task, participants engaged in task-relevant practice by being asked to make a word substitution in response to a target cue. Participants were provided with a single practice text paragraph to perform the task. No participant required more than two attempts to make the correct target word substitution. Following this procedure, neither the practice text paragraph nor the practice prospective memory target cues were included in the experimental stories. This practice procedure was followed immediately by provision of the general experimental prospective memory task instructions and the spaced-retrieval technique as described above.

Using two versions of stories and target word substitutions, each participant undertook the prospective memory task under both learning conditions, counterbalanced in administration order. Testing was completed in a single session of approximately 60 minutes duration and the prospective memory

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learning conditions were separated by administration of neuropsychological tests over at least 30 minutes. On completion of the experimental procedure, participants were questioned about their recall of task instructions.

Results

Response to learning conditions. Under supported learning conditions, participants with AD performed at a higher level than that observed in the baseline condition in Study 1 (see Figure 2). However as expected, the AD group was less successful in the proportion of correct responses in prospective remembering (spaced-retrieval: $M = 0.54$, $SD = 9.42$; elaborated spaced-retrieval: $M = 0.80$, $SD = 5.97$) than the older adult group (spaced-retrieval: $M = 0.94$, $SD = 1.24$; elaborated spaced-retrieval $M = 0.97$, $SD = 0.70$) but they were more influenced by the learning condition than healthy older adults.

The magnitude of the effect size for group was moderate, accounting for 34% of the variance, $F(1, 30) = 15.72$, $p < .001$, $\eta^2 = .34$. The effect size for task was slightly smaller, with task condition accounting for 29% of the variance, $F(1, 30) = 12.45$, $p < .01$, $\eta^2 = .29$. Most importantly, there was a small but significant effect of the interaction between group and task, $F(1, 30) = 8.74$, $p < .01$, $\eta^2 = .23$, indicating that compared to healthy

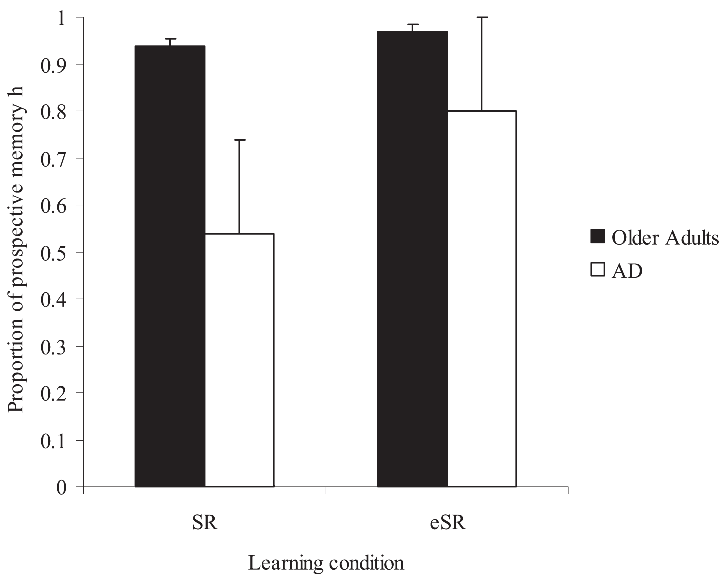

Figure 2. Study 2: Mean proportion of correct prospective memory responses by healthy older adults ($n = 16$) and older adults with AD ($n = 16$) in spaced-retrieval (SR) and elaborated encoding and spaced-retrieval (eSR) learning conditions. Error bars are standard errors

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older adults, participants in the AD group demonstrated a moderate and significant benefit in prospective memory in the combined training condition as compared to spaced-retrieval alone (see Figure 2).

In order to ascertain whether or not the significant difference between groups in estimated IQ contributed significantly to the effect of group on task, NART was examined as a covariate. The effect size for group was reduced from 34% to 28% of the variance, $F(1, 29) = 11.47$, $p < .01$, $\eta^2 = .28$, but remained significant indicating that the magnitude of the effect size for NART was small, accounting for only 6% of the variance. In addition, an order effect of task administration was investigated by evaluating whether it made a difference to performance if the spaced-retrieval only condition was administered first or after the elaborated spaced-retrieval condition as it could be argued that there might be some carry-over practice effect from the elaborated spaced-retrieval condition being presented first in order. In the older adult group there was no significant difference across order conditions; spaced-retrieval alone first $M = 0.94$, $SD = 1.25$; spaced-retrieval alone second $M = 0.94$, $SD = 1.30$; $F(1, 14) = 0.10$, $p > .05$. For the AD group there was a slight trend towards improved performance on spaced-retrieval alone if the condition was administered after elaborated spaced retrieval; spaced-retrieval alone first $M = 0.45$, $SD = 9.24$; spaced-retrieval alone second $M = 0.62$, $SD = 9.76$, however, the order effect was not significant, $F(1, 14) = 0.70$, $p > .05$).

Maintenance of performance across task. To investigate whether there was any change in success across the text reading task and the 12 prospective memory target cues for either group, we contrasted performance for the initial trials (Trial block 1: trials 1–6) and for the later trials (Trial block 2: trials 7–12) (see Table 2). Using a $2 \times 2 \times 2$ ANOVA there was no significant effect of trial block ($p > .1$) or group × condition × block interaction effect ($p > .1$), indicating that prospective memory did not systematically vary across trials. Of importance for this sample, there was no evidence of significant decline in performance across the text reading task by the AD group which would have been suggestive of failure to maintain the memory trace and compounding difficulties on the prospective memory task.

Individual differences in response to task

As regards individual differences in performance, the means and standard deviations for each of the neuropsychological measures are presented in Table 1. The AD group demonstrated poorer retrospective memory (HVLT-R DI $t = 4.925$, $p < .001$), less efficient set-shifting skills (TMT B-A $t = -3.371$, $p < .01$) and lower working memory capacity (Digit Span total score $t = 3.937$, $p < .001$). In the healthy older adult group

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TABLE 2
Mean proportion of prospective memory successes across conditions and trial blocks and for healthy older adults and older adults with AD

Group	*Condition*	*Trial block*	*Mean*	*Std. error*
Healthy older adults ($n = 16$)	1	1	.938	.069
		2	.958	.074
	2	1	.984	.038
		2	.958	.053
AD ($n = 16$)	1	1	.552	.069
		2	.531	.074
	2	1	.802	.038
		2	.813	.053

Condition 1 = Spaced-retrieval; Condition 2 = Elaborated encoding and spaced-retrieval; Trial block 1 = Trials 1–6; Trial block 2 = Trials 7–12

there were no significant correlations between neuropsychological tests and the learning conditions of prospective memory. However, in the AD group there were significant correlations between prospective memory and executive attention (Trails B-A) and retrospective memory (HVLT-R DI) in the combined learning condition (see Table 3), indicating that better set-shifting skills and/or retrospective memory were associated with better prospective remembering. Interestingly, although there were strong positive correlations between these two measures in the healthy older adults group, this was not found in the AD group.

TABLE 3
Correlations of prospective memory with neuropsychological measures in healthy older adults (A) and older adults with AD (B) in spaced-retrieval (SR) and elaborated encoding and spaced-retrieval (eSR) learning conditions

	Trails B-A	*Digit span*	*SR*	*eSR*
(A) Older Adults				
HVLT-R (DI)	−.850**	.641**	−.038	−.225
Trails (B-A)		−.690**	−.067	.064
Digit Span			−.057	−.237
SR				.478
(B) Older Adults with AD				
HVLT-R (DI)	−.212	.018	.018	.631**
Trails (B-A)		−.219	−.320	−.663**
Digit Span			.094	.131
SR				.566*

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

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Only four participants in the AD group were unable to make at least one correct substitution in the spaced-retrieval alone condition. All of these participants had successfully achieved learning criterion immediately prior to commencing the task. Upon questioning following task completion, one of the four participants remembered having been asked "to change something" during the reading task but was unable to recall task content. The remaining three participants were unable to remember any task instructions, including specific content. In the combined learning condition, all four of these participants were able to successfully identify multiple prospective memory targets. Among this particular sub-group, half were administered the spaced-retrieval learning condition first, and half the elaborated encoding and spaced-retrieval learning condition first. It should be noted that improvement across learning conditions was not confined to these four participants in the AD group. When assessing how many participants in the AD group changed more than 1 point between the spaced-retrieval condition and the elaborated spaced-retrieval condition, we found that 63% (10) improved under elaborated spaced-retrieval conditions, 37% (6) remained unchanged and no one declined.

Trials to attain criterion. In respect to the number of trials required to reach criterion in the spaced-retrieval training schedule, all participants in the healthy older adult group completed the schedule in the minimum number of trials required (9 trials) in both spaced-retrieval alone condition and elaborated spaced-retrieval condition. The AD group, however, required more trials in the spaced-retrieval alone condition (mean number of trials = 11.6, $SD = 2.90$) than in the elaborated spaced-retrieval condition (mean number of trials = 9.94, $SD = 1.34$). A one way ANOVA of number of trials to criterion in the AD group, $F(1, 30) = 4.0$, $p = .055$) indicated a trend towards the AD group encoding task instructions more quickly when spaced-retrieval was combined with elaboration of encoding.

GENERAL DISCUSSION

Our results lend support to a growing body of evidence from researchers that persons with mild AD can use cognitive support to improve remembering although they will need more support than healthy older adults (Bird, 2001; Camp, 2001; Clare et al., 2002, 2004; De Vreese et al, 2002; Grandmaison & Simard, 2003). The focus of our study was prospective memory and even within this cognitively complex domain of memory, we have shown that performance of persons with mild AD can be substantially improved by providing supported learning conditions – spaced-retrieval with elaborated encoding of task demands. The results of our preliminary exploration of prospective memory performance in AD demonstrated that in unsupported

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learning conditions when prospective memory is assessed via a simple low cognitive-load paradigm, the AD group was devastatingly impaired. In contrast, in the subsequent intervention study the AD group showed substantial improvements in prospective memory performance when learning was provided under conditions of elaborated encoding combined with spaced-retrieval.

Bäckman (1996) has argued that cognitive support of memory is most effective if based in elaborated encoding and support at retrieval. Furthermore, he argues that interventions based on relatively preserved skills in AD such as implicit memory are more likely to result in gains than interventions based on significantly compromised skills such as explicit episodic memory. In this respect, spaced-retrieval is often described as utilising automatic or implicit learning processes and provides support by strengthening the memory trace so that the probability of accurate retrieval is increased. Spaced-retrieval has been found to be effective in improving retention of information for relatively simple memory tasks, such as remembering to look in a diary or planner each morning, or face–name association (Bird, 2001; Bird and Kinsella, 1996; Camp et al., 2000; Clare et al., 2000, 2002). However, using only spaced-retrieval intervention our AD group continued to find prospective remembering a challenge as compared to the healthy adult group. This could suggest that implicit learning processes in mild AD are not as enduring as previously thought, however analysis of success of the AD group across the target prospective cues indicated that forgetting of the target did not clearly accelerate over time. Alternatively, the complexity of prospective memory is such that both implicit and more strategic cognitive processing as used in explicit learning processes, is required to effect a satisfactory level of prospective memory in the AD group. The cognitive demands of prospective memory are invariably complex as successful performance requires forming an intention to carry out something in the future, maintaining task information over time and interrupting ongoing activities to perform the task at the appropriate time. McDaniel and Einstein (2000) have conceptualised prospective remembering as multi-process, drawing on both executive function (dividing attention, set-shifting, etc.) and episodic memory skills. As a consequence it is understandable that an intervention such as spaced-retrieval based in implicit learning will be limited in its impact on effecting satisfactory prospective memory task performance.

The combined learning condition, elaborated encoding and spaced-retrieval, was found to be the most effective learning condition for participants with AD; the majority of the AD group (63%) improved under elaborated spaced-retrieval conditions as compared to spaced-retrieval alone. Support was provided not only through strengthening the memory trace but also by providing the use of a practice paragraph thereby providing practice in the

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procedures of the task. The effect of elaboration of encoding may have led to better performance in at least a couple of ways. It may be that in the early AD group the provision of a task-specific context served to utilise explicit learning functions that contributed to establishing a relatively strong memory trace that was more resilient to the potential impact of interference from the ongoing task than the trace established by implicit, automatic process only (cf. Tailby & Haslam, 2003). In this respect, it was noted that in the elaborated encoding condition the AD group more quickly achieved successful encoding of task information (number of trials to reach criterion) than in the spaced-retrieval alone condition indicating a more focused or effective response to learning new information; furthermore, performance did not significantly deteriorate across targets within the text-reading task. Another possible explanation for the better prospective memory performance by the AD group in the elaborated condition was that the provision of the task-specific context simply helped participants to create a good understanding of the procedure of the task and what the task required of them.

In respect to individual differences in components of cognitive skills relevant to prospective memory, under conditions of elaborated encoding and spaced-retrieval, participants with AD who demonstrated better executive function (set-shifting) and/or retrospective memory (delayed discrimination) were more successful in prospective memory providing some indication of who will benefit most from intervention. However, the lack of inter-correlation between these two cognitive resources, attention set-shifting and associative discrimination memory, within the AD group suggests that: (1) Prospective memory is multi-factorial and can be challenged or supported by the resources of both working memory and/or retrospective memory (Jones, Livner, & Bäckman, 2006); and, (2) The cognitive decline in the mild AD group is multi-process (Baudic et al., 2006) and the profile of individual strengths and deficits will be critical to the success of individual intervention. In addition to remembering the task content or what has to be remembered, many prospective memory tasks in everyday situations require keeping track of multiple tasks and allocating attention across different task demands, such as following and cooking a new recipe or driving through traffic, and even a minor decline in executive attention in early AD will be expected to have significant impact on prospective memory performance.

It should be noted that the present investigation of learning techniques used a relatively brief delay interval between task instructions and task performance. In order to assess whether gains in prospective memory are able to be maintained over functional periods of delay, several weeks for example, it will be necessary in further research to extend the time interval between encoding of task requirements and activation of task performance. This will be critical to evaluating the potential application of the techniques to

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everyday activities. Clare et al. (2002) provide encouragement through their group study of 12 participants with mild AD who demonstrated a significantly positive response to an intervention that was based in errorless learning principles incorporating a component of spaced-retrieval. The gains in intervention in a face–name recognition task were maintained at 6 and 12 month follow-up even though practice on task was discontinued after the one-month follow-up. McKitrick et al. (1992) in a single case design with four patients with AD reported similarly encouraging results that learning on experimental prospective memory tasks using spaced-retrieval techniques can be maintained over a week's delay. Camp et al. (2000) argue that an important issue in relation to spaced-retrieval training is the critical length of the delayed-recall interval over which participants with AD can retain information within a training session and is predictive of subsequent recall of information days later. Bird and Kinsella (1996) found that in using spaced-retrieval participants who could recall an experimental task after a delay of one hour were usually able to recall the task one day later. The length of spaced-retrieval training used in our current study was experimentally useful to demonstrate that the technique of spaced retrieval can be improved but clearly the delay interval of training will need to be expanded in order to evaluate whether consistent functional gains can be achieved in prospective memory using elaborated encoding and spaced-retrieval.

In summary, Camp (2001) has argued that effort needs to be focused on translating neuropsychological research to impact meaningfully on everyday problems. The present research is some distance from this aim but it has contributed to extending our understanding of the optimal conditions under which persons with mild AD can respond to spaced-retrieval intervention for prospective memory. We need to replicate and extend our initial findings of efficacy of intervention under controlled conditions by investigating larger samples of persons with AD to allow closer interpretation of the impact of individual differences in cognitive skills and also to evaluate additional tasks of prospective memory that are functionally relevant to patients and families in improving quality of life.

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