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Differential effects of age on prospective and retrospective memory tasks in young, young-old, and old-old adults.

Remembering to post a letter, make a phone call, or take a medication are important everyday tasks that rely on prospective memory—one's ability to remember and carry out intended actions at some point in the future. Prospective memory tasks have been classed into two broad categories. In event-based tasks one has to remember to do something in response to a certain event (e.g., posting a letter when you pass the post box in the street). In time-based tasks the action has to be carried out at a particular time (e.g., making a phone call at 2:00 pm). Because there is no external event in time-based tasks, signifying the opportunity for recall, they require more self-initiated processing and are considered to be more difficult to remember than event-based tasks (e.g., Einstein, McDaniel, Richardson, Guynn, & Cunfer, 1995; Kvavilashvili & Fisher, 2007; Sellen, Louie, Harris, & Willkins, 1997).1 However, an important feature that is common to all prospective memory tasks is the absence of an explicit prompt for recall at the time of retrieval. Hence, prospective memory has often been referred to as one's ability to “remember to remember”, and distinguished from retrospective memory that is almost always instigated by an explicit prompt to recall the past information (e.g., “How was your holiday last week?”, “Please recall all the words that you saw earlier in the experiment”).

Despite this self-cued aspect of prospective memory, each prospective memory task also consists of a retrospective component. After having remembered that something needs to be done, one also has to remember “what” it is that needs to be done. This retrospective component is usually minimal and it is the prospective, “remembering to remember” aspect of the task that is problematic to both adults and children (Meacham, 1977; Zimmerman & Meier, 2006).

According to Craik (1986), this self-cued aspect of prospective memory should be even more problematic for older adults, who are generally known to experience difficulties with self-initiated, strategic retrieval. He predicted that age effects should be particularly pronounced in prospective memory and even exceed those observed in free recall retrospective memory tests, which are known to require high levels of internal strategic processes and produce large age decrements. However, in stark contrast to Craik's prediction, initial naturalistic studies of prospective memory (where participants had to remember to send postcards or make phone calls at certain dates/times) failed to obtain significant age effects (Devolder, Brigham, & Pressley, 1990; Martin, 1986; Moscovitch, 1982; Patton & Meit, 1993; Rendell & Thomson, 1993; West, 1988, Study 1). Furthermore, no age effects were obtained in the first laboratory study of event-based prospective memory in which participants were busily engaged in an ongoing short-term memory test and additionally had to remember to press a key every time they encountered a particular target word in the ongoing task (Einstein & McDaniel, 1990). These findings prompted Einstein and McDaniel to conclude that “prospective memory seems to be an exciting exception to typical age-related decrements in memory” (p. 724). However, research that has accumulated since 1990 has produced contradictory patterns of findings that are much more difficult to interpret

Age effects were initially identified in laboratory studies that investigated time-based prospective memory, e.g., Einstein et al. (1995), in which there was no age effect in the event-based condition but older participants were significantly worse in the time-based condition. Einstein et al. (1995) explained this pattern of results (i.e., age by type of task interaction) as being in line with Craik's (1986) theoretical model, which assumes large age-related memory decrements for tasks with high degree of self-initiation. However, subsequent studies reported age effects even in event-based prospective memory tasks. Currently, the results with event-based tasks are mixed, with some studies consistently failing to obtain age effects (e.g., Cherry & LeCompte, 1999; Cherry et al., 2001; Cherry & Plauche, 2004; Einstein & McDaniel, 1990; Einstein et al., 1995; Marsh, Hicks, Cook, & Mayhorn, 2007; Reese & Cherry; 2002), and others resulting in significant age effects (Mäntylä, 1993, 1994; Maylor, 1993, 1996, 1998; Maylor, Smith, Della Sala, & Logie, 2002; Park, Hertzog, Kidder, Morrel, & Mayhorn, 1997; Smith & Bayen, 2006; West & Craik, 1999, 2001; Zimmerman & Meier, 2006).

It has been pointed out that the majority of laboratory studies that failed to obtain age effects have adjusted (i.e., reduced) the difficulty of ongoing task (into which prospective memory target events are embedded) for older participants. For example, if the ongoing activity involved answering general knowledge questions, the presentation rate would be slower for older participants (Einstein et al., 1995; Experiment 3) to compensate for their reduced speed of processing, or in the case of a short-term memory test, they would be presented with fewer items to remember (Einstein & McDaniel, 1990; Cherry & Plauche, 2004). Another important variable that can potentially account for discrepant findings is the nature of an event-based task, where performance may vary considerably as a function of cue event and its relation to the ongoing activity (focal vs non-focal cues) (Einstein & McDaniel, 2005; McDaniel & Einstein, 2007). With focal cues, a prospective memory event (e.g., the word "president") is processed as part of an ongoing activity (e.g., answering general knowledge questions). With non-focal cues, a target event (e.g., a face with glasses) requires additional processing since it is irrelevant to the processing of material in the ongoing task (e.g., naming the photos of celebrities). Age effects should therefore be more pronounced in event-based tasks with non-focal than focal cues (see also the task-appropriate account of Maylor, 1998). Recently several studies have started to address this issue explicitly by manipulating the nature of cues and/or the ongoing activity as a function of age (e.g., Rendell, McDaniel, Forbes, & Einstein, 2007; Zimmerman & Meier, 2006).

Although considerable progress has been made in trying to solve the basis for discrepant findings in laboratory studies of event-based prospective memory, most studies have failed to explicitly address the prediction made by Craik (1986) about the differential effects of age on prospective and retrospective memory. Given that age effects have been obtained in many laboratory studies of prospective memory, Craik's prediction needs to be addressed by comparing age effects in prospective and retrospective memory tasks within the same participant population to see if larger effects are obtained for the former than the latter (e.g., see Kvavilashvili, Messer, & Ebdon, 2001; Uttl, Graf, Miller, & Tuokko, 2001). However, the majority of published studies used only one or two prospective and retrospective memory tasks and did not report or compare the effect sizes (but see Zeintl, Kliegel, & Hofer, 2007).

In this respect, a major advance was made by a seminal meta-analysis of 26 studies on prospective memory and ageing which covered a total of 152 study-level effects with a large number of young (N=1426) and old (N=1462) participants (see Henry et al., 2004). This meta-analysis resulted in several key findings. First, negative correlations with age in laboratory time-based tasks (r=-.39) were not reliably larger than in event-based tasks (*r*=-.34). This finding contradicts the view that time-based tasks impose greater demands on self-initiated processes than event-based tasks. Second, the magnitude of age effects in laboratory event-based tasks was minimal, with focal cues and/or undemanding ongoing tasks (*r*=-.14) explaining only a very small percentage of variance (1.9%) in performance, and fairly large for tasks that imposed high attentional demands (*r*=-.40) explaining 16.4% of variance. Third, contrary to Craik's prediction, the magnitude of age effects on prospective memory was reliably smaller than in retrospective free recall tasks, and did not differ from those in recognition tasks. This finding has important implications for the understanding of mechanisms involved in prospective memory retrieval and indicates that self-initiation in prospective memory tasks may be mediated by predominantly automatic than by attentionally demanding controlled processes (cf. Kvavilashvili & Fisher, 2007).

Despite these interesting findings several important questions still need to be addressed. First, it remains unclear whether the patterns of findings obtained in meta-analysis of 26 studies with several thousand participants are robust enough to emerge within a single study. Second, if age effects are more pronounced in retrospective than in prospective memory tasks, then older adults should report experiencing more problems in everyday retrospective than prospective memory tasks. Finally, in order to gain better insight into differential effects of age on prospective and retrospective memory it is necessary to compare the onset of age decline in different prospective and retrospective memory tasks within one participant population by having at least two groups of old participants who are in their 60s and 70s (young-old and old-old).

The important information about the onset of decline in prospective memory and how it differs from that of retrospective memory is largely missing due to an existing practice in ageing research of using only one group of old participants whose age varies considerably (from as young as 55 to 80 or above in some studies). The results of few existing studies that have used age cohorts have shown that old participants in their 60s are reliably better on prospective memory tasks than those in their 70s (e.g., Bisiacchi, 1996; Dobbs & Rule, 1987, the red pen task; Huppert, Johnson, & Nickson, 2000; Maylor, 1996; Uttl et al., 2001; Zimmerman & Meier, 2006) with an accelerated decline starting only after 75 years of age (Mäntylä & Nilsson, 1997, analysis on conditionalised scores). Moreover, the studies that also included a sample of young adults showed that age effects were obtained only when young adults' prospective memory performance was compared to an old-old group in their 70s, but not when it was compared to young-old group in their 60s (Dobbs & Rule, 1987; Zimmerman & Meier, 2006; but see Maylor, 1998, who obtained age effect between young and old groups in their 50s to early 60s). It thus appears that by collapsing old participants of various ages into one single group important age effects on prospective memory may be masked.

The aim of the present study was to extend the findings of Henry et al.'s (2004) meta-analysis by addressing the set of important issues outlined above. Thus, in order to test Craik's (1986) prediction in more fine-grained manner, we compared the onset of decline in prospective and retrospective memory in three groups of participants (young, young-old, and old-old). Retrospective memory was assessed by tests of free recall and recognition. Prospective memory was assessed by three different laboratory-based tasks.

The main experimental task was modelled after Einstein et al. (1995, Experiment 3). Thus, participants had to answer a long set of general knowledge questions presented on the computer screen (ongoing task). In the event-based condition, participants had to type in six numbers (1, 2, 3, 4, 5, and 6) when they received a question about "telephone". In the time-based condition, they had to do this once in every 3 minutes. Unlike Einstein et al. (1995) we also had an activity-based condition in which participants had to type in the numbers after they finished each block of trials during a short 15-second rest interval between the blocks (see Footnote 1). Prospective memory performance was scored as a proportion of correct, on time, responses out of six opportunities, which in each condition occurred once in every 3 minutes during a 19-minute task of answering general knowledge questions.

In addition to this main experimental task, participants were also assigned to two additional event-based tasks during a 90-minute experimental session. Thus, participants had to remember to write down a name of a colour if they noticed that the task they were working on was on a coloured sheet of paper (there were three response opportunities). In another task, modelled after Dobbs and Rule (1987), participants had to remember to request a red pen when later in the session they were asked to copy a geometric figure (one response opportunity). These tasks can be considered as more "naturalistic" than our main experimental task because retrieval opportunities are separated by longer delay intervals filled with various activities (mimicking the complexities of everyday prospective memory task situations). In addition, the difficulty of ongoing tasks is not adjusted according to the age group. The few studies that used such "naturalistic" laboratory tasks have all reported significant age effects (Cockburn & Smith, 1991; Dobbs & Rule, 1987; Huppert et al., 2000; Kliegel, McDaniel, & Einstein, 2000; Mäntylä & Nilsson, 1997; Uttl et al., 2001; West, 1988, Study 2; Zeintl et al., 2007).

Several important predictions were made in the present study. First, it was predicted that the magnitude of age effects in the laboratory tasks of prospective memory would vary depending on the nature of tasks. For example, largest age effects would be obtained for the time-based condition in the main experimental task and for the event-based colour task as the latter involved a non-focal cue (the colour of the paper was irrelevant to the task the participant was working on at the time).

Furthermore, it was expected that age effects would be significantly larger in a simple three-item retrospective free recall task (see Method section) than in any of the laboratory prospective memory tasks. Most importantly, it was hypothesised that different patterns of decline would be observed in retrospective and prospective memory tasks. In particular, it was expected that while age effects in free recall and recognition tasks would be present in the young-old participants (those in their 60s), age effects in prospective memory tasks would be present only in the old-old (those in their 70s) but not in the young-old participants. Taken together, this pattern of findings would mean that for young-old, and especially old-old participants, everyday retrospective memory tasks should be more problematic than prospective memory tasks. This idea was assessed informally by asking all participants to recall their most recent everyday memory failure.

Method

Participants

The sample consisted of 223 participants, recruited from the local community in order to minimise differences due to background and education levels: 72 young (21 males, 51 females, mean age 23.50 years, *SD*=3.60; range 18-30), 79 young-old (36 males, 43 females, mean age 66.05, *SD*=3.07, range 61-70), and 72 old-old (30 males, 42 females, mean age 75.06, *SD*=2.77, range 71-80). The majority (*N*=157) were recruited by letters to residents on the local doctor's (general practitioner's) register and the remaining 66 (51 young and 15 old) by advertising in the local newspaper, job centre, youth centre etc.

In the young group 61% were employed, 8% were unemployed, 28% were students from various universities/colleges, and 3% were housewives. In the old group 75% were retired, 11% were semi-retired, 7% were working full time, and 7% were housewives.

No participant reported any of the following conditions: serious head injury; stroke, mental health, and/or memory problems (diagnosed by a doctor). None of the young women were pregnant at time of testing. All older participants were healthy and residing in the community. In an initial telephone interview with the experimenter none of them reported experiencing problems with vision, hearing, or physical mobility. English was the first language for all the participants.

Table 1 lists scores on background variables by age group. There was no reliable difference on self-rated general health between young and old participants on a 5-point rating scale with 1=poor and 5=excellent (*F*=1.08). However, in comparison to young adults, both groups of older adults rated their health as being better than that of their peers on a 5-point rating scale where 1=worse, 3=same, and 5=significantly better (*p*=.03 and *p*=.0004 for young-old and old-old groups, respectively).

TABLE 1. Participants' mean scores on several background variables as a function of age group

	Age group				
	Young	**Young-old**	**Old-old**		
	(*N*=72)	**(*N*=79)**	**(*N*=72)**	***F* value (2, 220)**	**Effect size (η^2)**
Health rating	3.93 (0.70)	4.09 (0.80)	3.94 (0.69)	1.08	-
Health (self vs peers)	3.26 (0.61)	3.57 (0.61)	3.74 (0.73)	7.76	.07
Vocabulary (SCOLP- Spot-The-Word Test)	48.58 (4.25)	53.19 (4.16)	52.92 4.62	25.99	.19
General knowledge questions	0.50 (0.09)	0.55 (0.10)	0.52 (0.13)	4.08	.04
MMSE	29.06 (.96)	28.23 (1.28)	27.64 (1.31)	25.99	.19

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	Age group				
	Young	Young-old	Old-old		
	(*N*=72)	(*N*=79)	(*N*=72)	*F* value (2, 220)	Effect size (η^2)
Speed of Processing (SCOLP-Speed of Comprehension)	74.26 (13.15)	69.32 (13.60)	64.06 (10.80)	11.82	.10
Years of education	14.01 (2.23)	12.43 (2.53)	11.35 (2.21)	23.83	.18

Standard deviations in brackets. See text for details of these measures.

Vocabulary, estimated from scores on the Spot-the-Word Test of the Speed and Capacity of Language Processing Test (SCOLP; Baddeley, Emslie, & Nimmo-Smith, 1993), was reliably better in both young-old and old-old participants than in the young group (both *p*s<.0001). Young-old were also significantly better than young participants in the General Knowledge Task (*p*=.017), while the difference between the young and old-old was not significant (*p*=.70). These results indicate that any superiority in performance of the younger group in memory tests was not likely to be due to different crystallised cognitive ability. A test of general cognitive functioning revealed an opposite trend. Although all the old participants scored at least 24/30 on Mini Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975), their scores were reliably lower than in the young group (*p*s<.001 for both groups of old participants). Similarly, young-old and old-old participants were reliably worse on the Speed of Comprehension Test of the SCOLP than the young group (*p*=.04 and *p*=.001, respectively). Finally, in common with other studies (cf. Freeman & Ellis, 2003; Huppert et al., 2000), young participants had spent significantly more years in full time education than either young-old (*p*=.0001) or old-old (*p*<.0001). The difference between the two old groups was also significant in the expected direction (*p*=.01).

Materials

Speed and capacity of language comprehension test (SCOLP)

This consists of Speed of Comprehension and Spot-the-Word Tests (Baddeley et al., 1993). Version B of both tests was used. In the Speed of Comprehension Test participants have 2 minutes in which to work through a maximum of 100 sentences and rate them as true or false as quickly and accurately as possible. The performance is scored as a total number of sentences rated in 2 minutes. In the Spot-the-Word Test participants have to identify a real word in 60 pairs of words consisting of a word and a nonword. There is no time limit on this test and performance is scored as a total number of correct responses out of 60.

Retrospective memory tests

(a) In the recognition memory test participants were presented with 18 sets of four words on a coloured sheet of A4 paper and asked to identify the one word in each set that they had just seen in the Spot-the-Word Test (see Baddeley et al., 1993). The performance was scored as the proportion of correct responses out of possible 18. (b) The three-item free recall test was part of the MMSE. Participants were told that their memory would be tested and were asked to repeat the three words "apple", "penny" and "table". This was followed by counting backwards in sevens from 100, and after five responses participants were asked to recall the three words. Performance was scored as the proportion of correctly recalled words.

General knowledge task (GKT)

This was a 19-minute ongoing task for the main experimental prospective memory task of typing in six numbers. The GKT consisted of a computer analogue of stacks of cards (12 cm × 18 cm) presented on the screen with one general knowledge question per card. A total of 117 general knowledge questions were used, adapted from the pool of 160 questions used by Einstein et al. (1995) by selecting those questions most appropriate for a British sample. Six target questions about the American presidents used by Einstein et al. (1995) were changed into political and historical questions relevant to a British population. In the event-based condition, six of these questions were replaced by the six target questions about the "telephone". The "telephone" questions were not used in activity- and time-based conditions lest they acted as incidental reminders to the participants (the main experimental prospective memory task involved typing in six numbers as if "making a phone call to a friend").

Presentation rate of the cards varied across the age groups. Following Einstein et al. (1995), presentation rate for each card was 12 seconds in the young group and 15 seconds in the old groups. With the presentation rate of 12 and 15 seconds per question, 88 and 70 questions respectively were randomly chosen from a pool 117 and presented in a random order. In the event-based condition, the target telephone questions occurred in fixed positions (once in every 3 minutes).

Design

For the main prospective memory task of typing in six numbers while answering general knowledge questions the design was a 3 age (young vs young-old vs old-old) × 3 type of task (event- vs time- vs activity-based) between-participants factorial. There were at least 24 participants in each of the resultant nine cells. For all the other tasks as dependent variables, the design was one-factor between-participants ANOVA with age as the independent variable. Unless otherwise specified, the number of participants in each of the three age groups was 72, 79, and 72 for young, young-old and old-old, respectively.

Procedure

Participants were tested individually by one of the three female experimenters (two of them being the first and the third author) in offices in the same building and with a similar layout. On average, testing sessions lasted 1½ to 2 hours including a short break of 10-15 minutes. All participants received a payment of £10 for their time and travel expenses.

At the beginning of the session the experimenter read a short description of the aims of the project and some of the tasks that had to be performed during the session. After signing a consent form participants made two ratings about their health, provided basic demographic information, and described their most recent memory failure. Participants were then informed that some of the paper and pencil tasks throughout the session would be printed on coloured sheets of paper. When presented with one of these coloured sheets, they had to remember to write the name of that colour anywhere on the page as soon as they noticed that the paper was coloured (this was the prospective event-based colour task). It was made clear that they would not be reminded of this task by the experimenter. Three opportunities throughout the session to make this response occurred in the recognition memory test (green paper), a brief 14-item questionnaire (yellow) and the MMSE interlocked pentagons subtask (peach).

Next, participants were informed that they would be tested on a general knowledge task (GKT). It was explained that each question would appear in the centre of a computer screen as though it was written on a card within a stack of several cards, and that there would be several such stacks. As each question was answered the stack would (visibly) diminish by one so that when all the questions from the stack had been answered there would be a blank screen for several seconds. This was described as a rest interval, which would be followed by a tone indicating that the next stack of cards was about to appear on the screen.

Participants were reassured that there would be a variety of questions and that nobody was expected to get them all right. They were also encouraged to guess if necessary. They were given the opportunity to question the instructions and then given a practice session of eight questions, consisting of a stack of three cards, a 15-second rest interval, then a stack of five cards.

The practice session was followed by the instructions for the main prospective memory task. The experimenter informed the participants that a secondary aim of the study was to explore how people remember to do things in the future, such as remembering to pass on a message to a friend or making a phone call at a certain time. In order to study their memory for future actions the experimenter wanted them to remember to do something additional while they were engaged in answering the questions. Thus, in the activity-based condition participants were asked to give an imaginary phone call to a friend every time they finished answering a stack of cards by typing in six numbers 1, 2, 3, 4, 5, 6 on the number pad of the computer keyboard. In the event-based condition they had to do this every time they saw a question containing the word “telephone”. In the time-based condition they had to type in numbers every 3 minutes, i.e., at 3, 6, 9, 12, 15, and 18 minutes. They could check the elapsed time by pressing a space bar, which showed a small digital clock on the screen for a few seconds. Participants could not check the time on their own wristwatches as all participants had been asked to remove them at the beginning of the session (cf. Einstein et al., 1995).

Participants were encouraged to ask questions and the experimenter moved on only after she had made sure they had understood the instructions. There was then a filled delay of approximately 10-12 minutes before participants were asked to carry out the GKT (see Einstein & McDaniel, 1990). During this period participants completed both components of the SCOLP and the recognition memory test. This test was presented on the green sheet of paper and thus represented the first target occasion for the event-based colour task.

The participants then carried out the GKT. The prospective memory task of typing in six numbers was not mentioned at this point. The GKT lasted for 19 minutes and contained a total of six opportunities to respond prospectively, which occurred at 3-minute intervals in all conditions (activity-, event-, and time-based). The first question together with four possible answers (denoted as A, B, C, and D) was presented on the first (top) card of a stack. After a few seconds a prompt “Please enter your selection (A-D)” appeared on the bottom of the card and the participant had to type in the correct answer by pressing one of four designated keys marked (as A, B, C, D) on the keyboard. This was followed by feedback on the same card, indicating whether the participant had run out of time or whether the response option chosen was correct or not. The correct answer together with a cumulative percentage score at that point in the task was also presented. Then the card disappeared and revealed the second question written on the next card in the stack and so on. In line with Einstein et al. (1995), the feedback period always lasted for 3 seconds, but the amount of time the questions were displayed and the time participants were given to enter their response after the prompt varied according to participants' age (in the young group 6 and 3 seconds, and in the old group 8 and 4 seconds, respectively). Each stack of cards represented a block of trials. In all experimental conditions there were seven blocks of trials (one short and six long). In the event- and time-based conditions the first short block lasted for 1 minute and the remaining long blocks for 2 minutes 45 seconds. In the activity-based condition the first long block lasted for 3 minutes, blocks 2-6 for 2 minutes 45 seconds, and the final short block for 45 seconds. The rest intervals between the blocks were always 15 seconds. This sequence of long and short blocks ensured that retrieval occasions occurred in every 3 minutes in the middle of the blocks in event- and time-based conditions (requiring an interruption of ongoing activity), but at the end of the blocks in the activity-based condition.

On completion of the GKT participants who forgot to type in six numbers on all six occasions were given successive questions or prompts (increasing in specificity) to find out whether failure was due to complete forgetting of the instructions (i.e., a retrospective memory failure) or a failure to carry out the task at an appropriate moment. Thus participants were asked if, in addition to answering general knowledge questions, they were also supposed to do something else (first prompt), whether they had to do something on a particular occasion (3 minutes, rest interval, telephone question) (second prompt), or what was it that they were supposed to do every 3 minutes/rest interval/telephone question (third prompt). If participants could not recall the prospective memory task even after this most specific prompt they were given a recognition test consisting of three possible tasks (tap with a finger, type in six numbers, type in six letters) from which they had to choose the correct one (i.e., type in six numbers).

After probing, participants were asked to fill a short 14-item questionnaire, which was presented on the yellow sheet of paper and thus represented the second target occasion for the event-based colour task introduced in the beginning of the session. This was followed by a short (coffee/tea) break.

At the beginning of the second half of the session participants were given the instructions for the event-based red pen task. They were told that if at some stage in the session they were asked to copy a geometric figure, they had to request a red pen with which to draw it. After this, participants were engaged in a self-paced cognitive task presented on the computer, lasting 10-15 minutes and unrelated to the present study. This was followed by the MMSE, which included the retrospective memory free recall task (recalling the words “apple”, “penny”, and “table”) (see Materials section above). In addition, the last item contained two cue events for remembering the event-based red pen and colour prospective memory tasks. The experimenter gave the participant a sheet of peach-coloured paper with two interlocked pentagons and asked them to copy the figure in the space underneath. As soon as the participants heard this request they had to remember to ask for the red pen. Subsequently they also had to remember to write the colour of the paper on the sheet. As soon as participants finished copying the pentagons post-experimental probing questions were asked about the red pen task and then the colour task in the same way as for the main prospective memory task of typing in six numbers (see above).

Results

This section is broken down into subsections corresponding to the different prospective and retrospective memory tasks described above. Participants' descriptions of their most recent memory failure as a function of age were also analysed. For all analyses the alpha level was set at .05, the Tukey HSD test was used for post hoc comparisons and effect sizes were measured by partial eta-squared (η^2) with small, medium, and large effects defined as .01, .06, and .16, respectively (Cohen, 1977).

Self-reported memory failure

Out of 223 participants, 17 could not remember their most recent memory failure (4 young, 7 young-old, and 6 old-old). The data of a further four participants were missing due to experimenter error. The remaining 202 participants provided either a specific example of their most recent failure or their most frequently occurring failure (when they were unable to retrieve the most recent one). Participants' descriptions of their memory lapses were categorised either as *prospective* (i.e., forgetting to turn up for an appointment, pass on a message, return a phone call, send a letter etc.), *retrospective* (forgetting a name, a word, where one put something, etc.), or *other* which mostly were absent-minded errors (going upstairs and forgetting why, opening a fridge to fetch a cup, repeating a simple action twice, etc.).

Percentage of participants as a function of age group and type of reported memory failure are presented in Table 2. As one can see from this table, young participants were more likely to report prospective memory lapses (53%) than young-old (18%) and old-old participants (19%). In contrast, both young-old and old-old participants were more likely to report retrospective memory lapses (54% and 55%, respectively) than young participants (35%). They were also more likely to report absent-minded errors (28% and 26%) than young participants (12%). These age differences in percentages of reported errors were highly significant $\chi^2=26.13$, $df=4$, $N=202$, $p<.0005$.

TABLE 2. Percentage of participants as a function of type of reported memory failure (prospective vs retrospective vs other) and age group (young vs young-old vs old-old)

Age group	Prospective	Retrospective	Other	Total
	Type of reported memory failure			
Raw numbers in brackets.				
Young	53% (35)	35% (23)	12% (8)	100% (66)
Young-old	18% (13)	54% (38)	28% (20)	100% (71)
Old-old	19% (12)	55% (36)	26% (17)	100% (65)
Total	30% (60)	48% (97)	22% (45)	100% (202)

Retrospective memory tasks

Recognition was measured as the proportion of correctly recognised words (out of a possible 18) in the recognition component of the Spot-the-Word Test. Free recall was measured as the proportion of correctly recalled words (out of possible three) in the recall component of Mini Mental State examination. The mean proportions of correctly recognised and recalled words are presented in Table 3. One-way ANOVAs on these means with age as an independent variable revealed significant effects of age both for recognition, $F(2, 220)=18.91$, $MSE=.01$, $p<.0001$, $\eta^2=.15$, and for free recall, $F(2, 220)=34.20$, $MSE=.01$, $p<.0001$, $\eta^2=.24$. Post hoc comparisons revealed identical patterns for recognition and recall: young participants recognised and recalled significantly more words than either young-old (*p*s<.0005) or old-old (*p*s<.0005) participants, while differences between the two old group were not significant ($p=.54$ and $p=.19$, respectively). These large age effects were not due to large participant numbers per age group (at least 72). Identical results were obtained when the analysis was repeated on participants in the activity, event-, and time-based conditions of the main experimental task with only 24 participants per age group.

TABLE 3. Mean scores on prospective and retrospective memory tasks as a function of age (young vs young-old vs old-old)

Memory tasks	Young	Young-old	Old-Old	Effect size (η^2)
RM - Recognition	.85 [a b] (.12)	.75 (.14)	.73 (.12)	.15
RM - Free Recall	.90 [a b] (.19)	.62 (.31)	.54 (.31)	.24
PM - Main experimental task				
Activity-based	.96 b (.20)	.85 b (.35)	.66 (.48)	.04
Event-based	.73 (.29)	.69 (.32)	.54 (.34)	.019
Time-based (strict scoring - 15 s)	.88 a b (.24)	.47 (.40)	.36 (.31)	.13
Time-based (lenient scoring - 60 s)	.92 b (.21)	.76 (.35)	.68 (.33)	.03
PM - Event-based colour	.68 b (.29)	.59 b (.37)	.37 (.40)	.12
PM - Event-based red pen	.92 b (.28)	.79 (.41)	.66 (.48)	.07

Results of post hoc comparisons between means of three age groups are denoted by subscripts a and b. Standard deviations in brackets.

[a]Reliably better than young-old. [b]Reliably better than old-old.

Prospective memory tasks

Main experimental task - typing in six numbers

This task was embedded within the general knowledge question answering task and varied in terms of type of prospective memory cue (event vs time vs activity). As pointed out in the Method section, old participants were better or equally as good as young participants at answering questions in the general knowledge task (see Table 1 for means).

Out of 223 participants, 121 remembered to type in numbers on all six occasions (50 young, 46 young-old, and 25 old-old), 75 remembered on some but not on all occasions (20 young, 24 young-old and 31 old-old), and 27 participants forgot on all six occasions (2 young, 9 young-old, and 16 old-old). Post-experimental probing of these participants revealed that there was only one 79-year-old participant (in the activity-based condition) who could not identify the prospective memory task even at the fourth most specific prompt involving recognition of the correct action. All other participants remembered about the task either at the first (2 young, 6 young-old, and 5 old-old), second (2 young-old and 2 old-old), third (1 young-old and 1 old-old), or the final fourth prompt (7 old-old).

Participants in the activity- and event-based conditions tended to respond to the target occasions immediately or not at all. Prospective memory performance in these conditions was measured as a proportion of these on-time responses (cf. Einstein & McDaniel, 1990; Einstein et al., 1995). In contrast, participants in the time-based condition were predominantly responding late rather than not at all (i.e., few responses were made at exactly 3-minute intervals). Performance in this task was therefore measured as a proportion of responses that occurred within 15 seconds of the target time.

The mean proportions of correct prospective memory responses (out of possible 6) are presented in Table 3 as a function of age group (young vs young-old vs old-old) and the type of prospective memory task (event- vs time- vs activity-based). These means were entered into a 3 (age) × 3 (task) between-participants ANOVA. This analysis revealed a significant main effect of task, $F(2, 214)=10.60$, $MSE=.112$, $p<.0001$, $\eta^2=.09$. Post hoc tests showed that performance in the activity-based condition ($M=.82$, $SD=.38$) was significantly better than in the event- ($M=.66$, $SD=.33$) and time-based ($M=.57$; $SD=.39$) conditions ($p=.007$ and $p<.0001$, respectively). Although performance in the event-based condition was numerically higher than in the time-based condition, this difference was not statistically significant ($p=.27$). There was also a reliable main effect of age, $F(2, 214)=18.17$, $MSE=.112$, $p<.0001$, $\eta^2=.145$. Post hoc tests showed that young participants were reliably better ($M=.86$, $SD=.26$) than young-old participants ($M=.67$, $SD=.38$) who were reliably better than old-old participants ($M=.52$, $SD=.40$) ($p=.003$ and $p=.016$). However, this main effect was qualified by a significant age by condition interaction $F(4, 214)=2.49$, $MSE=.112$, $p=.04$, $\eta^2=.04$.

Tests of simple main effects showed that age effects were significant in the activity-based, $F(2, 214)=4.87$, $MSE=.112$, $p=.009$, $\eta^2=.04$, and the time-based conditions, $F(2, 214)=16.14$, $MSE=.112$, $p<.0001$, $\eta^2=.13$, but not in the event-based condition, $F(2, 214)=2.12$, $MSE=.112$, $p=.12$, $\eta^2=.019$. Follow-up post hoc tests indicated that in the activity-based condition performance of young and young-old participants did not reliably differ from each other ($p=.24$) but young were reliably better than old-old participants ($p=.002$). Although young-old participants were numerically better (*M*=.85) than old-old participants (*M*=.66), this difference was marginally significant (p=.05). In contrast, in the time-based condition young participants were reliably better than both young-old and old-old participants (both *p*s<.0001) who did not differ from each other (p=.24).

However, it is important to note that the results of the above analysis were different when we adopted a more lenient scoring criteria for the time-based task, used by Einstein et al. (1995), by expanding the time window for correct responses up to 60 seconds from the target time. This substantially enhanced the time-based scores in all three age groups (*M*=.92, *M*=.76, and *M*=.68 in young, young-old. and old-old groups, respectively), and the age effect in time-based condition was substantially reduced, $F(2, 214)=3.38$, $MSE=.109$, $p=.036$, $\eta^2=.03$. Moreover, post hoc tests showed that performance of young and young-old participants was not reliably different (p=.12), but both groups were reliably better than old-old group (p<.0001 and p=.026, respectively).

Event-based colour task

In this task participants had to remember to write down the colour of the paper as soon as they noticed that a task they were carrying out was presented on a coloured sheet of paper. The performance score was the proportion of correct responses out of a possible three. Out of 223 participants, 62 remembered to perform this task on all three occasions (23 young, 25 young-old, 14 old-old), 107 participants remembered on one or two occasions (44 young, 39 young-old, 24 old-old), and 54 forgot on all three occasions (5 young, 15 young-old, and 34 old-old). Post-experimental probing of these participants revealed that only 12 participants recalled the task at the very first prompt (4 young-old and 8 old-old). The majority (78%) recalled the task on the successively specific prompts. While 32 participants (4 young, 9 young-old, and 19 old-old) recalled the task on the second and the third prompt, 10 participants (1 young, 2 young-old, and 7 old-old) needed the fourth most specific prompt to be able to recognise the correct action.

The mean proportions of correct prospective memory responses were .68 (*SD*=.29) in the young group, .59 (*SD*=.37) in the young-old group, and .37 (*SD*=.40) in the old-old group. These means were entered into a one-way between-participants ANOVA with age group as an independent variable. This analyses resulted in a significant main effect of age, $F(2, 220)=14.58$, $MSE=.126$, $p<.0001$, $\eta^2=.12$. Post hoc analysis showed that while young and young-old participants' scores did not reliably differ from each other (p=.27), they were both reliably higher than the scores of old-old participants (p<.0001 and p=.001, respectively).

Event-based red pen task

During the Mini-Mental-State-Examination (towards the end of the session) participants had to request a red pen to carry out the task of copying a geometric figure. Out of 223 participants, 173 remembered to request the red pen and were given a score of 1 (66 young, 61 young-old, and 46 old-old). The remaining 50 participants who forgot to do so were given a score of 0 (6 young, 18 young-old, and 26 old-old). Post-experimental probing of these 50 participants revealed that only 13 participants recalled the task at the very first prompt (3 young, 3 young-old, and 7 old-old). The majority (i.e., 31) recalled the task on the last most specific prompt, which involved the recognition of the to-be-performed action (3 young, 12 young-old, and 16 old-old). Four old participants (2 young-old and 2 old-old) were unable to even recognise the correct action. The data of these four participants were excluded from the analysis. Mean scores of young, young-old, and old-old participants were entered into a one-way ANOVA with age as an independent variable. This resulted in a significant main effect of age, $F(2, 216)=7.61$, $MSE=.16$, $p=.001$, $\eta^2=.07$. Post hoc comparisons showed that performance of young participants ($M=.92$, $SD=.28$) did not differ from that of young-old participants ($M=.79$, $SD=.41$) ($p=.14$) but was reliably better than old-old participants ($M=.66$, $SD=.48$) ($p<.0001$). The difference between young-old and old-old was not significant ($p=.10$).2

General Discussion

Research in prospective memory has grown enormously over the past decade and addresses a variety of important questions (see Einstein & McDaniel, 2005; Kliegel, McDaniel, & Einstein, 2008; McDaniel & Einstein, 2007). Investigating age effects on prospective remembering has been, and continues to be, a major focus of this research (Ellis & Kvavilashvili, 2000; Henry et al., 2004). Increased interest in this topic is understandable given that the ability of an ageing population to lead an independent life in the community depends crucially on their preserved prospective memory functioning. This research is also important theoretically as it can shed light on processes involved in prospective remembering (e.g., absence of age effects would be indicative of the involvement of predominantly automatic processes), and inform us about the relationship between prospective and retrospective memory (e.g., similar or different patterns of decline).

The major aim of the present study was to evaluate Craik's (1986) prediction about differential age effects on prospective and retrospective memory tasks, and to replicate some of the results of Henry et al.'s (2004) meta-analysis in a single study. This was achieved by comparing the onset of age decline in several retrospective and prospective memory tasks in three groups of participants: young, young-old, and old-old. On the whole, results replicated the main findings of the meta-analysis (outlined in the introduction) and in addition established different patterns of age decline in prospective and retrospective memory tasks. The latter finding underscores the importance of dividing older participants into at least two groups of younger and older adults (who are in their 60s and 70s) in prospective memory research.

Differential effects of age on prospective and retrospective memory

The first and most important finding was that, contrary to Craik's prediction (1986), effects of age on prospective memory were smaller than on retrospective memory. Thus, age effects in recognition and especially free recall tasks were fairly large, and explained 15% and 24% of variance in performance, respectively. These percentages are almost identical to those found in the Henry et al. (2004) meta-analysis (14% for recognition and 27% for free recall). By contrast, although reliable age effects occurred in all three laboratory tasks of prospective memory (the main experimental task of typing in six numbers, as well as event-based colour and red pen tasks), these were noticeably smaller than in the free recall task. The largest age effects were obtained in those prospective memory tasks that imposed relatively high demands on participants' processing resources, such as in the time-based condition of the main experimental task (but only when using a strict scoring criterion of a short, 15-second time window) and in the non-focal event-based colour tasks. However, even in these tasks age effects did not explain more than 13% and 12% variance in performance, respectively. In the Henry et al. (2004) meta-analysis the laboratory time-based and non-focal event-based tasks explained similar 15% and 16% of variance (see Table 2 of Henry et al., 2004).

Taken together, these findings extend the results of Henry et al.'s (2004) meta-analysis in several important ways. For example, according to Henry et al. (2004), one potential problem with interpreting the presence of larger age effects in free recall than in prospective memory tasks is that “the former are typically associated with list lengths that are substantially longer than those used in the latter” (p. 34). To counter this problem, in the present study we used the simplest possible free recall task with three items only, but still observed a large age effect, comparable to those obtained with multi-item lists. Importantly, this large age effect in free recall was not due to impaired cognitive functioning in older samples. Older adults scored significantly higher than young on the vocabulary test (Spot-the-Word Test), and the vast majority (i.e., 96%) scored 26 and above on the MMSE. In addition, the exclusion of six old participants who scored close to the cut off point of the MMSE (one participant scored 24 and five scored 25) did not change the pattern of results or the magnitude of age effects reported in Table 3.

Another novel finding concerns recognition memory. At first sight, the similar effect sizes obtained for recognition and prospective memory tasks (both in meta-analysis and in our study) might be interpreted as indicative of some similarities between these two forms of memory, given that event-based tasks may depend to some extent on noticing or recognising the event as an appropriate cue for action (e.g., Cherry et al., 2001; Einstein & McDaniel, 1996; McDaniel & Einstein, 2007; Reese & Cherry, 2002). However, our results concerning the onset of age decline in young-old and old-old participants show that this may not be the case. Post hoc comparisons revealed that a reliable age decline in recognition memory (and in free recall) was already present in the young-old group (61-70). In prospective memory tasks, however, the decline started mainly in the old-old group (71-80) (see Table 3).

In order to pinpoint the onset of decline more precisely, we further subdivided the groups of young-old and old-old into 5-year age bands of 61-65, 66-70, 71-75, and 76-80, with at least 36 participants in each subgroup. Post hoc tests with these five age groups showed that age decline for both recognition and free recall was present in the youngest age group of 61-65. By contrast, decline in prospective memory tasks was present only in the groups older than 61-65. Specifically, in the main experimental and event-based colour tasks it was present in the 71-75 group, and in the red pen task in the 66-70 group.

These findings are important for current research on ageing and prospective memory for the following reasons. First, they can explain the large variability in prospective memory scores that often exists within a group of older adults with a wide age range (typically 60 to 80 years and above) (e.g., Kidder, Park, Hertzog, & Morell, 1997; Park et al., 1997; Salthouse, Berish, & Siedlecki, 2004; West & Craik, 1999). Second, they can potentially explain some of the contradictory findings in the literature concerning the presence or absence of age effects in prospective memory. It appears that age effects can disappear, or be substantially reduced, in studies in which the older sample consists primarily of individuals in their 60s, and be more likely to emerge when the older sample is predominantly in their 70s and above.

The pattern of findings concerning the differential effects of age on prospective and retrospective memory tasks was further supported by the analysis of participants' most recent self-reported memory failure. While old participants were more likely to report retrospective memory failure (54.5%) than young adults (35%), the latter were more likely to report prospective memory failure (53%) than older adults (18.5%) (see Table 2).3 One possible explanation is that older adults have fewer prospective memory tasks to complete in everyday life and therefore they have less opportunity to experience prospective memory failures. However, the results of a study on participants' real-life intentions by Freeman and Ellis (2003) have shown that there were no age effects in the number of completed prospective memory tasks within a 1-week period. In fact, older people had a reliably higher proportion of intended and successfully completed tasks than young adults.

In conclusion, the results of the present study indicate that, in laboratory tasks, age effects are stronger and the decline starts earlier for retrospective than prospective memory. In addition, older adults reported experiencing more retrospective than prospective memory failures in their everyday life. These conclusions appear to contradict the results of a recent study by Zeintl et al. (2007) who compared performance of older adults (aged 65 to 80) in three prospective and three retrospective memory tasks. They found larger age effects for prospective than retrospective memory tasks. The discrepancy between our results and those of Zeintle et al. (2007) may stem from the fact that they did not have a group of younger adults in their study. Indeed, when we calculated correlations between the chronological age and prospective and retrospective memory scores in our older participants only (N=151), the obtained pattern was almost identical to that of Zeintl et al. (2007). Correlations between age and retrospective memory tasks were small and non-significant (r=-.14, p=.08; and r=-.14, p=.079 for recall and recognition, respectively), while correlations between age and prospective memory tasks ranged between-.20 and-.34 and were statistically significant. Taken together, results from Zeintl et al. (2007) and our study suggest that the decline in retrospective memory tasks starts in early 60s (possibly even earlier) with relatively little further decline in the 70s and early 80s, whereas decline in prospective memory tasks starts later but then continues at a more steady rate. Clearly, this is an interesting avenue for future research.

Performance on prospective memory tasks

An additional set of findings concerns the variable performance levels on different laboratory prospective memory tasks, as well as differential age effects on these tasks. Results from the main experimental task showed that performance in the activity-based condition was better than in both event- and time-based conditions (given strict scoring criterion for the time-based task). This might be due to the less demanding nature of this task as participants did not need to interrupt an ongoing activity to type in the numbers (see Kvavilashvili & Ellis, 1996). It should be noted that Kvavilashvili et al. (2001) observed negative effects of interruption in young children even in an event-based task. Thus, the findings indicate that a more systematic examination of the effects of task interruption on prospective memory may help us to have a better insight into similarities and differences between the event-, time-, and activity-based tasks.

Another interesting finding was that performance in the time-based condition varied greatly depending on the scoring criterion adopted. When we used a relatively strict criterion of counting a response as correct if it occurred within 15 seconds of the critical time, performance was worst in the time-based condition for both groups of older adults, and the effect of age explained 13% of the variance in performance (see Table 3). However, when we adopted a more lenient 60-second time window for scoring correct responses, the performance in the older groups substantially improved and the size of the age effect was markedly diminished, and comparable to that found for event- and activity-based conditions. Given that different studies have used a very wide range of time windows from few seconds (e.g., Maylor et al., 2002; Park et al., 1997) to 90 seconds (Martin & Schumann-Hengsteler, 2001), it is obvious that performance levels will vary across the studies, which may partly contribute to contradictory findings in the literature about the differential effects for age on time-based prospective memory.

It is important to point out that performance levels in three event-based tasks also varied substantially, with performance being highest in the red pen task (M=.77), lowest in the colour task (M=.55) and intermediate in the main (event-based) telephone task (M=.65). This pattern seems to be in line with the multi-process theory of McDaniel and Einstein (2007), which would predict that performance in the non-focal colour task should be worse than in the red pen and telephone tasks, since both are focal event-based tasks. However, in the telephone task, the target word "telephone" was a familiar and less distinctive word in the context of answering general knowledge questions,4 whereas the target event in the red pen task (the words "please copy this geometric figure") was relatively unfamiliar and distinctive in the context of other predominantly verbal sub-items of Mini Mental State Examination. Previous findings on the positive effects of unfamiliar distinctive targets on prospective memory (Brandimonte & Passolunghi, 1994; McDaniel & Einstein, 1993) would suggest that performance in the red pen task should be superior to the telephone task. These predictions were indeed supported by the results of an additional analysis of variance on those participants who were in the event-based condition of the main prospective memory task (24 young, 28 young-old, and 24 old-old).

This large variability in event-based scores as a function of target event characteristics can at least partly account for the contradictory findings in the literature concerning variable effects of age on event-based prospective memory (cf. Cherry et al., 2001; McDaniel & Einstein, 2007). It is interesting, however, that a reliable age effect was obtained in the red pen task, even though it was a focal task with a distinctive cue. As noted in the introduction, this could be due to the fact that the red pen task (as well as the colour task) is different from the typical laboratory tasks in two respects: they both have longer and/or irregular delay intervals and the target event(s) does not occur within one single ongoing activity. It is also noteworthy that the majority of older adults (32 out of 44) who forgot the red pen task also had difficulties remembering prospective memory instructions. Thus, 64% remembered the task at the fourth most specific prompt involving the recognition of the correct action and a further 9% (two young-old and two old-old) could not event recognise the correct action. Similar difficulties (albeit to a lesser degree) were encountered with remembering the task instructions for the colour task (see Results section). There is now a growing number of studies indicating that age decrements in prospective memory can be at least partly explained by the increased difficulty older adults have in remembering the retrospective component of prospective memory instructions (e.g., Cherry et al., 2001; Mäntylä & Nilsson, 1997; Salthouse et al., 2004).

Methodological considerations

A couple of methodological points need to be considered in the light of the present findings. First, it can be argued that by equating the difficulty of the ongoing question-answering task we artificially reduced the size of age effects in the main experimental prospective memory task. However, in order to properly assess age effects on prospective memory it is necessary to ensure that both age groups have equal amounts of attentional resources available for the execution of prospective memory tasks. Due to cognitive slowing, older adults needed more time to read the questions/type in their responses. If they had not been given the extra 3 seconds they would have had fewer processing resources available for the prospective memory tasks than young adults. This would give an unfair advantage to the younger group.[5] Moreover, age effects in those prospective memory tasks (colour and red pen tasks) in which no equating of ongoing task difficulty took place were still smaller than in the simple (retrospective) free recall task.

The second methodological issue concerns ceiling effects in the young sample for some of the memory tasks (e.g., both the retrospective memory tasks, as well as the activity-based, time-based, and red pen prospective memory tasks). Ceiling effects are known to reduce the size of age effects **(**e.g., Uttl, 2005**)**. While this criticism may apply to the activity-based, time-based, and red pen tasks, it does not apply to the two event-based tasks—the telephone and the colour tasks. Performance on these tasks was not near ceiling, but there was still no age effect in the former, and in the latter the age effect explained 13% of variance. Although this is a medium to large effect, it is still smaller than the age effect in the free recall task (24%). Moreover, since the ceiling effect was present in the free recall task as well, the age effect on free recall task would probably have been even larger if we had used a longer word list to avoid ceiling effects.

Conclusions and future directions

Results of the present study have both practical and theoretical implications, and raise key questions for future research. The results strongly suggest that the collapsing of old participants of various ages into one single group can mask interesting and important age effects on prospective memory. It is of little help to a layperson, who is 60 and concerned about his or her current or near-future prospective memory, to be informed of the results of the study in which older sample comprises individuals aged 60 to 80 and above. What is urgently needed from both practical and theoretical perspectives is to be able to determine the onset of age decline in different types of prospective memory tasks. Most importantly, future research will need to compare the onset of decline in prospective and retrospective memory tasks in a more systematic fashion by including a wider range of retrospective memory tasks such as cued recall, story recall, and implicit memory (perhaps even autobiographical memories), to get a better understanding of differential effects of age on prospective and retrospective memory.

Findings from our study, comparing age effects in several prospective memory tasks with a restricted number of retrospective memory tasks, suggest the involvement of different retrieval mechanisms in these two types of memory tasks (see also Zeintl et al., 2007). One possibility is that prospective and retrospective memory draw on different memory structures. Our results concerning the differential onset of age decline in these tasks seem to support this idea. Converging evidence has also been obtained in several other studies that identified separate factors for prospective and retrospective memory tasks using exploratory factor analysis (Maylor et al., 2002; Uttl et al., 2001), or examined the construct validity of event-based prospective memory tasks (Salthouse et al., 2004).

Another possibility is that prospective and retrospective memory tasks differ mainly in terms of the amount of automaticity involved in retrieval. The relatively small age effects on prospective memory obtained in the present study provide some support for the idea that the retrieval of prospective memory tasks is, to some degree, an automatic process. Thus, in terms of automaticity one can regard memory tasks as lying on a continuum, with the implicit memory tasks at the one end of the continuum representing mostly automatic processes (with small or no age effects), and the free recall tasks at the other end representing mostly strategic/controlled processes (with large age effects). Prospective memory tasks appear to occupy an intermediate position, in that they seem to be largely automatic, but at the same time also contain some controlled strategic processes (hence the small to medium size age effects in some tasks). This conflicts with Craik's (1986) functional model of ageing and memory, which places prospective memory at the strategic/controlled end of the continuum, but is in line with the multi-process theory of prospective memory which stipulates that, depending on circumstances, prospective memory can be subserved by both automatic and controlled processes (see McDaniel & Einstein, 2007). Hence, when examining the effects of age, future research will need to carefully specify the resource demands and other components of both prospective and retrospective memory tasks as well as the age composition of older populations.

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Notes

[1]Kvavilashvili and Ellis (1996) have also distinguished activity-based tasks that involve remembering to do something before or after finishing a certain activity, for example, taking a pill after the breakfast (see also Harris, 1984). Because these tasks do not involve the interruption of ongoing activity, as something is to be done during the “gap” between the two consecutive activities, Kvavilashvili and Ellis (1996) have suggested that activity-based tasks may be easier to remember than event- and time-based tasks both of which usually require the interruption of ongoing activity.

[2]Since the variable for remembering the red pen was binary, a more sensitive logistic regression analysis was also conducted. As with ANOVA, there was a significant main effect of age group $\chi^2(2)=15.1$, $p=.002$, with a modest effect size (Nagelkerke $r^2=.10$). However, post hoc comparisons resulted in a significant difference between young and young-old, $\chi^2(1)=12.5$, $p=.0004$, and marginally significant difference between young-old and old-old, $\chi^2(1)=3.3$, $p=.068$.

[3]A similar pattern has also been obtained with the Everyday Memory Questionnaire by Martin (1986) as older adults scored better on prospective memory items (keeping appointments, paying bills, and taking medications), and younger adults on retrospective items (remembering names, telephone numbers, and sports results). However, other questionnaire studies (see e.g., Dobbs & Rule, 1987; Smith, Della Sala, Logie & Maylor, 2000) did not obtain any differences between prospective and retrospective items as a function of age. This could be due to problems that older adults may have when trying to retrospectively evaluate the frequency of different types of memory failures experienced in everyday life. In this respect, asking participants to recall their most recent failure can substantially reduce demands on retrospective memory and produce more valid results.

[4]For example, “What is the telephone number for Directory Enquiries?” Answers: 999, 192, 129, 555, or “What is the lowest value coin used in public telephones?”: 1p, 2p, 5p, 10p.

[5]A question about available processing resources is not properly solved even when young and old participants have similar performance levels on the ongoing activity. This is because older adults may need to put more effort (available attentional resources) into ongoing tasks than young to maintain similar levels of performance (cf. Kvavilashvili & Fisher, 2007).