The Effect of Perceptual Distinctiveness on the Prospective and Retrospective Components of Prospective Memory in Young and Old Adults

Anna-Lisa Cohen, Roger A. Dixon, D. Stephen Lindsay, and Michael E. J. Masson
University of Victoria

Abstract In two experiments, the effect of perceptual distinctiveness of cues on prospective memory performance was examined. Young and older adults completed a visual search task with embedded prospective memory instructions. On each trial, participants were asked to indicate the position of a target letter in a letter string, unless either of two letters previously identified as prospective memory cues was presented. Each prospective cue was associated with a specific response. Perceptual distinctiveness was manipulated by spatially displacing a single letter. The prospective component (successful detection of the cue) and the retrospective memory component (recalling the correct response when a cue is detected) were measured separately. Perceptual displacement of cues modulated performance of the prospective component but not the retrospective component. Young adults successfully detected a larger proportion of cues (prospective component) than older adults. However, there were minimal effects of age and no effect of cue displacement on participants' ability to recall the intention once they detected a cue (retrospective component performance). Results are discussed within the context of current theoretical models of prospective memory.

Remembering to carry out a previously formed intention is termed "prospective memory." This type of memory underlies important everyday activities such as remembering to take medication, make a phone call, keep an appointment, or mail a letter (Einstein, McDaniel, Richardson, & Guynn, 1995; Hertzog, Park, Morrell, & Martin, 2000; Park, Morrell, & Shifren, 1999). Successful prospective memory performance is thought to involve two components: remembering at an appropriate moment that one must do something, and recalling what is to be done (Einstein, Holland, McDaniel, & Guynn 1992). The former is called the prospective component, whereas the latter is referred to as the retrospective component. For example, if a person has to remember to give a friend a message, successful prospective memory requires that the appearance of the friend trigger the memory that a message has to be given (prospective component). Successful prospective memory also requires that the person remember the content of the message (retrospective component).

Results pertaining to adult age differences in prospective memory performance are conflicting, with some studies reporting no deficits for older adults (e.g., Einstein & McDaniel, 1990; Einstein et al., 1992) and others observing significant age-related differences (e.g., Einstein, McDaniel, Smith, & Shaw, 1998; Maylor, 1993, 1996a, 1998; West & Craik, 1999). These discrepant results must be qualified by at least two observations. First, older adults tend to show superior prospective remembering relative to younger adults in naturalistic contexts with little experimental control (Moscovitch, 1982). This may be due to older adults' tendency to use everyday external memory aids such as notes (Dixon, de Frias, & Bäckman, 2001). In contrast, older adults typically exhibit prospective memory deficits within laboratory contexts in which memory supports such as reminder notes are not permitted (e.g., Rendell & Thomson, 1999). Second, specific task characteristics also modulate age differences (Craik & Kerr, 1996). For example, tasks that require an individual to remember to perform an action in future circumstances that contain no prompts or cues and that involve an unrelated (and attention demanding) ongoing activity are associated with age-related deficits (D'Ydewalle, Luwel, & Brunfaut, 1999). It is well known that disengaging from demanding concurrent activities presents special challenges to older adults (Maylor, 1996b).

In a study by Maylor (1998), young, middle-aged, and older adults were tested on their sensitivity to a prospective memory cue. Participants completed an event-based prospective memory task embedded in a task in which they were instructed to identify the names of famous faces. The prospective memory task required them to mark the trial number of any of the faces wearing glasses. Results showed that performance declined across age groups (*M*s = .77, .62, .26), with the older adults correctly identifying only 26% of the prospective memory cues. Based on self-reports from participants, Maylor claimed that older adults appeared to think less frequently of the prospective memory instructions relative to other age groups.

Several cue properties known to affect level of recall in retrospective memory also have an impact on prospective memory performance. These properties include complexity, salience, and relatedness (Mäntylä, 1996). Because prospective memory tasks are typically embedded in some attention-demanding ongoing cognitive activity, it is likely that the perceptual salience of a prospective memory cue would influence prospective memory performance. The more perceptually salient the target-cue relative to the array of other stimuli, the more likely the successful recognition of that cue. In line with this idea, several researchers have investigated the distinctiveness of prospective memory cues and their effect on performance. For example, Uttl and Graf (2000) showed that increasing the size of target pictures resulted in better detection of the cue. Several researchers have shown that presenting a cue word in upper-case letters relative to the majority of lower-case words results in superior prospective memory performance (Einstein, McDaniel, Manzi, Vochran, & Baker, 2000; West, Herndon, & Crewdson, 2000). An explanation for this phenomenon offered by McDaniel and Einstein (2000) is that cues that are distinctive, relative to existing knowledge or to the current context, result in the involuntary capture of attention. Thus, cue distinctiveness can operate to switch attention from an ongoing task to the prospective cue and it can function to re-instantiate context and provide a frame of reference for retrieving the associated intention (McDaniel & Einstein, 2000).

A general conclusion from these studies is that perceptually distinctive prospective memory cues facilitate prospective memory performance. However, two remaining questions should be addressed. First, do such cues affect performance on the prospective component and retrospective components equivalently? Second, do such cues affect performance similarly for young and older adults? Given that older adults may think about prospective memory instructions less often than younger adults (Maylor, 1998), older adults' prospective memory performance may be less likely to be affected by a perceptual salience manipulation. Ellis (1996) also suggests that prospective failures are associated with a low frequency of recollections of that intention during retention intervals. Therefore, failures in prospective memory are thought to occur due to an inability to maintain an intention throughout the retention interval of the task. In line with this idea, it may be that the activation level of the representation of an intention in consciousness may determine how receptive older adults will be to perceptual distinctiveness manipulations. That is, if the representation of an intention has sank below consciousness to such an extent that participants are unresponsive to even powerfully perceptually salient events, one would expect little impact of perceptual distinctiveness. Alternatively, it may be that people who tend to monitor less often should be more affected by a manipulation that orients attention and focal processing to the target item if the representation of an intention is at a level that is accessible when the cue is presented. For example, in an investigation of recognition memory, Parkin et al. (2001) examined the effect of varying the perceptual relationship between targets and distractors. Results of their study revealed that older adults were more negatively affected by the degree of perceptual similarity between targets and distractors. However, when target and distractor stimuli were made distinct from each other and did not overlap, older adults' performance improved, showing that they benefited from the perceptual distinctiveness. This result was interpreted as consistent with the notion that aging produces a recognition memory impairment that is characterized by greater reliance on the perceptual characteristics of stimuli.

Relatively few studies have separately examined the prospective and retrospective components of prospective memory. Therefore, cue detection processes are often confounded by memory retrieval processes because most studies tend to only look at a single accuracy measure. Recently, however, Cohen, West, and Craik (2001) studied two issues: a) whether adult age differences were greater for the prospective or the retrospective component of prospective memory and b) whether data-driven and conceptually driven processes differentially influenced these two components. Data-driven processes are those that depend on information that is perceptual in nature (e.g., the colour of a word) and conceptually driven processes are those that recruit the semantic meaning of a stimulus to aid in responding (e.g., the definition of a word).

In the Cohen et al. (2001) study, the influence of data-driven processes was varied by maintaining or changing the format of the prospective cue from study to test. Thus, young and older adults were given a cue for an intention in either a picture or a word form. The influence of conceptually driven processes was manipulated by varying the degree of semantic relatedness between the prospective cue and the intention. That is, the cue was either related or unrelated to the intention. For example, given the intention "I must go to the doctor," a related cue might be an ambulance and an unrelated cue might be a hot air balloon. Results showed that there was a greater effect of age (young more accurate than older adults) for the prospective component than for the retrospective component even when the retrospective demands of the task were high. Furthermore, the results of Experiment 2 revealed that data-driven and conceptually driven processes differentially influenced the prospective and retrospective components of prospective memory. Specifically, the manipulation of semantic relatedness (thought to influence the contribution of conceptually driven processes) had the greatest effect on the efficiency of the retrospective component. In contrast, the manipulation of study-test format (thought to influence data-driven processes) had the greatest impact on the efficiency of the prospective component. Therefore, results showed that a data-driven processing manipulation affected prospective component performance to a greater extent.

These results are informative but it is useful to consider an experimental perceptual manipulation of cues that is more relevant to prospective memory in everyday life. Such a manipulation involves the perceptual distinctiveness of prospective memory cues. One can imagine numerous everyday examples in which perceptual distinctiveness of cues may affect prospective memory performance. For instance, in the morning a person may encode an intention to go to the store on the way home from work to buy milk with the prospective memory cue being the grocery store sign. Later in the afternoon on the drive home from work, how distinctive the store's sign is relative to other stimuli may modulate successful detection of the cue. Arguably, the degree of effort in detecting the cue will vary according to the level of support in terms of cueing conditions and, specifically, performance may vary according to how perceptually distinctive the cue is in capturing attention. Therefore, the memory that something needs to be done (prospective component) may be remembered upon encountering a distinctive cue; however, the exact content or retrospective component of that intention (e.g., what one was supposed to buy) may not necessarily be benefited to the same degree by the perceptual distinctiveness of that cue. In the current experiments, we explore this issue.

Experiment 1

The purpose of Experiment 1 was to examine adult age differences in sensitivity to a perceptual salience manipulation in a prospective memory paradigm. Participants were asked to complete a visual search task in which two prespecified cues served as reminders to carry out a prospective memory intention. These cues varied systematically in their perceptual salience relative to the primary task in which it was embedded. Both the prospective component (realization that a response should be made) and the retrospective components (recalling the correct response when a prospective cue is recognized) were measured separately. Therefore, Experiment 1 was designed to examine whether the perceptual manipulation differentially affected both prospective and retrospective components of prospective memory equivalently for young and older adults. We predicted that the manipulation of perceptual distinctiveness would modulate performance on the prospective component but not the retrospective component.

Method

Participants. Thirty young adults ranging in age from 17 to 36 years old (M = 19.87 years, SE = .55) and 30 older adults ranging in age from 57 to 78 years old (M = 71.67 years, SE = .77) were tested. Although the sample was well-educated, a one-way analysis of variance (ANOVA) revealed that 57 to 78-year-old adults (M = 14.08 years, SE = .43) had significantly more years of education compared to 17 to 36-year-old adults (M = 13.10 years, SE = .26), $F(1, 58) = 3.86$, $p < .05$. Self-reported health was measured using a Likert scale. Participants were asked to reflect on their health in the last month and then rate themselves on a 5-point scale (1 = very good, 2 = good, 3 = fair, 4 = poor, 5 = very poor). There was no significant difference between the 17- to 36-year-old (M = 1.63, SE = .12) and 57- to 78-year-old (M = 1.80, SE = .17) adults' self-reported health (p = .43). The younger adults were recruited from an undergraduate psychology course and they received optional extra credit for their participation in the experiment. The older adults were recruited from a volunteer pool maintained by the University of Victoria. These community-dwelling participants were reimbursed for their travel expenses (e.g., bus fare, parking).

Design and apparatus. The design was a 2 (Age: 17 to 36 years, 57 to 78 years) x 3 (Perceptual Displacement: prospective memory cue displaced, none displaced, target displaced) mixed factorial design with age as the between-subject variable and perceptual displacement as the within-subject variable. For the primary visual search task, the dependent variable was the proportion of correct responses. For the prospective memory task, the dependent variables were the proportions of correct responses on the prospective component and on the retrospective component. Participants were tested on an IBM-compatible personal computer using Schneider's Micro-Experimental Laboratory Professional software package (Schneider, 1988). Letters from the alphabet served as the stimuli in this task. Letters were presented in upper case, white Arial font on a black background. All of the letters from the alphabet were randomly selected and used for the letter strings, with the constraint that letter strings not spell words. The character size of the stimuli was approximately 10 x 14 mm. This size was suitable for all levels of visual acuity. The letters were always presented centred in the middle of the screen. The stimuli subtended 1.29 degrees vertically at a distance of 62 cm.

Procedure

The experimenter first obtained informed consent from participants, who were tested individually. A brief biographical questionnaire was administered to obtain basic demographic information. The study was described to participants by the experimenter and participants were asked to read instructions on the computer screen outlining the requirements of the study (see Appendix). After reading the instructions, participants repeated back to the experimenter what they had read. The experimenter clarified any ambiguities until the participant showed full understanding. Finally, participants were given a short training phase that consisted of 10 practice trials (with two trials being prospective memory trials) to ensure that the instructions for the primary task and the embedded prospective memory task were clearly understood.

Visual search task. The primary task was a visual search task in which participants were asked to identify the serial position of a target letter. Participants were told that on each trial they would see a single target letter appear on the computer screen. They were instructed to say aloud and remember this letter because it would appear in a subsequent string of six letters. The purpose of saying the letter aloud was to ensure that the participant visually and orally processed each letter, thus controlling for possible lapses in attention. After the letter was read aloud, the experimenter pushed the space bar and the target was replaced by a six-letter string. Letter strings were presented serially from left to right with each letter's presentation separated by 300 ms. As each letter appeared it stayed on the screen until the letter string was complete; at this point, participants could make their response. The letter string remained visible until participants made their response, which advanced the study to the subsequent trial. They were instructed to press the number key on the numeric keypad that corresponded to the position of the target letter. Target letters appeared in either the first, second, third, fourth, or fifth positions an equal number of times. For example, if the target letter was "E" and it appeared in the fourth position from the left, then the participant was to press the number "4" on the numeric keypad. Participants were told that there would be a target present in the letter string in every trial. Instructions emphasized that the visual search task should be performed as quickly and accurately as possible.

On a portion of the trials, one letter in the letter string was spatially displaced one line below the remainder of the string. Displacement of letters was varied systematically in both position in the string and position of the displaced trials within the total number of trials. There were 112 trials in total (excluding the 10 practice trials). There were three types of trials in the visual search task: a) *none-displaced trial*: on 80 trials there were no letters displaced, b) *target-displaced trial*: on 10 trials the target letter was displaced, and c) *distractor-displaced trial*: on 10 trials one of the distractors was displaced. (The 12 remaining trials were prospective memory trials that are described in the following section.) Therefore, on the majority of trials there was no letter displaced. These proportions were selected purposefully so that a displaced letter was an uncommon event.

Prospective memory task. The prospective memory task was embedded within the visual search task described above. The prospective memory cues occurred in 12 trials out of the total 112 trials. During the instruction phase, participants were told that if at any point during the experiment they saw the letter "B" they should press the number "9" and if they saw the letter "D" they should press the number "7." These specific numbers were chosen with two criteria in mind: a) the numbers do not conflict with the primary task responses (1-6) and b) the earlier number "7" is paired with the later letter "D" and the later number "9" is paired with the earlier letter "B." This last criterion was used to increase the difficulty of remembering the correct response after viewing a "B" or "D." Participants were told that these cues might or might not occur throughout the duration of the study, to discourage them from excessive monitoring on every trial. Participants were instructed to tell the experimenter verbally every time they recognized a prospective cue (as well as manually push "7" or "9"). They were not given a specific phrase but were told that they should say something like, "there is one of those

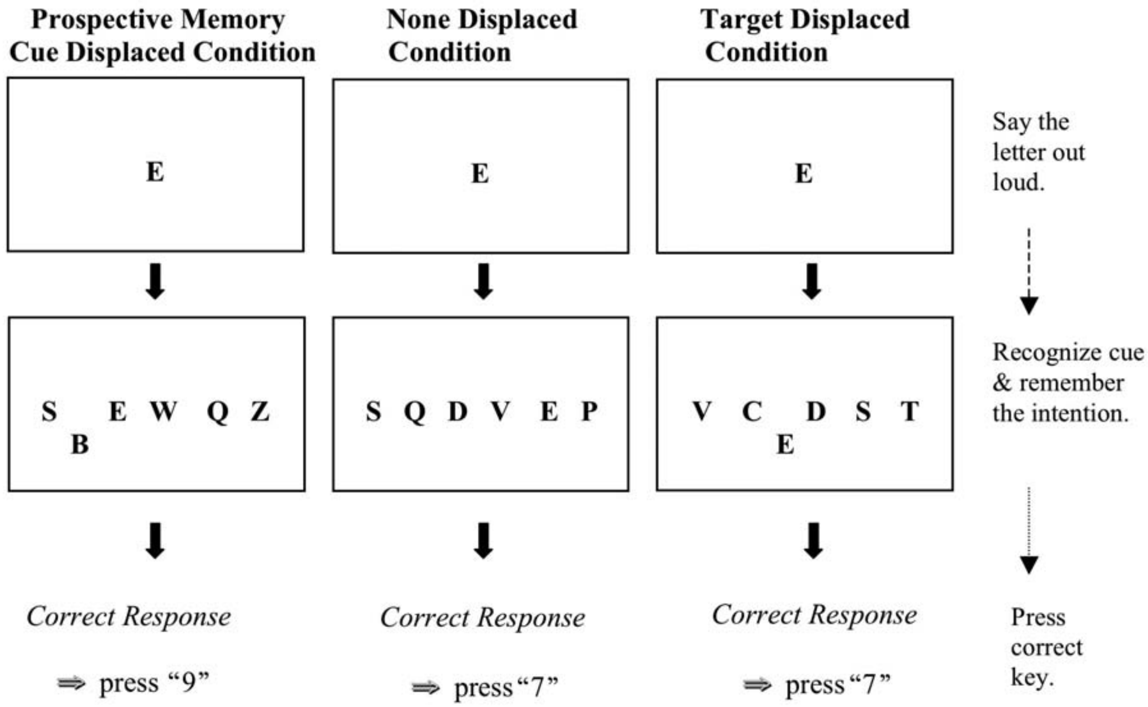

Figure 1. Schemata of stimuli from the three cue conditions: (a) none-displaced condition (b) prospective memory cue-displaced condition, (c) target-displaced condition. (This figure is for illustrative purposes – actual stimuli were much larger.)

special letters," if they detected either a B or D letter, in addition to pressing the correct cue. We constructed our instructions in this way to ensure that each successfully recognized prospective cue was scored by the experimenter even if the participant forgot the correct response associated with it. Thus, much like real life, when participants recognized a prospective cue they had to disengage from the primary task of identifying the target letter to perform the intention of pressing the "7" or "9" key. The prospective cues never occurred in the first or sixth positions of the letter string. On half of the prospective memory trials, the prospective cue was before the target cue, whereas on the remaining half of the trials the prospective cue was after the target cue. Three cue conditions were used.

Participants were told that making a prospective memory response precluded the need to make the serial position response. Therefore, subjects were asked to make their prospective memory response as soon as they detected the PM cue and not respond to the primary task. During practice trials, participants had two opportunities to execute a prospective memory response so that there was no confusion once the experiment began.

The *prospective memory cue-displaced condition* consisted of four trials. In this condition, the prospective memory cue (B or D) was spatially displaced relative to the other letters in the letter string. Therefore, the target cue from the primary task (visual search task) appeared within the letter string whereas the prospective memory cues appeared in the displaced position. In the *none-displaced condition*, there were four trials in which target cues from the visual search task and the prospective memory task appeared within the letter string, with none of the letters in the string displaced. Therefore, the relationship between the target cue and the prospective cue was neutral. Finally, in the *target-displaced condition*, there were four trials in which the target cues from the visual search task were in the displaced position and the prospective memory cues appeared within the letter string. Thus, the prospective cues (B or D) were less perceptually distinctive than the target cues. These cue conditions are represented in Figure 1.

Scoring. Responses were scored using two criteria designed to reflect memory for the prospective and retrospective components of prospective remembering. The prospective component was scored as the proportion of times that an individual correctly identified a letter as a prospective memory cue, regardless of whether he or she recalled the associated intention.

For example, if the participant incorrectly pressed "7" for the "B," they received credit for detecting the letter as a prospective cue (prospective component) but they did not receive credit for remembering the correct response (retrospective component). As noted above, participants were instructed to tell the experimenter verbally and to push "7" or "9" whenever they detected a prospective memory cue. Therefore, in the case that participants pressed a wrong key (e.g., other than 7 or 9) when they detected a prospective memory cue, their response could still be coded as correct on the prospective component because they would have responded verbally to the experimenter. The retrospective component was scored as the proportion of detected prospective cues to which the participant also correctly recalled the intention. Thus, if the participant correctly detected the cue as a prospective cue and executed the correct response, they received credit for the prospective and retrospective components of prospective memory. For example, if a participant correctly identified 3 out of the 4 prospective cues in a given condition, and also recalled the associated intention to 2 out of the 3 identified cues, the participant received a score of (.75 or 3/4) for the prospective component, and a score of (.67 or 2/3) for the retrospective component.

The means for the retrospective component were conditionalized upon participants' performance on the prospective component. That is, when a participant failed to detect a prospective cue, we were unable to probe the person's memory for the associated intention because this would result in reminding them that they had forgotten the prospective memory cue, which would contaminate performance on subsequent prospective memory trials. Therefore, retrospective component performance was measured only for trials in which participants successfully detected a prospective cue.

Results and Discussion

Visual search task. Performance was evaluated using a 2 (Age: 17 to 36 years, 57 to 78 years) x 3 (Perceptual Displacement: none-displaced, target-displaced, distractor-displaced) analysis of variance (ANOVA) with repeated measures on the second factor. The dependent variable was the proportion of target letters that were evaluated correctly with respect to serial position on trials on which there was no prospective cue. Accuracy was extremely high on this task (e.g., 17- to 36-year-old adults' overall mean = .97, 57- to 78-year-old adults' overall mean = .96). No main effects or interactions were observed (all *F*s < 1). Performance was at ceiling on the primary task in which the prospective memory task was embedded, so there were no significant differences between 17- to 36-year-old and 57- to 78-year-old adults' performance (see Figure 1).

TABLE 1
Mean Proportion of Correct Identifications of Targets in Serial Position in Experiment 1 by Age Group

	M	*SE*
17- to 36-year-olds		
None Displaced	.99	(.003)
Target Displaced	.97	(.001)
Distractor Displaced	.97	(.001)
57- to 78-year-olds		
None Displaced	.97	(.012)
Target Displaced	.97	(.016)
Distractor Displaced	.95	(.020)

Prospective memory task. The effects of perceptual displacement and age on the prospective component of prospective remembering were evaluated in a 2 (Age: 17 to 36 years, 57 to 78 years) x 3 (Perceptual Displacement: none-displaced, target-displaced, prospective memory cue-displaced) mixed factorial ANOVA with repeated measures on the second factor. Analyses revealed a main effect of age, $F(1, 58) = 7.99$, $p < .05$, $\eta^2 = .12$, indicating that 17- to 36-year-old adults ($M = .78$, $SE = .04$) detected significantly more prospective memory cues than 57- to 78-year-old adults ($M = .55$, $SE = .07$). The age effect on prospective component performance may be understood by examining participants' performance on the primary task. It is plausible that the older adults may have devoted more resources to performing the visual search task accurately in which performance was at ceiling, reducing the probability of disengaging from the primary task and successfully identifying the prospective memory cues. It is well known that an inherent challenge of prospective memory tasks is the need to disengage attention from the ongoing task to execute successfully the planned intention (Maylor, 1996b).

Although there was no main effect of perceptual displacement, this factor was involved in a marginally significant interaction with age, $F(2, 57) = 2.72$, $p = .07$, $\eta^2 = .09$. Multiple comparisons analysis showed that there was a significant difference ($p = .043$) between none-displaced ($M = .83$) and target-displaced ($M = .71$) conditions for 17- to 36-year-old adults and a marginally significant difference ($p = .086$) between target-displaced and prospective memory cue-displaced ($M = .80$) conditions. However, there were no significant differences between these cue conditions for the 57- to 78-year-old adults. That is, results showed that the

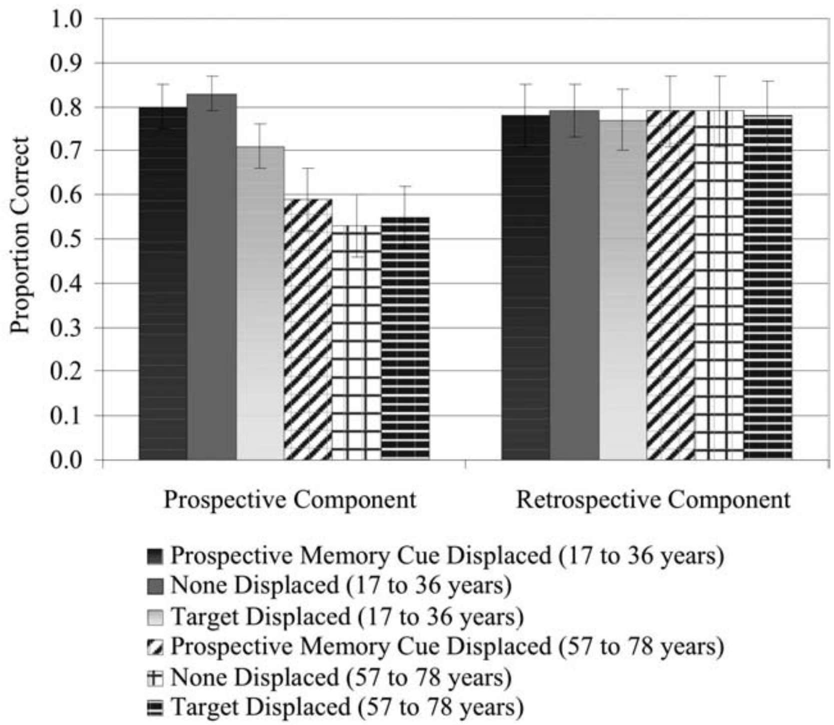

Figure 2. Mean accuracy for responding on the prospective and retrospective component of prospective memory in Experiment 1 as a function of cue type for young and old adults. Error bars show the 95% within-subjects confidence intervals (Loftus & Masson, 1994).

younger adults' performance varied as a result of the perceptual salience manipulation to a larger extent than the older adults. Therefore, when the target from the ongoing cover task was displaced (target-displaced condition), there was no significant difference between 17- to 36-year-old adults' and 57- to 78-year-old adults' performance (p = .12); however, there was a significant age difference for none-displaced (p = .001) and prospective memory cue-displaced (p = .03) conditions. Although the interaction between Age and Perceptual Displacement was only marginally significant, it suggests a trend in which the 17- to 36-year-old adults were more affected by the perceptual distinctiveness manipulation than the 57- to 78-year-old adults (see Figure 2). Therefore, it appears that for both age groups performance was poorest in the target-displaced condition (although more so for the younger adults relative to the other conditions). If the main cover task requires one to detect a target letter and in some conditions it is displaced, it may be more difficult for participants to successfully notice the prospective memory cue because the displaced target from the cover task competes with this goal. Thus, it appears that displacing the cover task target had a greater negative effect on prospective remembering for the 17- to 36-year-old adults than for the older age group.

The influence of perceptual displacement and age on the retrospective component of prospective remembering was considered in a similar analysis. Because a cue must be detected before the retrospective component can be evaluated, older adults who missed every prospective memory cue (n = 4) were dropped from the analysis of the retrospective component. As Figure 2 shows, there was virtually no difference between means for 17- to 36-year-old adults (M = .78, SE = .05) and 57- to 78-year-old adults (M = .79, SE = .06). That is, when participants successfully detected the cue, there was little difference between age groups in their ability to recall the associated intention. No main effects or interactions involving the perceptual manipulation were observed. A power analysis was conducted to determine whether there was sufficient power to detect a medium-to-large effect size for the main effect of perceptual displacement on retrospective component performance. A medium effect size (f^2 = .24) was used in this analysis because this effect size was obtained in Experiment 2 for the main effect of perceptual displacement on the prospective component and it corresponds to the 15% difference found for that effect. The power analysis revealed that the power to obtain a medium effect size for retrospective component performance with an alpha level of .05 was .92 (Buchner, Erdfelder, & Faul, 1997). To demonstrate that perceptual salience has little effect on the retrospective component, an additional power analysis was conducted using a small effect size. Using a smaller estimate of effect (f^2 = .11) based on differences of around 5-10%, the power to detect a significant effect was .65, indicating decent power to detect even a small effect.

As described in the Method section, prospective cues appeared half of the time before the target cue from the ongoing primary task and half of the time they appeared after the target cue. We conducted an analysis to examine whether the order of the cue relative to the target affected performance. A 2 (Age: 17 to 36 years, 57 to 78 years) x 2 (Order: before, after) x 3 (Perceptual Displacement: none-displaced, prospective memory cue-displaced, target-displaced) mixed factorial analysis of variance (ANOVA) was conducted with repeated measures on the second and third factor. There was no main effect of Order nor did this factor interact with any other factors (all Fs < 1). See Table 2 for inspection of means.

TABLE 2
Mean Number of Prospective Memory Cues and Standard Errors in Experiment 1 When the Prospective Memory Cue Occurred Before or After the Serial Position Task Target

	Before		After	
	M	*SE*	*M*	*SE*
17- to 36-year-olds				
Prospective Cue Displaced	1.49	(.12)	1.44	(.13)
None Displaced	1.43	(.13)	1.57	(.10)
Target Displaced	1.34	(.14)	1.29	(.15)
57- to 78-year-olds				
Prospective Cue Displaced	1.17	(.16)	1.09	(.17)
None Displaced	1.04	(.16)	0.92	(.16)
Target Displaced	1.05	(.16)	1.04	(.16)

Note: The total maximum value per cell is two.

At the end of the testing session, the experimenter asked each participant whether he/she remembered the cues and his/her associated responses as a memory check. We coded responses in the following way: "2" = remembered both cue responses, "1" = remembered one cue response, "0" = did not remember either cue responses. Results showed that there was a significant difference between age groups, $F(1, 58) = 6.42$, $p < .05$, $\eta^2 = .12$, revealing that the 17- to 36-year-old adults (M = 1.93) were more accurate in remembering both cues compared to older adults (M = 1.63). Although there was no age effect for retrospective component responding, the memory check analysis at the end of the experiment showed an age difference in which 17- to 36-year-old adults more often remembered the prospective memory responses compared to the 57- to 78-year-old adults. These results make it necessary to question why there was no age difference for retrospective component responding but there was an age difference for the memory check analysis. There are several procedural differences that may account for these results. It may be that retrieving the material on line and retrieving the material in response to a direct probe from the experimenter at the end of the experiment, set up different retrieval contexts that rely on different processing. During the experiment, upon encountering a prospective cue, participants retrieve the associated response (7 *or* 9) whereas at the end of the experiment, participants are questioned and must retrieve both responses (7 *and* 9) at the same time, which could lead to more errors. It may be that these procedural differences account for the observed results. Furthermore, it is important to note that perfect performance would be a score of 2 and although there was a significant age difference, older adults (M = 1.63) performed well on average showing good memory for both cue responses. Another possible interpretation suggested by a reviewer was that it might be that 17- to 36-year-old adults performed better than older adults because they actually had more retrieval practice (i.e., responding "7" when they saw D). It may be that the younger adults were able to "practice" the associations more often than the older adults.[1]

In this experiment, letters in the letter string appeared one at a time. We used this type of presentation to ensure that participants would have to attend to each letter before making their response. In the next experiment, we altered the presentation of letter strings in an effort to boost the power of our perceptual manipulation. We changed the presentation of letter strings in the hopes that the effect of perceptual displacement of letters would be greater. Therefore, instead of letters appearing one at a time, all letters in the letter strings appeared simultaneously in the hopes of increasing the potential that displacement of letters would capture attention of older adults.

Experiment 2

Two modifications of the procedure of Experiment 1 were implemented. First, in addition to a young adult group, we included two older adult age groups. Although evidence regarding late-life changes in retrospective memory is accumulating (Bäckman et al.,

[1] We wish to thank a reviewer for suggesting this possible interpretation.

TABLE 3
Mean Proportion of Correct Identifications of Targets in Serial Position Task in Experiment 2 by Age Group

	M	*SE*
17- to 34-year-olds		
None Displaced	.95	(.008)
Target Displaced	.81	(.019)
Distractor Displaced	.96	(.015)
54- to 73-year-olds		
None Displaced	.97	(.007)
Target Displaced	.76	(.023)
Distractor Displaced	.96	(.016)
75- to 88-year-olds		
None Displaced	.94	(.012)
Target Displaced	.77	(.015)
Distractor Displaced	.95	(.019)

2000), there is little available information regarding age-related patterns of prospective memory performance among very old adults. Second, in Experiment 2, to strengthen the perceptual displacement manipulation, the letters in the letter strings appeared simultaneously instead of one letter at a time. The reasoning was that if all letters appeared at the same time, one letter that differed from the rest would "pop out" and appear distinctive compared to the rest of the letters. Therefore, we predicted that this would increase the effect of displacement of prospective cues. Furthermore, in Experiment 1 when letters were presented serially from left to right, there was a 300-ms gap between each letter's presentation, thus allowing time for participants to prepare a response. In contrast, in Experiment 2, all letters in a given string were presented simultaneously, thus considerably speeding up the presentation of letter strings.

Method

Participants. Thirty-one adults ranging in age from 17 to 34 years old (M = 19.94 years, SE = .55), 32 older adults ranging from 54 to 73 years old (M = 66.91 years, SE = .77), and 34 older adults ranging from 75 to 88 years old (M = 80.15 years, SE = .54) participated in this experiment. A one-way analysis of variance (ANOVA) revealed a significant difference between age groups with respect to years of education, $F(2, 95) = 6.12$, $p < .05$. Tukey HSD tests showed that 54- to 73-years olds (M = 15.13, SE = .56) had significantly more years of education compared to the 17- to 34-year-old (M = 13.13 years, SE = .22) and 75- to 88-year-old (M = 13.57 years, SE = .39) adults. Self-reported health was measured as in Experiment 1, using a 5-point Likert scale (1 = very good to 5 = very poor). A one-way ANOVA showed a significant difference between age groups, $F(2, 93) = 4.30$, $p < .05$. A post-hoc Tukey HSD test revealed that the 17- to 34-year-old adults (M = 1.48, SE = .12) reported significantly better health than the 75- to 88-year-old adults (M = 2.03, SE = .13). The 54- to 73-year-old adults' ratings (M = 1.69, SE = .15) were intermediate, and not significantly different from either of the two other age groups. As in Experiment 1, the younger adults were recruited from an undergraduate psychology course and received optional extra credit for their participation in the experiment. Participants from the two older adult age groups were recruited from the same volunteer pool as used in Experiment 1 and they were reimbursed for their travel expenses.

Materials and procedure. The method for Experiment 2 was identical to that of Experiment 1 except that the six letters in each letter string were presented simultaneously rather than sequentially as in the previous experiment. The six letters remained on the computer screen and were visible until the participant made his/her response, which advanced the study to the next trial.

Results and Discussion

Visual search task. Performance on the visual search task (excluding the 12 prospective memory trials) was evaluated using a 3 (Age: 17 to 34 years, 54 to 73 years, 75 to 88 years) x 3 (Perceptual Displacement: none-displaced, target- displaced, distractor-displaced) analysis of variance (ANOVA) with repeated measures on the second factor. Once again the dependent variable was the proportion of letters that were evaluated correctly with respect to serial position. Performance was near ceiling and analyses yielded a main effect of perceptual displacement, $F(2, 94) = 351.09$, $p < .01$, $\eta^2 = .88$, showing that performance was most accurate in the distractor-displaced (M = .96, SE = .01) and the none-displaced (M = .95, SE = .01) conditions and least accurate in the target-displaced condition (M = .78, SE = .01). Post-hoc Tukey HSD tests revealed significant performance differences between target-displaced trials and both the none-displaced and distractor-displaced conditions. In contrast to our predictions, performance in the target-displaced condition was least accurate. We speculate that this unexpected effect occurred because participants found it more difficult to identify the serial position (1 through 6) of the target when it was displaced (on a line below the rest of the letters) than in the none-displaced and distractor-displaced conditions (when the target was on the same line as the distractors). There is much research that shows that increasing complexity leads to an age by complexity interaction with older adults being more

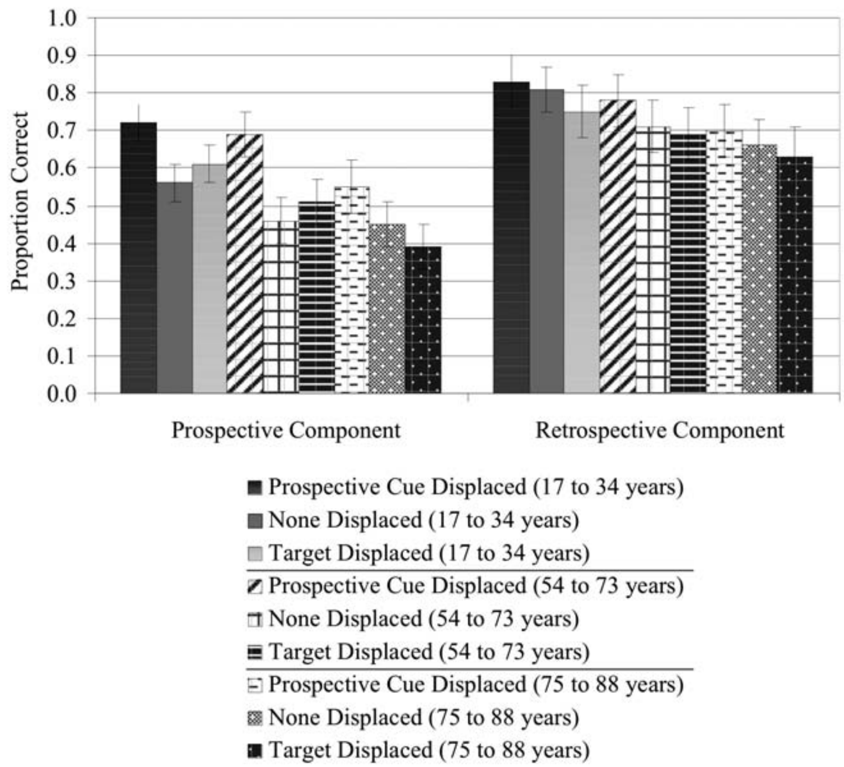

Figure 3. Mean accuracy for responding on the prospective and retrospective component of prospective memory in Experiment 2 as a function of cue type for young and old adults. Error bars show the 95% within-subjects confidence intervals (Loftus & Masson, 1994).

prone to errors (e.g., Salthouse, 1991).

Although no main effect of age was observed, there was a significant interaction between age and perceptual displacement, $F(4, 188) = 6.93$, $p < .05$, $\eta^2 = .13$. All age groups performed similarly in none-displaced and distractor-displaced trials, but in the target-displaced trials the 54- to 73-year-old adults ($M = .76$, $SE = .01$) and 75- to 88-year-old adults ($M = .77$, $SE = .02$) performed significantly more poorly than the 17- to 34-year-old adults ($M = .81$, $SE = .01$). See Table 3 for inspection of means.

Prospective memory task. The effects of perceptual displacement and age on the prospective component of prospective remembering were evaluated in a 3 (Age) x 3 (Perceptual Displacement) ANOVA with repeated measures on the second factor. There was a main effect of perceptual displacement, $F(2, 94) = 18.81$, $p < .01$, $\eta^2 = .28$, showing that a higher proportion of cues were detected in the prospective memory cue-displaced condition ($M = .65$, $SE = .04$) compared to the none-displaced ($M = .49$, $SE = .03$) and target-displaced ($M = .50$, $SE = .04$) conditions, which were not significantly different from one another. Although the main effect of age was not significant, simple effects analysis showed that the 17- to 34-year-old adults ($M = .63$, $SE = .05$) were significantly more successful ($p = .046$) at detecting prospective memory cues compared to 75- to 88-year-old adults ($M = .46$, $SE = .07$) (see Figure 3). No interaction was observed ($F = 1.47$).

The influence of perceptual distinctiveness and age on the retrospective component of prospective remembering was considered in a similar analysis. As in Experiment 1, several older adults who failed to detect any prospective cues (54- to 73-year-olds: $n = 4$; 75- to 88-year-olds: $n = 6$) were dropped from the analysis. As noted above, there was an effect of perceptual distinctiveness for prospective component performance, but for retrospective component performance means did not differ reliably from each other ($p > .05$; none-displaced: $M = .71$, prospective memory cue-displaced: $M = .75$, target-displaced: $M = .67$). Nor was there a significant main effect of age or interaction (all ps > .05). Once again, a power analysis was conducted and it indicated that the power was .94 to detect a

TABLE 4
Mean Number of Prospective Memory Cues and Standard Errors for Performance in Experiment 2 When the Prospective Memory Cue Occurred Before or After the Serial Position Task Target

	Before		After	
	M	*SE*	*M*	*SE*
17- to 34-year-olds				
Prospective Cue Displaced	1.26	(.14)	1.42	(.13)
None Displaced	1.12	(.13)	0.92	(.13)
Target Displaced	1.07	(.15)	1.12	(.12)
54- to 73-year-olds				
Prospective Cue Displaced	1.24	(.14)	1.22	(.14)
None Displaced	0.83	(.13)	0.77	(.13)
Target Displaced	0.99	(.14)	0.80	(.12)
75- to 88-year-olds				
Prospective Cue Displaced	0.97	(.12)	0.92	(.13)
None Displaced	0.75	(.12)	0.77	(.13)
Target Displaced	0.62	(.12)	0.69	(.13)

Note: The maximum possible number of cues per cell is two.

medium effect size (f^2 = .24) for the within-subjects perceptual displacement effect at an alpha level of .05. Using a smaller estimate of effect size (f^2 = .11, based on differences of around 5-10%), power was .67, indicating sufficient power to detect a small effect. Once again, we did an analysis to examine whether the order of the prospective cue relative to the target letter from the visual search task affected performance. A 3 (Age) x 2 (Order: before, after) x 3 (Perceptual Displacement: none-displaced, target-displaced, prospective memory cue-displaced) mixed factorial analysis of variance (ANOVA) was conducted with repeated measures on the second and third factor. There was no main effect of order nor did this factor interact with any other factors (all *F*s < 1.27). See Table 4 for inspection of the means.

General Discussion

The purpose of these studies was to examine the effect of perceptual distinctiveness of cues on prospective memory performance for young and older adults. Both the prospective component (realization that a response should be made) and the retrospective components (recalling the correct response when a prospective cue is recognized) were measured separately. These results demonstrated that manipulating perceptual salience of prospective memory cues, thought to reflect the contribution of data-driven processes, enhanced the efficiency of the prospective component of prospective remembering. That is, when a prospective memory cue was displaced relative to other letters, successful detection of this cue was enhanced (prospective component performance) in Experiment 2. In contrast, this manipulation had no reliable effect on the efficiency of remembering the intention once the cue was detected (retrospective component performance).

Therefore, we were able to examine whether the perceptual manipulation differentially affected both components of prospective memory for young and older adults. It should be noted that our separation of the prospective and retrospective component required that the latter is always conditionalized upon prospective component performance. There is no easy way of avoiding this aspect of the design unless we probed participants for the retrospective component even when they failed on the prospective component.

The retrospective memory errors were not due to a few participants responding randomly but rather because a significant number of participants made occasional errors. For example, in Experiment 1, 30% of the 17- to 36-year-old adults made some proportion of retrospective memory errors and 40% of the 57- to 78-year-old adults. In Experiment 2, 45% of 17- to 34-year-olds, 59% of 54- to 73-year-olds, and 72% of 75- to 88-year-olds made some proportion of retrospective memory errors. So, these numbers indicate that retrospective memory errors were not solely due to a few people making a large number of errors.

Consistent with our hypothesis and previous research (Cohen et al., 2001), the manipulation of salience of prospective memory cues, thought to influence the contribution of data-driven processes, had the greatest impact on the efficiency of the prospective component of prospective remembering. Our results showed that this manipulation had no reliable effect on the efficiency of the retrospective component. Recently, neuropsychological evidence has supported the idea that there are different event-related potential (ERP) modulations associated with detecting the cue (prospective component) and retrieval of the intention (retrospective component). In a study by West, Herndon, and Crewdson (2000), a difference between prospective and retrospective component performance was dissociated at the neural level. The prospective component was associated with a negativity over the occipital-parietal region that was greatest in amplitude at approximately 320 milliseconds following stimulus onset. The retrospective component was associated with a positivity over the parietal region between 400 and 1,000 ms poststimulus onset. Our behavioural results are consistent with findings from this neuropsychological study.

It may be useful to consider the current findings within the context of an account of prospective memory that was developed by Burgess and Shallice (1997). They suggested that prospective memory performance

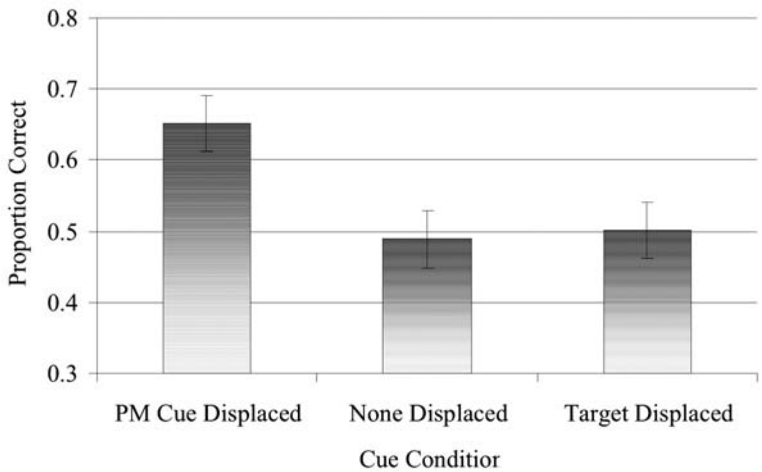

Figure 4. Mean accuracy for responding on the prospective and retrospective component of prospective memory in Experiment 2 as a function of cue type collapsed across age groups. Error bars show the 95% within-subjects confidence intervals (Loftus & Masson, 1994).

is mediated by the Supervisory Attentional System (SAS) and that this form of memory is a voluntary and strategic process. The authors suggested that individuals use the SAS to monitor the environment for target cues that signal whether an intention should be executed. A key assumption is that executive resources are set aside to be available to monitor the environment for cues. McDaniel and Einstein (2000) noted that the exact nature of these monitoring processes are not well understood. They proposed two possible accounts: a) monitoring can be described as executive resources that are committed to continuously monitoring the environment for cues, or b) monitoring can be described as a system that periodically brings the intention into mind and thereby sets the individual in a state of readiness for when the cue actually occurs. It might be the case that participants were strategically devoting some portion of overall resources to monitoring the environment for prospective memory cues. We define monitoring in terms of Smith's (2003) suggestion that successful prospective memory performance requires a redirection of capacity to monitor the environment for cues and that prospective memory performance is determined in part by the level of monitoring. In this vein, we speculate that monitoring may interact with salience showing best performance in situations where maximum resources are devoted to monitoring the environment and salience of cues within the environment are maximized. However, since we do not have any systematic measure of levels of monitoring within this study, we cannot really speak conclusively on this issue. Our results from Experiment 2 indicate that regardless of the amount of resources that participants devoted to monitoring the environment for cues, perceptual salience of cues relative to the ongoing cognitive activity in which they are embedded also plays a part in cue detection. For example, in cases in which the prospective memory cue was perceptually salient, prospective memory performance improved (M = .63) relative to none-displaced (M = .49) and target-displaced (M = .50) conditions (see Figure 4). Our experiment was not designed to measure the level of monitoring; therefore, it is difficult to comment conclusively on the relationship between monitoring and salience of cues. It may be more useful to discuss salience in terms of its impact on attention. For example, our results indicate that the detection of prospective memory cues is most enhanced when salience serves to capture attention triggering the notion that "there is something to do."

There was a marginal Age x Displacement interaction in Experiment 1 but no tendency toward such an interaction in Experiment 2. The tendency toward an interaction in Experiment 1 reflected the fact that displacing the cue affected performance of younger adults but conferred less of an effect on older adults. We suggest that this may have been due to the nature of the displacement manipulation in Experiment 1 in which the letters in the search string were presented sequentially with cue conditions being too subtle to affect older adults' performance. In Experiment 2, the strength of the manipulation was increased by displaying the entire letter string simultaneously, which enhanced the prospective-component performance of younger and older adults to the same extent. This finding is interpreted as evidence that when perceptual distinctiveness is sufficiently great older adults may benefit to the same extent as younger adults. This finding implies that perceptual distinctiveness manipulations need to be sufficiently perceptible for older adults to benefit to the same degree as younger adults. In the introduction section of the paper, we mentioned that the representation of the intention in consciousness could likely determine the extent to which older adults will be affected by a perceptual distinctiveness manipulation. We speculated that if the representation of the intention has receded below consciousness, an indivdiual may be unresponsive to even powerfully perceptually salient prospective cues. However, if we follow this line of thought, our results from Experiment 2 suggest that the representation of an intention for older adults was sufficiently activated to be responsive to our manipulation of perceptual distinctiveness.

The inclusion of two older adult age groups in Experiment 2 allowed us to make a more detailed analysis of older adults' performance. No significant difference was observed between the 17- to 34-year-old (M = 19.94 years) and 54- to 73-year-old adults (M = 66.91 years) nor was there a significant difference between 54- to 73-year-old and 75- to 88-year-old adults (M = 79.86 years). These results indicate that the performance of the 54- to 73-year-olds was intermediate and fell between that of the other two age groups. The only age effects, with respect to performance on the prospective component, were revealed when comparing young to older adults who are over 70 years of age. For example, the only reliable age differences for prospective component responding were between 17- to 36-year-old (M = 19.87 years) and 57- to 78-year-old (M = 71.67 years) adults in Experiment 1 and between the 17- to 34-year-olds (M = 19.94 years) and 75- to 88-year-olds (M = 79.86 years) in Experiment 2. This is consistent with other evidence indicating that age-related decline is gradual and occurs monotonically from young to late adulthood and reveals itself (relative to young) only well into the later years after age 70 (e.g., Dixon et al., in press; Nilsson et al., 1997). As well, the magnitude of age differences was greatest on the prospective component of prospective memory. The only effect of age on the retrospective component was a marginally significant effect that was due to a difference between the youngest and oldest adult age groups in Experiment 2.

It is theoretically useful to identify variables that differentially influence the prospective and retrospective components of prospective remembering. By studying both components and the factors that modulate them, we extend our understanding of successes and failures of prospective memory. The present findings serve to clarify what is known about older adults' performance on prospective memory tasks. By distinguishing between performance on the prospective and retrospective component, a clearer but not necessarily simple depiction of older adults' performance emerges, showing the impact of perceptual distinctiveness of cues on prospective memory performance. That is, a data-driven manipulation of displacement of cues modulated performance on the prospective component and not the retrospective component of prospective memory.

This research was supported by a grant (AG08235) from the National Institute on Aging to Roger Dixon, who is now at the University of Alberta. Anna-Lisa Cohen was supported by a PGSB scholarship from the Natural Sciences and Engineering Research Council of Canada. We wish to thank Meghan Evans and Elizabeth Nilsen for their dedicated assistance with data collection. For reprints, contact Anna-Lisa Cohen, who is now at New York University (E-mail: alc312@nyu.edu).

References

Bäckman, L., Small, B. J., Wahlin, A., & Larsson, M. (2000). Cognitive functioning in very old age. In F. I. M. Craik & T. A. Salthouse (Eds.), *The handbook of aging and cognition* (pp. 499-558). Mahwah, NJ: Erlbaum.

Brandimonte, M., Einstein, G. O., & McDaniel, M. A. (Eds.). (1996). *Prospective memory: Theory and applications*. Mahwah, NJ: Erlbaum.

Buchner, A., Erdfelder, E., & Faul, F. (1997). *How to use G*Power*. [On-line]. Available: http://www.psycho.uni-duesseldorf.de/aap/projects/gpower/how_to_use_gpower.html

Burgess, P. W., & Shallice, T. (1997). The relationship between prospective and retrospective memory: Neuropsychological evidence. In M. A. Conway (Ed.), *Cognitive models of memory* (pp. 247-272). Cambridge, MA: MIT Press.

Cohen, A.-L., West, R., & Craik, F. I. M. (2001). Modulation of the prospective and retrospective components of memory for intentions in younger and older adults. *Aging, Neuropsychology, and Cognition, 8*, 1-13.

Craik, F. I. M., & Kerr, S. A. (1996). Prospective memory, aging, and lapses of intention. In M. Brandimonte, G. O. Einstein, & M. A. McDaniel (Eds.), *Prospective memory: Theory and applications* (pp. 227-237). Mahwah, NJ: Erlbaum.

D'Ydewalle, G., Luwel, K., & Brunfaut, E. (1999). The importance of on-going concurrent activities as a function of age in time- and event-based prospective memory. *European Journal of Cognitive Psychology, 11*, 219-237.

Dixon, R. A., de Frias, C. M., & Bäckman, L. (2001).

Characteristics of self-reported memory compensation in older adults. *Journal of Clinical and Experimental Neuropsychology, 23*, 650-661.

Dixon, R. A., Wahlin, Å., Maitland, S. B., Hultsch, D. F., Hertzog, C., & Bäckman, L. (in press). Episodic memory change in late adulthood: Generalizability across samples and performance indices. *Memory & Cognition*.

Dunlosky, J., Hunt, R. R., & Clark, E. (2000). Is perceptual salience needed in explanations of the isolation effect? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26*, 649-657.

Einstein, G. O., Holland, L. J., McDaniel, M. A., & Guynn, M. J. (1992). Age-related deficits in prospective memory: The influence of task complexity. *Psychology and Aging, 7*, 471-478.

Einstein, G. O., & McDaniel, M. A. (1990). Normal aging and prospective memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16*, 717-726.

Einstein, G. O., McDaniel, M. A., Manzi, M., Cochran, B., & Baker, M. (2000). Prospective memory and aging: Forgetting intentions over short delays. *Psychology and Aging, 15*, 671-683.

Einstein, G. O., McDaniel, M. A., Richardson, S. L., & Guynn, M. J. (1995). Aging and prospective memory: Examining the influences of self-initiated retrieval. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21,* 996-1007.

Einstein, G. O., McDaniel, M. A., Smith, R., & Shaw, P. (1998). Habitual prospective memory and aging: Remembering instructions and forgetting actions. *Psychological Science, 9*, 284-288.

Ellis, J. (1996). Prospective memory or the realization of delayed intentions: A conceptual framework for research. In M. Brandimonte, G. O. Einstein, & M. A. McDaniel (Eds.), *Prospective memory: Theory and applications* (pp. 1-22). Mahwah, NJ: Erlbaum.

Hertzog, C., Park, D. C., Morrell, R. W., & Martin, M. (2000). Ask and ye shall receive: Behavioural specificity in the accuracy of subjective memory complaints. *Applied Cognitive Psychology, 14*, 257-275.

Hultsch, D. F., Hertzog, C., Dixon, R. A., & Small, B. J. (1998). *Memory change in the aged*. Cambridge, UK: Cambridge University Press.

Loftus, G. R., & Masson, M. E. J. (1994). Using confidence intervals in within-subject designs. *Psychonomic Bulletin & Review, 1*, 476-490.

Mäntylä, T. (1996). Activating actions and interrupting intentions: Mechanisms of retrieval sensitization in prospective memory. In M. Brandimonte, G. O. Einstein, & M. A. McDaniel (Eds.), *Prospective memory: Theory and applications* (pp. 93-113). Mahwah, NJ: Erlbaum.

Maylor, E. A. (1993). Minimized prospective memory loss in old age. In J. Cerella, J. Rybash, W. Hoyer, & M. L. Commons (Eds.), *Adult information processing: Limits on loss* (pp. 529-551). San Diego, CA: Academic Press.

Maylor, E. A. (1996a). Age related impairment in an event-based prospective memory task. *Psychology and Aging, 11*, 74-78.

Maylor, E. A. (1996b). Does prospective memory decline with age? In M. Brandimonte, G. O. Einstein, & M. A. McDaniel (Eds.), *Prospective memory: Theory and applications* (pp. 173-197). Mahwah, NJ: Erlbaum.

Maylor, E. A. (1998). Changes in event-based prospective memory across adulthood. *Aging, Neuropsychology, and Cognition, 5*, 107-128.

McDaniel, M. A., & Einstein, G. O. (2000). Strategic and automatic processes in prospective memory retrieval. *Applied Cognitive Psychology, 14*, 127-144.

McDaniel, M. A., Robinson-Riegler, B., & Einstein, G. O. (1998). Prospective remembering: Perceptually driven or conceptually driven processes? *Memory & Cognition, 26*, 121-134.

Moscovitch, M. (1982). A neuropsychological approach to memory and perception in normal and pathological aging. In F. I. M. Craik & S. Trehub (Eds.), *Aging and cognitive process* (pp. 55-78). New York: Plenum.

Nilsson, L. G., Bäckman, L., Erngrund, K., Nyberg, L., Adolfsson, R., Bucht, G., Karlsson, S., Widing, M., & Winblad, B. (1997). The Betula prospective cohort study: Memory, health, and aging. *Aging, Neuropsychology, and Cognition, 4*, 1-32.

Park, D. C., Morrell, R. W., & Shifren, K. (1999). *Processing of medical information in aging patients: Cognitive and human factors perspectives*. Mahwah, NJ: Lawrence Erlbaum.

Parkin, A. J., Ward, J., Squires, E. J., Furbear, H., Clark, A., & Townshend, J. (2001). Data-driven recognition memory: A new technique and some data on age differences. *Psychonomic Bulletin & Review, 8*, 812-819.

Rendell, P. G., & Thomson, D. M. (1999). Aging and prospective memory: Differences between naturalistic and laboratory tasks. *Journal of Gerontology: Psychological Sciences, 54*, P256-P269.

Salthouse, T. A. (1991). *Theoretical perspectives on cognitive aging*. Hillsdale, NJ: Lawrence Erlbaum.

Schneider, W. (1988). Micro-Experimental Laboratory: An integrated system for IBM PC compatibles. *Behavior Research Methods, Instruments, & Computers, 20,* 206-217.

Smith, R. E. (2003). The cost of remembering to remember in event-based prospective memory: Investigating the capacity demands of delayed intention performance. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 29*, 347-361.

Uttl, B., & Graf, P. (2000, November). *ProM is a distinct component of memory.* Paper presented at the meeting of the Psychonomic Society, New Orleans, LA.

West, R., & Craik, F. I. M. (1999). Age-related decline in prospective memory: The roles of cue accessibility and cue sensitivity. *Psychology and Aging, 14*, 264-272.

West, R., Herndon, R. W., & Crewdson, S. J. (2001). Neural activity associated with the realization of a delayed intention. *Cognitive Brain Research, 12*, 1-9.

West, R., Herndon, R. W., & Ross-Munroe, K. (2001). Event-related neural activity associated with prospective remembering. *Applied Cognitive Psychology, 14*, 115-126.

Appendix

Example of Instructions

In this experiment, you will be asked to search for a target letter among a string of letters. A target letter will appear on the screen (e.g., the letter "E") and you will be asked to say it out loud. After you say it out loud, the experimenter will press the space bar and a string of letters will appear on the screen. Your task is to quickly and accurately count from left to right and decide the position of the target letter within the letter string. Then, push the computer key on the numeric keypad that corresponds to the target letter's position. For example, if the target letter "E" is in the third position from left to right, then a correct response would be pressing "3."

Example:

E

X G E P O L

↑

RESPONSE: Push "3"

Your main objective in this study is the visual search task that I just described; however, another thing you must keep in mind is the following: If at any point during the experiment, you see either of two special letters within a letter string, you have to make a certain response. Specifically, if you see the letter "B" within a letter string, press the "9" key and if you see the letter "D" within a letter string, press the "7" key. Along with pressing the correct key (7 or 9), you must also verbally tell the experimenter when you see one of these letters. You are to press "7" or "9" regardless of the position of the letter within the letter string and this response overrides responding to the main visual search task. The letters "D" or "B" will never appear at the same time in a letter string and they may or may not appear throughout the experiment. To make these instructions clearer, we will do 10 practice trials.

Now, please try to repeat back the instructions to me to show that you understand them.

Sommaire

La mémoire prospective est un phénomène de la mémoire par lequel le traitement appuie la réalisation et l'exécution d'une intention encodée précédemment (Ellis, 1996). On attribue à cette forme de mémoire la base des activités de tous les jours, telles que se souvenir d'assister à une réunion ou une activité importante, de passer des appels téléphoniques et de prendre ses médicaments à un moment précis. Les résultats positifs de performance mnésique de la mémoire prospective sont censés faire appel à deux éléments distincts : se souvenir, au moment approprié, qu'il faut faire quelque chose et se rappeler des choses à faire (Einstein, Holland, McDaniel & Guynn, 1992). Le premier élément est appelé « volet prospectif », tandis que le second appartient au « volet rétrospectif ». Par exemple, si une personne se rappelle qu'elle doit transmettre un message à un ami, pour que la mémoire prospective soit agissante, il faudra que la représentation de cet ami apparaisse pour déclencher le souvenir, chez cette personne, du message à faire (volet prospectif). De plus, pour que la mémoire prospective soit agissante, il faudra que la personne se souvienne du contenu du message (volet rétrospectif). Très peu d'études ont examiné de façon distincte les volets prospectif et rétrospectif de la mémoire prospective. Ainsi, les processus de détection des signaux sont souvent confondus avec les processus de remémoration car la plupart des études ont tendance à ne rechercher qu'une seule mesure d'exactitude. Dans deux expériences, nous avons examiné l'effet de la distinctivité perceptuelle des signaux tant sur le volet prospectif que sur le volet rétrospectif de la mémoire prospective. Des adultes, jeunes et âgés, ont effectué une tâche de recherche visuelle, qui intégrait des directives sur la mémoire prospective. À chaque essai, on demandait aux participants d'indiquer la position d'une lettre cible dans une suite de lettres, sauf lorsque l'une des deux lettres identifiées antérieurement comme des signaux appartenant à la mémoire prospective était présentée. Chaque signal appartenant au volet prospectif était associé à une réponse précise. La distinctivité perceptuelle était manipulée au moyen du déplacement spatial d'une seule lettre. Le volet prospectif (détection réussie du signal) et le volet appartenant à la mémoire prospective (rappel de la bonne réponse lors de la détection d'un signal) ont été mesurés séparément. Les résultats ont démontré que la manipulation perceptuelle résultant du déplacement d'une lettre modulait la performance du volet prospectif, mais non pas celle du volet rétrospectif. Les jeunes adultes ont réussi à détecter une plus grande proportion de signaux (volet prospectif) que ne l'ont fait les adultes âgés. Toutefois, en ce qui a trait à la capacité des participants à se rappeler de leur intention après la détection d'un signal (performance du niveau rétrospectif), les effets de l'âge étaient négligeables et ceux du déplacement du signal se sont avérés nuls. Par conséquent, la mémoire qui permet de se rappeler qu'il faut effectuer une tâche (volet prospectif) était avantagée par l'évidence perceptuelle, mais le contenu exact ou le volet rétrospectif de l'intention (p. ex., ce qu'une personne était supposée faire) n'était pas avantagé au même degré. Nous terminons par une discussion des résultats abordés sous l'angle des modèles théoriques actuels de la mémoire prospective.