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Relationship of cognitive strategy use to prospective memory performance in a diverse sample of nondemented older adults with varying degrees of cognitive complaints and impairment

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Abstract

Although older adults typically have better performance on prospective memory (PM) tasks carried out in naturalistic settings, a paucity of research directly assesses older adults' use of compensatory strategies on such tasks. The current study investigates external memory strategy use during performance of a clinical PM test that features both short-term (in laboratory) and long-term (out of laboratory) subtasks (i.e., the Royal Prince Alfred Prospective Memory Test – RPA-ProMem. Nondemented, community-dwelling older adults ($n = 214$; mean age = 80.5; 68.2% female; 39.7% non-white) with mild cognitive impairment, subjective cognitive decline, and healthy controls completed the RPA-ProMem while external strategy use was permitted and recorded. Overall, participants utilized external strategies 41% of the time on the RPA-ProMem. Increased utilization of external memory strategies was significantly associated with better PM performance. Additionally, better performance on executive functioning tasks was associated with increased use of external memory strategies. Results are discussed in relation to how memory strategy use can be enhanced to improve everyday memory ability in older adults at risk for dementia.

Keywords

memory strategy use; external memory strategies; prospective memory; subjective cognitive decline; mild cognitive impairment

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Introduction

Memory strategy use is a cognitive tool that enables older adults to compensate for perceived and actual memory failures (de Frias, Dixon, & Bäckman, 2003; Dixon, de Frias, & Bäckman, 2001; Dixon & Hultsch, 1983). Memory strategies are broadly categorized as external or internal (Harris, 1980). External strategies are executed by manipulating or relying on the environment to provide memory cues; such methods include writing notes, making lists, using a calendar or alarm, placing objects or notes of importance in one's visual field or in an obvious place, and relying on others to provide reminders (Harris, 1980). Internal memory strategies, by contrast, include using mental images or the method of loci, repeating information to oneself, using mnemonic devices such as creating acronyms, or creating a story in which the to-be-remembered task is embedded (Harris, 1980).

External memory aids are more frequently employed than internal aids in everyday life (Harris, 1980; Park, Smith, & Cavanaugh, 1990) and especially among older adults (Dixon et al., 2001; Dixon, Hopp, Cohen, de Frias, & Bäckman, 2003; Garrett, Grady, & Hasher, 2010; McDougall, 1995). Older adults' preference for external over internal memory strategies has been explained by the reduced cognitive resources hypothesis, which posits that it is difficult for elderly individuals to execute effortful self-initiated encoding and retrieval processes required for effective prospective remembering (Anderson & Craik, 2000; Craik, 1986). Bouazzaoui et al. (2010) found that greater use of internal strategies was positively correlated with higher-order cognitive abilities such as executive functioning and fluid intelligence while self-reported external strategy use was not associated with executive functioning. These findings lend support to the idea that high levels of cognitive resources, including intact executive functioning, are required for successful utilization of some types of memory strategies (Bouazzaoui et al., 2010; Lovelace & Twohig, 1990). However, research has yet to examine the association of executive functioning to actual use of external strategies during performance of neuropsychological tasks.

Memory strategies may be helpful in coping with age-related cognitive changes (Bouazzaoui et al., 2010; Cavanaugh, Grady, & Perlmuter, 1983; de Frias et al., 2003; Dixon et al., 2001). In fact, research using naturalistic paradigms (e.g., calling a previously provided phone number, taking a medication, mailing a letter at a set time) has established that older adults can perform at comparable or better levels than young adults on such tasks (Leirer, Morrow, Pariente, & Sheikh, 1988; Maylor, 1990; Rendell & Thomson, 1993, 1999), possibly due to strategy use. Though it is difficult to study older adults' strategy use in naturalistic settings, laboratory-based tasks that permit and record the utilization of strategies have the capacity to measure this behavior. Prospective memory (PM) tests lend themselves to the study of strategy use. PM can be defined as remembering to carry out intended actions at a given point in the future (Einstein & McDaniel, 1990; Henry, MacLeod, Phillips, & Crawford, 2004; McDaniel & Einstein, 2011). Real-world PM tasks include remembering to take medications at the prescribed time, keep appointments, and turn off the stove or iron and are critical to maintaining independent living (Schmitter-Edgecombe, Woo, & Greeley, 2009; Woods et al., 2008). Accordingly, laboratory-based PM

tests incorporate an interval of time between when participants are expected to encode and then to execute a task, during which they are required to complete an ongoing activity that simulates the distractions of everyday life (e.g., work on a crossword puzzle). This delay period provides an opportunity to measure and assess methods of strategy use. The limited available research suggests that when healthy middle-aged and older adult females are given the opportunity to use memory aids during performance of PM tasks, reported use of conjunction (i.e., linked task performance with another routine event) or external strategies facilitates PM performance to a greater degree than use of internal strategies (Maylor, 1990). In a study of healthy older adults, reported use of external (but not internal) memory strategies enhanced PM performance on a laboratory-based task (Masumoto, Nishimura, Tabuchi, & Fujita, 2011). Furthermore, factors such as age, retrospective memory performance, and perception of memory ability were unrelated to use of external memory strategies, particularly for complex tasks involving task and time monitoring (Masumoto et al., 2011).

Recent research documents a fairly significant decrement in PM ability in individuals with mild cognitive impairment (MCI) (Costa, Caltagirone, & Carlesimo, 2011; van den Berg, Kant, & Postma, 2012), which is conceptualized as a transitional stage between normal cognitive aging and clinically manifest dementia (Petersen, 2004). By definition, those with MCI present with an isolated deficit in memory or other cognitive abilities (relative to demographically equivalent peers), self- or informant concerns about cognitive decline, and intact general cognition and generally preserved independence in functional activities (Albert et al., 2011; Winblad et al., 2004). MCI is associated with high risk of progression to Alzheimer's disease and other dementias (Petersen et al., 2009). Diagnosis of MCI typically involves administering standardized tests of episodic memory, executive functioning, and other cognitive abilities to identify individuals at an early stage of disease expression, when there remains a window of opportunity for intervention (Albert et al., 2011). Some advocate for the incorporation of PM tasks into clinical assessments of older adults with suspected MCI (Costa et al., 2011; Delprado, Kinsella, Ong, & Pike, 2013; van den Berg et al., 2012). PM tasks tax various cognitive abilities, including episodic memory retrieval, complex attention, working memory, and executive functions, and may be highly sensitive to preclinical dementia conditions (Blanco-Campal, Coen, Lawlor, Walsh, & Burke, 2009). In addition, PM tasks lend themselves to assessing real-world aspects of functioning that may impact an MCI individual's performance (e.g., self-generated memory strategies) and therefore may provide information relevant not only to diagnosis but to possible cognitive intervention approaches.

There are a limited number of investigations of strategy use on episodic memory tasks in MCI, with some studies identifying deficits in spontaneous semantic clustering on list-learning tasks in MCI (Price et al., 2010; Ribeiro, Guerreiro, & De Mendonça, 2007). More recently, one study compared a group of healthy older adults to those with aMCI (i.e., the amnesic subtype of MCI that manifests as episodic memory deficits) on knowledge of memory strategies, self-reported strategy use, internal strategy use on an episodic memory task (serial, subjective, or semantic clustering across trials of a learning task), and external strategy use on a standardized laboratory-based PM task of note-taking versus no note-taking (Hutchens et al., 2012). The aMCI group had less knowledge about memory

strategies than the healthy adults, although the groups did not differ on self-reported internal or external strategy use. Additionally, those with aMCI used significantly less semantic and subjective clustering on the list-learning task but an equivalent amount of writing reminder notes on the PM task. Importantly, on both objective memory tasks those with aMCI performed significantly better when they employed strategies. By contrast, self-reported strategy use was not predictive of memory performance on either objective memory task (Hutchens et al., 2012).

In another study, a small group of older adults with aMCI was impaired relative to healthy controls (HC) on a naturalistic measure of PM in which the tasks were self-generated (i.e., participants identified their own PM tasks over a 2-week period and later were queried about task completion and strategy use) (Delprado et al., 2013). Notably, those with MCI reported using the strategy of asking someone else to remind them of the PM tasks more frequently than the older adult HC, which may not be the most reliable method since those being counted on for reminders could experience PM failures of their own (Delprado et al., 2013). In another study, older adults with MCI were compared to elderly HC on two episodic memory tests of story and grocery list recall (Brum, Yassuda, & Forlenza, 2013). Participants were permitted to use the mnemonic strategy of underlining important ideas for the story recall task, and a semantic clustering index was derived for the grocery list task. Overall, those with MCI had lower performance on the memory tasks but had comparable scores for number of underlined words (although this strategy was not correlated with task performance). Those with MCI also had lower semantic clustering scores on the grocery list task and higher use of semantic clustering was associated with better task performance.

Together, this small group of studies suggests that older adults with MCI perform better on memory tasks if they utilize memory strategies. Moreover, those with MCI may be less effective at implementing compensatory strategies. The limited available research, however, has not investigated strategy use in MCI on more naturalistic (out of laboratory) clinical PM tasks. Furthermore, research has yet to investigate strategy use among older adults with subjective cognitive decline (SCD), where individuals present with significant complaints about memory and other cognitive abilities yet score within normal limits on standard neuropsychological tests of memory and other cognitive functions. There is increasing evidence that SCD is associated with neuropathological changes and clinical progression to dementia that may represent a pre-MCI condition (Amariglio et al., 2012; Jessen et al., 2014; Kryscio et al., 2014; Mitchell, Beaumont, Ferguson, Yadegarfar, & Stubbs, 2014; Reisberg, Shulman, Torossian, Leng, & Zhu, 2010; Stewart et al., 2011; van Harten et al., 2012). As those with SCD are functionally and cognitively intact, they may be fully able to employ and possibly benefit from strategy use.

The current study aims to broaden knowledge of external strategy use and its impact on PM task performance in demographically diverse, nondemented, community-dwelling older adults with varying degrees of cognitive complaints and impairment. We recorded external strategy use on a recently developed clinical PM test measure that features both time- and event-based tasks measured over short-term (within the laboratory) and long-term (outside of the laboratory) retention intervals (i.e., the Royal Prince Alfred Prospective Memory Test – RPA-ProMem; Radford, Lah, Say, & Miller, 2011). Based on research reviewed earlier,

which suggests that those with MCI may be under-resourced or less strategic when it comes to implementing effective compensatory strategies, and based on research suggesting that those with SCD represent a pre-MCI condition, we hypothesize that older adults with SCD and MCI will utilize fewer external memory strategies than HC. We also investigate the association of external strategy use, various demographic variables (age, sex, race/ethnicity, education), and group classification (HC, SCD, MCI) to overall performance on the RPA-ProMem. Based on limited previous research in healthy older adults (Masumoto et al., 2011), we hypothesize that external strategy use will lead to better PM task performance in our participant groups. Finally, we investigate the association of various demographic variables (age, sex, race/ethnicity, education) and cognitive variables (including executive functioning composite score and participant group) to level of strategy use on the RPA-ProMem. We hypothesize that better executive functioning will be associated with greater external strategy use.

Methods

Participants and procedures

Participants were a subset of individuals recruited from the Einstein Aging Study (EAS), a longitudinal, community-based study of individuals aged 70 years and above. Potential participants are recruited through systematic sampling from Medicare or voter registration lists for Bronx County (for details, see Katz et al., 2012; Lipton et al., 2003). Exclusion criteria include visual or auditory impairments or psychiatric symptomatology that interferes with the completion of the neuropsychological assessment, non-English speaking, and non-ambulatory status. For the current study, we also excluded individuals diagnosed with dementia at a consensus case conference (see Katz et al., 2012, for details). Participants were assessed at two time points: (1) during their annual EAS visit at which they completed a standard neuropsychological assessment, neurological examination, and physical measures (see Katz et al., 2012); and (2) approximately 2 weeks after their annual EAS visit, at which time they completed the study-specific PM measure described later. Participants were transported to and from the testing facility via car service, provided with lunch, and compensated \$25 for their participation. The local institutional review board approved the study protocol, and all the participants provided written informed consent. Study examiners were blinded to participant group.

Participants were classified, using a novel psychometric approach (Rabin, Chi, et al., 2014; Rabin, Wang, Katz, & Lipton, 2014), into one of the following groups: HC, SCD, or MCI. First we established robust norms for 13 neuropsychological tests for 411 EAS participants who were dementia-free for 3 years (and did not include participants in the current study). The 13 neuropsychological tests used to establish robust norms were: (1) verbal episodic memory/word learning – free recall from the Free and Cued Selective Reminding Test (FCSRT; Grober & Buschke, 1987); (2) verbal episodic memory/story recall – Logical Memory I subtest of the Wechsler Memory Scale – Revised (WMS-R; Wechsler, 1987); (3) verbal fluency/word generation according to an initial letter – Letter Fluency (Spreen & Strauss, 1998); (4) verbal fluency/naming exemplars from a category –Category Fluency (Rosen, 1980); (5) confrontation naming – short form of the Boston Naming Test (BNT;

Kaplan, Goodglass, & Weintraub, 1983); (6–7) visuomotor tracking, divided attention, and cognitive flexibility – Trail Making Test Parts A and B (Reitan, 1958); and select subtests of the Wechsler Adult Intelligence Scale – Third Edition (WAIS-III; Wechsler, 1997), including (8) visuospatial organization – Block Design, (9) psychomotor processing speed – Digit Symbol-Coding, (10) auditory attention and working memory – Digit Span, (11) general fund of knowledge – Information, (12) vocabulary level – Vocabulary, and (13) verbal abstraction of categories – Similarities. We identified three underlying cognitive factors using a principal component analysis: (1) *global/verbal* (Boston Naming, Information, Similarities, Vocabulary, Digit Span, and Letter Fluency); (2) *executive/processing speed* (Block Design, Digit Symbol-Coding, and Trail Making Test Parts A and B); and (3) *memory* (FCSRT, Category Fluency, Logical Memory). Cognitive domain scores for each participant were then calculated as the average Z score of each neuropsychological test associated within a given factor, derived using means and standard deviations (*SD*) of the robust sample stratified by age group (70–79 and 80 and above). Participants' executive/processing speed factor Z score was used as the measure of executive functioning in the current study.

Participants were classified as MCI if: (1) their cognitive domain scores were considerably lower (>1 *SD*) than the mean of the robust sample on only the memory domain or on the memory domain and one or more of the other cognitive domains; and (2) they presented with a cognitive complaint on one or both EAS self-report measures – that is, endorsed one or more items on the Cognitive Impairment Questionnaire of the Consortium to Establish a Registry for Alzheimer's Disease (CERAD; Heyman, Fillenbaum, & Nash, 1997) or endorsed the cognitive item from the short form of the Geriatric Depression Scale (GDS; Sheikh & Yesavage, 1986).

Participants were classified as SCD if: (1) their scores on all of cognitive domains did not fall considerably lower (>1 *SD*) than the mean of the robust sample; and (2) they presented with a high level of self- or informant-reported cognitive complaints – that is, exceeded an age-appropriate optimal cut-off score on self- and informant-reported items previously validated in our study (for details, see Rabin et al., 2012; Rabin, Wang, et al., 2014). We utilized cognitive complaints items with known reliability and predictive validity for dementia (Rabin et al., 2012) to derive scores that were the proportion of positive responses. Subsequently, we derived an optimal cut point from a receiver operating characteristic analysis, stratified by age group (70–79 and 80 and above), which used the robust sample and was based on the cross-sectional association between the self- or informant complaint and MCI.

Participants were classified as HC if: (1) their performance on all of the cognitive domains did not fall considerably lower (>1 *SD*) than the mean of the robust sample; and (2) they did not present with a high level of self- or informant-reported cognitive complaints (i.e., did not exceed the age-appropriate optimal cut-off score on self- and informant-reported items).

Prospective memory measures

The RPA-ProMem (Radford et al., 2011) was used to measure PM performance. Part 1 consists of a short-term, time-based laboratory task where participants are instructed to

remind the examiner to move his or her car in 15 minutes time to avoid getting a ticket. Part 2 consists of a short-term, event-based laboratory task where participants are instructed to tell the examiner upon the ringing of a cell phone that they would like a drink (the cell phone is set to ring 30 minutes after administration of instructions). The last two portions of the RPA-ProMem include long-term PM tasks designed to be performed in a naturalistic setting. Part 3 is a long-term, event-based task that requires participants to call and leave a message on the researcher's voicemail, stating the time, immediately upon arriving home from the testing session. Part 4 is a long-term, time-based task that requires participants to return a postcard in 1 week with their name and a description of what they are having for dinner written on the card. The RPA-ProMem has three alternate test forms (Radford et al., 2011), and the current study used RPA-ProMem Form 3.

Scoring criteria for Parts 1 and 2 are: a score of "3" indicates a correct response made up to 2 min delay or ahead of time; a score of "2" indicates either a correct response made at 2–5 min delay or ahead of time or an incorrect response made at up to 2 min delay or ahead of time; a score of "1" indicates a correct response made at greater than 5 min delay or ahead of the correct time; a score of "0" indicates either an incorrect response made at greater than 2 min delay or ahead of the correct time or no response. Scoring for Part 3 is: a score of "3" indicates a phone call at the correct time, with a 2-hour window period, with a correct message; a score of "2" indicates either a call at the correct time with an incorrect message or a call at the incorrect time with a correct message; a score of "1" indicates a call at the incorrect time with an incorrect message; a score of "0" indicates no call made up to 2 days after test administration. Scoring for Part 4 is: a score of "3" indicates a postcard sent at the correct day with the correct information; a score of "2" indicates either a postcard sent on an incorrect day with correct information or a postcard sent on the correct day with the incorrect information; a score of "1" indicates a postcard sent on the incorrect day with the incorrect information; a score of "0" indicates no postcard sent up to 2 weeks after test administration. The RPA-ProMem total score is a measure of overall PM performance and is obtained by summing the subscores from Parts 1 through 4 (range 0–12 points).

While the RPA-ProMem allows participants to use any strategy to aid in remembering the tasks, it does not provide any mechanism by which to record the types of strategies employed by the participants. The current study implemented an additional recording mechanism that measured type of external strategy used for each part of the RPA-ProMem. During the testing session, pencils, pens, post-it notes, notepads, and a digital clock were placed in plain view of the participants so that participants had the ability to utilize an external memory strategy, as well as keep track of time. After administering instructions for each part of the RPA-ProMem, we noted whether participants used (1) no memory strategy; (2) an external strategy, such as writing a note or entering information into a personal digital assistant, which was observed by the examiner; or (3) an internal strategy, such as active rehearsal, which was observed by the examiner and recorded. We subsequently calculated an external strategy use total score (ranging from 0 to 4) to determine the total number of parts on the RPA-ProMem on which participants used an external strategy (e.g., a score of 2 indicated that an external strategy was used on two parts of the RPA-ProMem). We also derived a "no external strategy" score for trials on which no external strategy was used, or

where a strategy other than an external strategy was observed such as the internal strategy of active rehearsal.

Statistical analyses

Descriptive statistics were calculated with mean and *SD* for the continuous variables and percentage and frequency for the categorical variables. The Fischer's exact test compared strategy use for each of the participant groups. Multivariate linear regression analyses were conducted with the outcome variables of RPA-ProMem total score and RPA-ProMem total external strategy use score. All *p*-values were two-tailed with an alpha level of .05. SPSS version 20 was used for all analyses.

Results

Table 1 shows the sample characteristics. Mean age was 80.5 years and mean education was 14.5 years; 68.2% of participants were women and 39.7% were of non-white race/ethnicity. The greatest percentage of participants was classified as HC (43%, *n* = 91), with 33% (*n* = 71) and 24% (*n* = 52) classified as SCD and MCI, respectively. Among the MCI participants, 17 had amnesic MCI (impairment in memory or memory plus executive/processing speed and/or global cognitive domains) and 35 had non-amnesic MCI (impairment in executive/processing speed and/or global cognitive domains). For the purposes of the current study these individuals were combined into a single MCI group.

Table 2 shows the percentages and comparisons for strategy use on each of the RPA-ProMem parts for each of the cognitive groups. With regard to comparisons of external strategy use between groups, the RPA-ProMem Part 2 significantly differed between the groups. The SCD group had the greatest percentage of external strategy use. In addition, an overall pattern occurred where a greater percentage of participants utilized external strategies on Parts 3 and 4 of the RPA-ProMem (the long-term tasks performed out of the laboratory) than on Parts 1 and 2 (the short-term tasks performed in the laboratory). Overall, combined among the HC, SCD, and MCI groups, external strategies were utilized 40.8% of the time on the RPA-ProMem.

An external strategy use total score was created to reflect the number of RPA-ProMem parts where individuals used an external strategy (range 0–4). External strategy use total scores were: no use on the RPA-ProMem: 31.8% (*n* = 68), strategy use on one RPA-ProMem part: 16.4% (*n* = 35), strategy use on two RPA-ProMem parts: 25.2% (*n* = 54), strategy use on three RPA-ProMem parts: 10.3% (*n* = 22), and strategy use on all four RPA-ProMem parts: 16.4% (*n* = 35). The mean external strategy use total score for any of the four RPA-ProMem parts was 1.63 (*SD* = 1.44).

Table 3 shows multivariate linear regression analyses for the outcome of RPA-ProMem total score. Predictor variables included participant group (HC, SCD, and MCI), relevant demographics (age, sex, race/ethnicity, and education), and external strategy total score. Both the SCD and MCI groups, as compared to the HC group, had significantly lower scores on the RPA-ProMem total score. The regression coefficients showed a greater magnitude for the association with lower RPA-ProMem scores for the MCI group than the SCD group. An

increasing number of external strategies was significantly associated with greater RPA-ProMem total scores. There was a trend level association for lower age being associated with better performance on the RPA-ProMem ($P = .051$). None of the other variables were significantly associated with RPA-ProMem total scores.

Table 4 shows multivariate linear regression analyses for external strategy use total score on the RPA-ProMem. Predictor variables included participant group (HC, SCD, and MCI), relevant demographics (age, sex, race/ethnicity, and education), and executive/processing speed factor Z score. Increasing years of education, lower age, and higher executive functioning scores were significantly associated with greater external strategy use.

Discussion

To our knowledge, this study is the first to investigate actual utilization of external memory strategies by nondemented older adults with varying degrees of cognitive complaints and impairment on a PM task with short- and long-term retention intervals carried out both within and outside of the laboratory setting. Overall, participants utilized external strategies 41% of the time on the RPA-ProMem. This level of utilization is difficult to compare directly with other older adult samples, as research has reported varying amounts of actual and self-reported strategy use across PM tasks. Einstein and McDaniel (1990), for example, reported that 83% of cognitively healthy older adults used an external strategy during a laboratory-based PM task that involved performing an action when a target word appeared during a short-term memory task. In this study, participants were given 30 s before the task began to formulate a memory aid. By contrast, Delprado et al. (2013) found that healthy older adults reported using an external strategy (i.e., written strategy) for approximately 30% of self-generated PM tasks carried out in a naturalistic study, while those with aMCI reported using strategies 20% of the time. Moreover, approximately 32% of participants in our study did not use an external strategy on any part of the RPA-ProMem, while approximately 16% of participants utilized an external strategy on all four parts of the RPA-ProMem. There was greater use of external strategies on the long-term, more naturalistic PM tasks (RPA-ProMem Parts 3 and 4) as compared to the short-term tasks carried out in the laboratory (RPA-ProMem Parts 1 and 2). This is consistent with some previous research suggesting that whereas older adults attain lower scores than their younger counterparts on laboratory-based PM tasks, they show superior performance on naturalistic or long-term tests of PM, possibly due to strategy use, greater motivation, the opportunity to contemplate and rehearse tasks over the retention interval, or a combination of factors (Rendell & Craik, 2000).

We hypothesized that older adults in the preclinical stages of dementia (i.e., those with MCI and possible pre-MCI conditions such as SCD) would utilize fewer external memory strategies than HC participants. This hypothesis was not supported. Three RPA-ProMem subtests did not show any statistical significance when comparing the groups on use of external strategies. The finding of statistical significance between the participant groups on the RPA-ProMem (i.e., on Part 2 only) occurred because SCD had the greatest percentage of usage and not because MCI utilized fewer strategies than HC. In future research we plan to explore knowledge about compensatory mechanisms among those with SCD. These

individuals, who present with significant concern about their memory and represent an at-risk group for dementia, may derive maximal benefit from cognitive interventions because of their relatively intact normal neuropsychological test performance and capacity for insight into their cognitive weaknesses. Our goal is to develop an instructional intervention focused on general and practically oriented cognitive strategies and to investigate whether enhanced strategy use results in positive memory changes among those with SCD.

With regard to MCI, others have found significant differences between cognitively intact older adults and those with MCI in cognitive strategy use, with MCI actually utilizing fewer strategies (Brum et al., 2013; Delprado et al., 2013; Hutchens et al., 2013, 2012) or self-reporting lower utilization (Delprado et al., 2013; Dixon & de Frias, 2007). In our sample, the MCI group used memory strategies at statistically comparable levels to HC even though their PM task performance was significantly poorer on all RPA-ProMem subtests. Although not the focus of the analyses reported in the results of this article, due to the relatively smaller subsample of aMCI, a possible explanation is that for participants with MCI, particularly the amnesic subtype, strategies were less effective because the episodic memory deficit, in combination with subtle impairment in executive attention, resulted in a global PM deficit. Further inspection of RPA-ProMem performance by the 17 aMCI participants revealed that the majority of errors related to loss of content (remembering *what* to do) rather than the prospective component (remembering *when* to act).

Obviously, memory strategies are only effective to the degree that they lead individuals to execute the correct tasks. This suggests that cognitive interventions for PM should target both cue detection and retrieval along with memory encoding. For example, McDaniel and Bugg (2012) describe a successful visual imagery strategy designed to help older adults remember to gather up the umbrella they brought to lunch. Alternatively, older adults could be taught the external strategy of situating a distinctive looking pill bottle in a location where it will be seen at breakfast time (so that they realize *when* to do something) along with how to make stronger initial links between cues and desired responses (so that they remember *that* and *what* to do when they encounter the distinctive pill bottle at breakfast time) (Zogg, Woods, Saucedo, Wiebe, & Simoni, 2012). A related approach involves the internal strategy of implementation instructions, whereby older adults are directed to explicitly link a cue to its related intentions; for example, individuals repeat to themselves “When I see X, I will do Y” (Gollwitzer, 1999; McFarland & Glisky, 2011).

We also investigated the association of demographic variables, participant group, and external strategy use with total score on the RPA-ProMem. First, lower age showed a trend level association with higher PM performance consistent with meta-analytic findings that age declines in PM are generally small until the fifth or sixth decade and increase thereafter (Uttl, 2008). Second, being classified as SCD or MCI showed a significant association with lower PM performance. Third, we found support for our hypothesis that external strategy use is related to higher PM performance. Given the limited previous research documenting actual performance benefits on PM tasks from strategy use, the current findings lend important support to the idea that training external strategy use could have beneficial effects on real-world PM functioning in those with compromised memory ability such as MCI. Additionally, for individuals with SCD, for whom the fear of dementia may be salient,

increased strategy use may have benefits beyond improvements in everyday memory such as helping these individuals feel more confident and less fearful about their current and future cognitive abilities.

We also investigated the association of demographic variables, participant group, and performance on a test of executive functioning with strategy use on the RPA-ProMem. First, having more years of education and lower age were associated with increased external strategy use. Some previous research suggests the opposite pattern for age – that increasing age is associated with increasing self-reported external strategy use (Bouazzaoui et al., 2010; Delprado et al., 2013; Dixon & Hultsch, 1983), although this research was based on self-reported data. By contrast, Masumoto et al. (2011) found no relation of age to actual use of external memory aids in older adults on a PM task. Further research is required before conclusions can be drawn regarding the relationship of increasing age to strategy use. With regard to education, the current findings are consistent with research indicating a positive association between education level and external strategy use (Bouazzaoui et al., 2010; de Frias et al., 2003). It is possible that increased education carries increased knowledge about memory aids and their implementation. It would be interesting to further investigate the relationship between education level and use of specific strategies to determine whether higher education leads not only to greater use of strategies but more effective use or better strategy selection. Second, we found support for the hypothesis that better executive functioning is associated with greater external strategy use on the RPA-ProMem. To our knowledge the current study is the first to investigate the association of executive functioning with actual external strategy use on a PM task. Some previous research did not report an association between executive functioning and self-reported use of external strategies but found an association between executive functioning and self-reported internal strategy use (Bouazzaoui et al., 2010). Further research is required to determine whether executive functioning is differentially related to the implementation of internal versus external strategies.

Several study limitations and additional future directions warrant mention. We would like to investigate various psychological, emotional, and cognitive variables that determine whether or not older adults employ strategies in their daily lives. These might include knowledge about memory strategies and their effectiveness, personality features, memory self-efficacy, and anxiety about the aging process. Unfortunately we were not able to account for these variables in the current study, but greater knowledge about how they impact strategy use may inform interventions tailored to specific psychological and cognitive profiles. Additionally, while in the laboratory, participants were reminded that they could use any technique to help them remember the task, but in the naturalistic setting participants had to rely on their own cognitive retrieval processes and memory. While we recorded strategy use immediately following the delivery of task instructions, we were unable to track out-of-laboratory strategy use over the course of the week. In future work we hope to create a recording mechanism of strategy use to assess the use and benefit of cognitive strategies in naturalistic settings. In the present study we also attempted to record internal strategy use (e.g., by simply observing whether participants engaged in active rehearsal, repetition of goals, etc.) but we found our approach to be inadequate. In future work we will expand the

recording of types of strategies used and devise a valid method to record internal strategy use during task execution or immediately thereafter (e.g., by querying participants directly).

Conclusions

Nondemented, community-dwelling older adults utilize external strategies with regularity to assist in the successful completion of PM tasks. Additionally, greater strategy usage occurs on tasks carried out in naturalistic environments. Although individuals with episodic memory deficits (i.e., MCI) use strategies at comparable levels to their non-impaired counterparts, their PM performance is poorer, suggesting that strategy use by MCI participants is less efficient and effective than it is for healthy elderly controls, and leading to ideas for practical interventions. Also, increasing the number of external strategies is significantly associated with better PM performance, suggesting that external strategies are effective memory aids for older adults. Training older adults on cognitive strategies may improve everyday cognitive and functional abilities, particularly for those at risk for neurodegenerative decline. Finally, interventions that seek to increase strategy use via enhancing executive functioning may provide the greatest boost to PM.

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Table 1

Sample characteristics of 214 participants.

Variable	Mean (<i>SD</i>)	Percentage (frequency)
Age (years)	80.52 (5.60)	
Sex (women)		68.2 (146)
Race/ethnicity (non-white)		39.7 (85)
Education (years)	14.48 (3.48)	
RPA-ProMem Total	8.23 (2.73)	
RPA-ProMem Part 1	1.75 (1.13)	
RPA-ProMem Part 2	2.28 (0.95)	
RPA-ProMem Part 3	2.19 (1.08)	
RPA-ProMem Part 4	1.91 (1.19)	
Executive/processing speed Factor Z score	0.55 (0.95)	
Participant group	0.55 (0.95)	
HC		42.5 (91)
SCD		33.2 (71)
MCI		24.3 (52)

Notes: *SD* = standard deviation, RPA-ProMem = Royal Prince Alfred Prospective Memory Test, HC = healthy control, SCD = subjective cognitive decline, MCI = mild cognitive impairment.

Table 2

Strategy type used for the Royal Prince Alfred prospective memory test parts ($n = 214$).

Variable	HC percentage (#) ($n = 91$)	SCD percentage (#) ($n = 71$)	MCI percentage (#) ($n = 52$)	<i>p</i>-value
RPA-ProMem Part 1				0.09
No external strategy	67.0 (61)	56.3 (40)	75.0 (39)	
External strategy	33.0 (30)	43.7 (31)	25.0 (13)	
RPA-ProMem Part 2				0.04
No external strategy	81.3 (74)	70.4 (50)	88.5 (46)	
External strategy	18.7 (17)	29.6 (21)	11.5 (6)	
RPA-ProMem Part 3				0.51
No external strategy	51.6 (47)	49.3 (35)	59.6 (31)	
External strategy	48.4 (44)	50.7 (36)	40.4 (21)	
RPA-ProMem Part 4				0.35
No external strategy	42.9 (39)	32.4 (23)	42.3 (22)	
External strategy	57.1 (52)	67.6 (48)	57.7 (30)	

Notes: HC = healthy control, SCD = subjective cognitive decline, MCI = mild cognitive impairment, RPA-ProMem = Royal Prince Alfred Prospective Memory Test.

Table 3

Multivariate linear regression analyses for performance on the Royal Prince Alfred prospective memory test total score ($n = 214$).

Variable	β	SE	P -value
Participant group			
HC	Reference		
SCD	-1.04	0.40	.009
MCI	-2.59	0.46	<.001
Age (years)	-0.06	0.03	.051
Sex (women)	-0.02	0.37	.95
Race/ethnicity (non-white)	-0.37	0.37	.32
Education (years)	0.00	0.05	.99
External strategy (total score)	0.25	0.12	.047
Constant	13.92	2.77	<.001

Notes: SE = standard error, HC = healthy control, SCD = subjective cognitive decline, MCI = mild cognitive impairment, external strategy = total number of external strategies utilized across Parts 1–4 of the Royal Prince Alfred Prospective Memory Test.

Table 4

Multivariate linear regression analyses for total number of external strategies used on the Royal Prince Alfred prospective memory test ($n = 213$).

Variable	β	<i>SE</i>	<i>P</i> -value
Participant group			
HC	Reference		
SCD	0.40	0.22	.067
MCI	0.38	0.28	.18
Age (years)	−0.05	0.02	.006
Sex (women)	−0.10	0.20	.61
Race/ethnicity (non-white)	0.09	0.22	.67
Education (years)	0.07	0.03	.015
Executive factor Z score	0.34	0.13	.008
Constant	4.23	1.54	.007

Notes: *SE* = standard error, HC = healthy control, SCD = subjective cognitive decline, MCI = mild cognitive impairment.