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An implementation intention strategy can improve prospective memory in older adults with very mild Alzheimer's disease

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Abstract

Objectives—The present study tested if 1) very mild Alzheimer's disease (AD) is associated with impaired prospective memory (PM) for tasks that are supported by either spontaneous retrieval (focal PM) or strategic monitoring (nonfocal PM) and 2) whether Implementation Intention (II) encoding could improve PM performance in very mild AD.

Design—Thirty-eight healthy older adults and thirty-four with very mild AD were randomly assigned to perform two PM tasks in either the standard or the II encoding condition.

Method—All participants performed blocks of category decision in which they were asked to respond to a focal PM target (e.g., the word “orange”) and a nonfocal PM target (e.g., words that begin with the letter “o”). Half of the participants encoded PM instructions in the standard manner, while the other half had a stronger encoding by forming II's. PM accuracy and category decision accuracy and reaction times were measured.

Results—Participants with very mild AD showed deficits in both focal and nonfocal PM performance compared to the healthy controls, reflecting deficits in both spontaneous retrieval and strategic monitoring. Participants with very mild AD in the II encoding condition showed better focal PM performance relative to those in the standard encoding condition.

Conclusions—Deficits in both focal and nonfocal PM are associated with very mild AD and II's may be a helpful behavioral intervention for the focal PM deficits.

Prospective memory (PM) refers to remembering to perform an intended action at the appropriate time in the future. Event-based PM refers to when the PM cue is specified by a particular event, such as remembering to deliver a message to a colleague when he sees her (see McDaniel & Einstein, 2007, for a review). Laboratory PM research has focused on identifying the mechanisms that support PM, and research suggests that multiple processes underlie successful PM retrieval (Einstein et al., 2005; McDaniel & Einstein; Scullin, McDaniel, & Shelton, 2013; Scullin, McDaniel, Shelton, & Lee, 2010). In the present study we focus on the decline in PM observed in very mild Alzheimer's disease (AD) (Duchek, Balota, & Cortese, 2006; Huppert, Johnson, & Nickson, 2000; Maylor, Smith, Della Sala, &

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Logie, 2002; McDaniel, Shelton, Breneiser, Moynan, & Balota, 2011; Tam & Schmitter-Edgecombe, 2013; Tse et al., 2014). One of our objectives was to identify the PM retrieval processes that are disrupted in very mild AD. A second objective was to test the utility of strengthening the encoding of PM intentions to determine 1) if an encoding deficit was at least partly responsible for observed PM failures in AD patients and 2) if a simple strategy could be effective in boosting PM performance in patients with very mild AD.

In this study we adopted a laboratory-based PM task designed to isolate the cognitive mechanisms supporting PM retrieval (e.g., Einstein et al., 2005; Scullin et al., 2010). In the typical PM paradigm, participants are asked to engage in an ongoing task, such as a category decision task in which decisions must be made about whether an exemplar (e.g., football) is a member of the given category (e.g., sport). In addition to the ongoing task, participants are asked to remember to perform a particular action such as pressing the “Q” key (PM response) when they later encounter the word “orange” (PM cue). The present study manipulated the focality of the PM cue to encourage reliance on different cognitive processes to support retrieval of the PM intention. In focal PM tasks, the processes needed to detect the PM cue match (i.e., are “focal” to) the processes required to perform the ongoing task. For example, the word “orange” is considered to be a focal PM cue within category decision tasks because the semantic processing required by the category decision task naturally directs attention to the semantic features of the encoded PM cue. This overlapping process increases the likelihood that the PM intention is spontaneously retrieved (McDaniel & Einstein, 2007).

By contrast, in nonfocal PM tasks, the processes needed to detect the PM cue do not match the processes required to perform the ongoing task. For example, detecting words that begin with a particular letter (initial-letter PM cue) would be nonfocal within category decision tasks because the semantic processing required by the ongoing category decision task does not overlap with the processing required to check the initial letter of words. In such nonfocal cases, spontaneous retrieval is unlikely and participants must rely on more demanding, strategic monitoring processes to support PM retrieval. Strategic monitoring is measured by the relative slowing of reaction times (RTs) on nontarget trials of the ongoing task when a PM intention is embedded (PM block) compared to RTs on the ongoing task when no PM intention is present (control block). This slowing is believed to reflect the employment of limited attentional resources to monitor for the PM cue (McDaniel & Einstein, 2007; Smith, 2003). Indeed, ongoing task slowing is typically observed in nonfocal PM tasks and are often absent in focal PM tasks (Brewer, Knight, Marsh, & Unsworth, 2010; Einstein et al., 2005; Scullin, McDaniel, & Einstein, 2010; Scullin et al., 2010).

The focal/nonfocal distinction is important for its theoretical bearings as these tasks are believed to be sub-served by different underlying mechanisms (Einstein et al., 2005; McDaniel, LaMontagne, Beck, Scullin, & Braver, 2013). Furthermore, the cue focality distinction in PM has been a useful approach to discriminating between healthy older adults (OAs) and those with very mild AD (McDaniel et al., 2011). McDaniel et al. had a group of healthy OAs (clinical dementia rating or CDR of 0.0, for more information about CDR, see ***Morris, 1999) and a group of patients with very mild AD (CDR 0.5) complete a focal and nonfocal PM task. They observed lower focal PM performance in OAs with very mild

AD relative to healthy controls, but no group differences in nonfocal PM performance. The lack of nonfocal effects in their experiment was possibly due to floor-level performance. In support of this latter possibility, a number of studies reported nonfocal PM deficits in participants with amnesic MCI (Tam & Schmitter-Edgecombe, 2013) and with mild AD (Farina, Young, Tabet, & Rusted, 2013). Therefore, one objective of the current experiment was to extend the McDaniel et al.'s finding using a less difficult nonfocal PM task to determine if AD-related deficits would be observed in nonfocal PM performance (i.e., in situations where nonfocal PM is at moderately good levels for healthy OAs) as well as in focal PM performance.

Specifying the type of PM task that shows declines in OAs with very mild AD has important implications for understanding the mechanisms underlying various PM deficits in AD. One hypothesis is that nonfocal PM tasks will be prone to AD-related decline because nonfocal PM tasks require the engagement of attentional resources that are compromised even with very mild AD (Balota & Faust, 2001). Another hypothesis is that focal PM performance will reveal substantial AD-related deficits due to this task being supported by a spontaneous retrieval process. The reasoning here is that hippocampal function is presumed to play a critical role in spontaneous retrieval (Moscovitch, 1994), and the hippocampus is compromised early in the AD process (Buckner, 2004; Head, Snyder, Gorton, Morris, & Buckner, 2005). Consistent with this prediction, the structural integrity of the hippocampus was positively associated with focal PM performance in a group of healthy OAs and those with very mild AD (Gordon, Shelton, Bugg, McDaniel, & Head, 2011).

To evaluate whether nonfocal PM tasks (in addition to focal tasks) would produce AD-related impairments, we implemented several important modifications to McDaniel et al.'s (2011) paradigm. First, we used an easier nonfocal PM cue. McDaniel et al.'s nonfocal PM task required participants to make a PM response whenever they encountered a particular *syllable* (embedded in words) during the ongoing task (a category decision task). In our experiment, the nonfocal PM task required participants to make a PM response whenever a word began with a particular *initial letter*. Past research has demonstrated that searching for "initial-letter" targets is less difficult than searching for syllable targets during a target vigilance task (not a PM task), as reflected by relatively faster target identification with initial-letter cues (Scullin et al., 2010). The focal PM task remained the same as in McDaniel et al. (single word as the PM cue). Second, we eliminated the 15 min distractor task McDaniel et al. inserted between the PM instructions and the start of the first PM block because such distractor tasks can lower PM performance. The third notable change was to increase the number of PM target trials from three to six (the PM trial to nontarget trial ratio was kept the same as in McDaniel et al.) to increase the sensitivity to detect effects.

The second objective of this project was to test the efficacy of a behavioral intervention to strengthen the encoding of PM intentions among OAs with very mild AD. Finding ways to reduce the PM deficit observed in patients with very mild AD could encourage greater independence in the daily functioning of these individuals. It is clear that individuals with very mild AD have difficulty strategically controlling their attention to appropriate stimuli in a goal-directed manner (Balota & Faust, 2001), and this compromised attentional control mechanism may be associated with an encoding deficit in these individuals. Furthermore,

this encoding deficit might contribute partly to their PM errors. Therefore, for both theoretical and practical reasons, it is important to determine whether an encoding deficit is associated with the observed prevalence of PM errors in AD patients.

One behavioral intervention that aims to improve PM performance by strengthening the encoding of the PM cue is termed implementation intention (II) encoding. An extensive literature exists showing the efficacy of II's for improving the likelihood of completing future intentions (Gollwitzer, 1993; 1999) across a wide range of populations, including those with limited mental resources, such as patients with brain injury (Lengfelder, & Gollwitzer, 2001). An II is a simple encoding strategy where participants verbalize the anticipated environmental cue and link the future intention to the cue (e.g., "When I see the word 'orange', then I will press the 'Q' key."). One view is that II encoding strengthens the association between the cue and intention, more so than the standard (non-II) encoding of PM intentions (Cohen & Gollwitzer, 2008; McDaniel, Howard, & Butler, 2008; see also Kliegel et al., 2007). Indeed, several studies have found support of II enhancement on PM performance in healthy young, healthy OAs, and in clinical patients in both laboratory-based and naturalistic settings (Brom et al., 2014; Burkard, Rochat, Juillerat Van der Linden, Gold, & Van der Linden, 2014; Chasteen et al., 2001; Cohen & Gollwitzer; Liu & Park, 2004; McDaniel et al.; McDaniel & Scullin, 2010; McDaniel et al., 2011; McFarland & Glisky, 2011; Schnitzspahn & Kliegel, 2009; Zimmermann & Meier, 2009; for a meta-analysis, see Chen et al., 2015). Recently, Burkard et al. demonstrated that OAs with MCI or various types of dementia benefitted from II for naturalistic PM tasks. Shelton et al. (under review) also found an II benefit for both healthy OAs and those with very mild AD in a PM task that simulates naturalistic tasks, termed the Virtual Week.

A unique contribution of our project is that we tested the efficacy of II on both focal and nonfocal PM tasks in healthy OAs and AD patients. Given that different mechanisms are thought to underlie focal and nonfocal PM, different predictions are formulated for the benefits of II for each PM type. The strengthening of association between the PM cue and the PM response is predicted to improve focal PM performance by facilitating the spontaneous retrieval process (McDaniel & Scullin, 2010), which is a retrieval process that can be effectively used in focal tasks. However, the same strengthening is predicted not to improve nonfocal PM performance because even the strengthened association between the nonfocal PM cue and the PM response is unlikely to facilitate the spontaneous retrieval. IIs would only be predicted to improve nonfocal PM if they increased the continuous engagement of strategic monitoring processes (which are necessary for the successful execution of nonfocal PM tasks), possibly as a consequence of the II conferring greater importance to the PM task (Kliegel, Martin, McDaniel, & Einstein, 2004; Meeks & Marsh, 2010; Smith, Rogers, McVay, Lopez, & Loft, 2014). Though these studies demonstrated that IIs improved nonfocal PM via increased monitoring in healthy young adults, it is unclear whether IIs could boost monitoring in OAs, particularly those with AD. The present study will test this hypothesis.

Method

Design

The experiment was a 2 (CDR status: 0.0/0.5) $\times$ 2 (Encoding condition: Standard/II) $\times$ 3 (Block type: Control/Focal PM/Nonfocal PM) mixed-factor design. Block type was the only within-participants factor.

Participants

Thirty-eight participants with CDR of 0.0 and 34 participants with CDR of 0.5 were recruited from a local Alzheimer's Disease Research Center (ADRC) where they were enrolled in a longitudinal study¹. The data from two CDR 0.0 participants were dropped, one for a medical reason and another for incompletion. All participants have been interviewed extensively by the clinicians at the ADRC and were given the diagnosis of either CDR of 0.0, which is indicative of cognitively normal, or 0.5, which is indicative of pre-clinical, very mild AD (Morris, 1993). All participants had normal or corrected vision and hearing, were within the age range of 65 – 85, and were screened for depression, reversible dementias, and other neurological conditions. Table 1 presents the number of participants in each condition, demographics, and neuropsychological test performance received from the ADRC to show the neuropsychological profile of our sample.

Materials

Three different lists of 200 category decision pairs were constructed based on materials used by Einstein et al. (2005). The word length and Log Hal Frequency of lists were comparable across lists (Balota et al., 2007). Use of lists was counterbalanced for each block. The control block had 100 trials² and focal and nonfocal PM blocks had 200 trials each. Half of the trials in each block were “yes” and the other half were “no” trials. In each list, nontarget category exemplar pairs repeated twice, four times, or six times to simulate the repetition of PM targets.

Participants were given the focal task of pressing the “Q” key when they saw the word “lawyer” (or “orange” in counterbalanced condition) and the nonfocal task of pressing “Q” for words that begin with the letter “o” (words beginning with “l” in counterbalanced condition). For each initial letter cue, there were three examples that repeated twice each, though not consecutively (orange, opera, olive, or lawyer, linen, lion). For each PM block, a total of six PM cues appeared on the 30th, 60th, 90th, 120th, 150th, and 180th trials.

Procedure

Participants were randomly assigned to one of two encoding conditions (standard versus II). They were asked to perform three blocks of the category decision task on a computer. Each

¹A portion of CDR 0.0 group's data was presented in Scullin et al., (2013) where the detrimental effect of history of hypertension on PM performance was investigated collapsed across encoding conditions. Also, participants in our study completed an additional, but separate, PM task at the end of the experimental session of our study and the results of this PM task are reported in Shelton et al. (under review).

²The first two participants had two hundred trials during the control block due to a programming issue. Those extra trials were not analyzed or included.

trial of the category decision task had a possible exemplar in the lowercase letters on the left side of the screen and paired with a possible category word in uppercase letters on the right side of the screen (e.g., football SPORT). Keys on the number pad (“1” and “2”) were labeled “y” and “n” and participants were asked to press the “y” key if the exemplar belonged to the presented category, or the “n” key if the exemplar did not. Participants first performed a set of practice trials with feedback regarding accuracy and reaction time on their responses. Participants were then told that no further feedback would be provided. The order of three experimental blocks was counterbalanced such that half of the participants received the control block first while the other half received the PM blocks first. The order in which each PM block was presented was also counterbalanced.

Following the practice trials of the category decision task (and the control block where appropriate), participants received the PM instructions. The instructions stated that the experimenter was additionally interested in people’s ability to remember to perform an action in the future and they were to perform the PM task of pressing the Q key for a specific word or word beginning with a specified initial letter. Participants were randomly assigned to one of two encoding conditions. In the standard encoding condition, participants first read the respective PM instructions at the beginning of each PM block at their own pace and then were asked to recite the instructions back to the experimenter to proceed with the task. In the II encoding condition, after reading the PM instructions at their own pace and reciting the instructions back to the experimenter, participants were asked to read aloud the II statement on the screen (e.g., for focal PM task, “When I see the word ‘orange’, or for nonfocal PM task, “When I see the words that begin with the letter ‘l’, during the category decision task, then I will press the ‘Q’ key”). Once participants successfully read the statement three times, on the following screen participants were instructed to spend 30 seconds imagining encountering the PM cue and performing the intended action.

After each PM block, participants were told that they no longer needed to perform the specific PM task (see Scullin & Bugg, 2013, for efficacy of these instructions). Upon completing all three blocks of the category decision task, participants’ retrospective memory (RM) for the PM instructions was tested. Participants were asked to pick the correct answer option from three alternatives on questions regarding which word they were to remember (for focal PM cue), which initial letter they were to remember (for nonfocal PM cue), and which key they were to press (for PM response).

Results

All statistical tests were two-tailed with an alpha of .05 unless noted otherwise. To indicate effect sizes, we report partial eta-squared for the analysis of variance (ANOVA) and Cohen’s *d* for the chi-square test and planned comparisons.

Retrospective Memory Performance

We first analyzed performance on the RM test (see Table 2 for descriptive statistics; RM for the PM response was excluded from analyses because of perfect scores by all participants) to test whether II’s enhanced memory for the *contents* of the PM intention rather than the cue—intention association. As expected, RM was poorer in the CDR 0.5 group than the CDR

0.0 group, for the focal PM cue, $\chi^2(1, N = 70) = 6.95, p < .01$, Cohen's $d = .66$, and for the nonfocal PM cue, $\chi^2(1, N = 70) = 10.94, p < .01$, Cohen's $d = .86$. More pertinent to the present goals, RM for focal and nonfocal PM cues did not differ by encoding condition in the CDR 0.5 group, for the focal PM cue $\chi^2(1, N = 34) = .81, p = .37$, and for the nonfocal PM cue $\chi^2(1, N = 34) = .15, p = .70$.

Prospective Memory Performance

In our analyses of PM performance we excluded participants who failed both to make PM responses and recognize the PM cues on the RM test to ensure that PM deficits are not ascribed to very mild AD patients that would be better described as RM deficits (McDaniel et al., 2011). This left 12 and 11 participants with CDR 0.5 in the standard and II encoding conditions, respectively, and all CDR 0.0 participants in both encoding conditions.

The proportion of correct PM responses was entered into a 2 (CDR status: 0.0/0.5) $\times$ 2 (Encoding condition: Standard/II) $\times$ 2 (PM cue type: Focal/Nonfocal) mixed ANOVA with the PM cue as the within-participants variable. There was a main effect of CDR status, $F(1, 55) = 8.83, MSE = .086, p < .01, \eta_p^2 = .14$, such that those in the CDR 0.0 group had higher overall PM performance ($M = .81$) than those in the CDR 0.5 group ($M = .64$) (See Table 3 for the means of focal and nonfocal PM performance). There was a significant main effect of PM cue type, $F(1, 55) = 55.24, MSE = .079, p < .001, \eta_p^2 = .50$, such that overall participants performed better on the focal PM task ($M = .92$) than on the nonfocal PM task ($M = .53$). There was a marginally significant main effect of II, $F(1, 55) = 3.63, MSE = .086, p = .062, \eta_p^2 = .06$, such that participants in the II encoding condition tended to perform better on PM tasks ($M = .78$) than those in the standard encoding condition ($M = .67$). No significant interactions were observed ($F_s < 2.12$). We followed up the ANOVA with planned comparison tests to investigate the effect of IIs on PM performance in each PM condition for both groups. For participants with very mild AD, IIs tended to produce higher PM performance for the focal PM task relative to the standard encoding condition, $F(1, 55) = 3.69, MSE = .086, p = .055$, Cohen's $d = .80$. No other comparisons were significant, $F_s < 1.31$.

Despite using random assignment, participants in the II condition had better associative memory than those in the standard condition (See Table 1 for relevant statistics), and CDR 0.5 participants were older than the CDR 0.0 participants. Thus, we also conducted a parallel mixed analysis of covariance (ANCOVA) with centered age and associative memory as covariates. The results of the ANCOVA revealed comparable patterns to the above ANOVA. The only difference between analyses was the increase in p-values for the main effect of encoding condition ($p = .13$) and the planned comparison of focal PM performance between CDR 0.5 participants in the II versus standard encoding conditions ($p = .08$). None of the covariates were significant or interacted with any of the independent variables ($F_s < 1$).

Category Decision Task Performance

We next tested whether focal and nonfocal PM performances were supported by monitoring or spontaneous retrieval processes by evaluating ongoing task performance (see Table 4 for descriptives). We calculated mean trimmed RTs on nontarget category decision trials

(Einstein et al.'s, 2005) and entered those means into a 2 (CDR status: 0.0/0.5) $\times$ 2 (Encoding condition: Standard/II) $\times$ 3 (Block type: Control/Focal PM/Nonfocal PM) mixed ANOVA with Block type as within-participants variable. There was a significant main effect of CDR status, $F(1, 54)^3 = 18.53$, $MSE = 679646.58$, $p < .001$, $\eta_p^2 = .26$ showing that participants in the CDR 0.0 group ($M = 1517$ msec) made faster category decisions than those in the CDR 0.5 group ($M = 2068$ msec). There was also a main effect of block type, $F(2, 108) = 21.01$, $MSE = 15772.63$, $p < .001$, $\eta_p^2 = .28$. Planned comparisons indicated that, RTs from the focal PM block did not differ from those in the control block in any of four individual groups (largest $F < 2.71$). In addition, mean RTs from the nonfocal PM block were significantly longer relative to the control block ($F_s(1, 108) > 5.66$, $MSE = 15772.63$, $ps < .02$, Cohen's $d_s > .77$) and the focal PM block ($F_s(1, 108) > 4.48$, $MSE = 15772.63$, $ps < .04$, Cohen's $d_s > .69$) for all individual groups, consistent with the allocation of effortful monitoring processes in nonfocal PM blocks. No other main effects or interactions were significant, $F_s < 1.01$.

Mean accuracy of category decisions on nontarget trials was also entered into a 2 (CDR status: 0/0.5) $\times$ 2 (Encoding condition: Standard/II) $\times$ 3 (Block type: Control/Focal PM/Nonfocal PM) mixed ANOVA with Block type as within-participants variable (see Table 5 for descriptives). There was a significant main effect of block type, $F(2, 110) = 4.60$, $MSE = 0.002$, $p = .012$, $\eta_p^2 = .08$. Planned comparisons revealed that accuracy did not differ across three blocks for three groups of participants, those with a CDR of 0.5 in both the standard and II encoding conditions and those with a CDR of 0.0 in the standard encoding condition ($F_s < 1$). Participants with a CDR of 0.0 in the II encoding condition were more accurate in the control block ($M = 0.98$) compared to the focal PM block ($M = 0.94$) and the nonfocal PM block ($M = 0.94$), $F_s > 6.08$, $MSE = 0.002$, $ps < .02$, Cohen's $d_s = .85$. No other main effects or interactions were significant, $F_s < 1.11$. We further conducted parallel mixed ANCOVAs with centered age and associative memory as covariates, and the results revealed comparable patterns to those observed in the above ANOVAs.

Discussion

One objective of this project was to test if a nonfocal PM task would reveal AD-related deficits. We used an easier nonfocal PM task (initial-letter PM cue, without a 15 minute distracter task) than in previous work (McDaniel et al., 2011), and we succeeded in elevating nonfocal PM performance levels by approximately 50%. Using this revised methodology we found that participants with very mild AD displayed significantly lower PM performance than healthy controls for both nonfocal and focal PM tasks. Further, this AD-related PM deficit was not significantly more pronounced for focal PM. This finding suggests that McDaniel et al.'s finding of AD-related deficits for focal but not nonfocal PM could have been due to relatively low performance levels in their nonfocal PM task. Indeed, Tam and Schmitter-Edgecombe (2013) also reported that individuals with an amnesic MCI (that were diagnosed with CDR 0.5) performed worse on a nonfocal PM task ($M = .46$), compared to their healthy controls ($M = .68$) (see also Farina et al., 2013; Tse et al., 2014, for similar

³One participant's category decision accuracy was too low to compute RTs for the "yes" trials of category decision in the focal and nonfocal PM blocks. Thus, we excluded this participant from the analyses of category decision RTs.

findings). Thus, together with previous findings of deficits on focal PM tasks in very mild AD (Duchek et al., 2006; Huppert et al., 2000; Maylor et al., 2002; McDaniel et al.), our findings suggest that OAs with very mild AD display deficits on both focal and nonfocal PM tasks relative to healthy OAs. While McDaniel et al. provided preliminary evidence for focal PM significantly contributing to the discrimination of healthy OAs from those with very mild AD beyond the usual neuropsychological measures, the small sample size per condition in the present study limits our ability to further examine the predictive utility of PM. Future research using large samples should test whether focal or nonfocal PM tasks provide additional discriminative value for detecting AD relative to common neuropsychological tests.

Our second objective was to test whether strengthening the encoding of future intentions using IIs is effective for OAs with very mild AD. Indeed, II encoding improved the PM performance of OAs with very mild AD to a level comparable to that of healthy controls for the focal PM task (see Table 3) without improving RM for PM cues. One possible explanation for the lack of II benefit on RM is that our RM test was insensitive to detect possible II benefits. Nonetheless, together with recent findings of improved naturalistic PM performance (Burkard et al., 2014; Shelton et al., under review), our findings suggest that forming IIs can be useful for patients with very mild AD. Further, a novel finding is that the II strategy enhanced focal PM performance in those with very mild AD, without slowing RTs of category decisions during the focal PM block compared to that of the control block; that is, IIs increased focal PM in the absence of monitoring costs. There are exciting practical implications of these findings. It is noteworthy to have a successful intervention that is simple and does not require the deployment of additional attentional monitoring resources in a clinical population whose attentional control abilities are already compromised (Balota & Faust, 2001; Perry & Hodges, 1999). Furthermore, daily life is filled with focal PM tasks such as delivering a message to a colleague when one sees him/her. In that situation, someone's face is a focal PM cue because one has to recognize that face to deliver the message. Given the abundance of focal PM tasks in daily life, our finding of an II benefit on focal PM in those with very mild AD is encouraging. Future research is needed to investigate whether our finding of II-enhanced focal PM will extend to PM tasks carried out by those with very mild AD in real-world contexts.

There are also important theoretical implications regarding the selective enhancement of II encoding on focal PM performance in the CDR 0.5 group without increasing the level of strategic monitoring costs. This finding lends credence to the view that II encoding enhances PM performance by strengthening the association between the cue and response, which increases the probability of spontaneous retrieval when the cue is *focally* processed (McDaniel & Scullin, 2010). The absence of an II effect in the CDR 0.0 group (for focal PM) was almost certainly due to performance levels being at ceiling in the standard encoding group. Importantly, the lack of a significant II benefit for nonfocal PM for both CDR groups could be informative regarding the underlying mechanism of IIs. II's strengthening of the cue-response association in focal PM tasks is unlikely to translate to benefits in nonfocal PM tasks because these tasks are dependent on strategic monitoring, not spontaneous retrieval. It is possible that II encoding could enhance nonfocal PM by increasing the engagement of strategic monitoring (but cf. McDaniel et al., 2008). However,

at least for our participants with CDR 0.0, this was not the case because their RTs on the nonfocal PM block were virtually the same between encoding conditions (and the control block RTs also did not differ, so that monitoring costs remained the same across the encoding conditions). Thus, our data suggest that it is unlikely that II increased monitoring behaviors and subsequently caused the nominally higher nonfocal PM performance observed in participants with CDR 0.0. While our findings offer initial insight into this theoretical question, given the relatively small sample size, future research is needed to better understand if, and by what mechanism, II encoding might benefit nonfocal PM tasks in healthy OAs and those with AD.

To summarize, participants with very mild AD revealed deficits in both focal and nonfocal PM tasks. Thus, the claim that very mild AD is associated with a signature decline in focal PM performance needs to be revised (cf. McDaniel et al., 2011). Importantly, a simple encoding strategy (cf. the expanded retrieval strategy in Camp, Foss, Stevens, & O'Hanlon, 1996) was effective in enhancing focal PM performance in patients with very mild AD to the level of healthy controls with no apparent need to engage taxing, strategic monitoring processes. The selective enhancement of focal PM for OAs with very mild AD using II encoding suggests that the spontaneous retrieval process can still support PM in very mild AD if the association between the PM cue and response is strengthened.

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Practitioner points

- Multiple deficits in PM are observable in very mild AD.
- Implementation intentions may enhance focal PM in very mild AD.
- Future research using larger samples is needed to better understand the effect of II on nonfocal PM tasks in healthy older adults and those with very mild AD.
- The use of simple laboratory PM tasks may limit the generality of our findings. Future research is needed to investigate whether IIs improve PM over a range of more realistic tasks.

Table 1

Demographic and Neuropsychological Characteristics of Participants

	CDR 0		CDR .5		Significance
	Standard	II	Standard	II	
N	19	17	17	17	
Age (yr)	74.8 (6.5)	73.2 (6.2)	78.6 (6.4)	80.5 (5.7)	*
Education	14.9(.64)	14.9(.66)	15.3(.72)	14.9(.75)	
MMSE	28.8(.43)	29.1(.45)	27.2(.49)	26.2(.51)	*
Associate Memory	13.0(1.00)	16.3(1.03)	7.5(1.13)	10.1(1.18)	* §
Selective Reminding Test	47.9(.8)	47.7(.8)	45.2(.9)	44.2(.9)	*
Forward Digit Span	6.9(.23)	7.0(.24)	6.5(.26)	6.6(.27)	
Backward Digit Span	4.9(.27)	5.1(.28)	4.8(.31)	3.9(.32)	*
Trail Making Test -Part A	36.3(3.5)	31.4(3.6)	45.9(3.9)	51.6(4.1)	*
Trail Making Test -Part B	92.6(8.8)	77.2(9.1)	120.4(10.0)	131.9(10.4)	*
WMS Logical Memory	13.7(.94)	14.3(.97)	7.7(1.07)	8.9(1.11)	*
Letter Number Sequencing	8.2(.69)	9.3(.71)	6.7(.78)	6.5(.81)	*

Note. Means with Standard Error of the Means in parentheses.

II= Implementation Intention; MMSE = Mini-Mental status Exam.

* for $p < .05$ for CDR groups,

§ for $p < .05$ for encoding groups.

Table 2

Percentage of participants with correct response on the retrospective memory test.

CDR Status	Focal PM cue		Nonfocal PM cue		PM response	
	Standard	II	Standard	II	Standard	II
CDR 0	100	100	100	100	100	100
CDR 0.5	77	88	77	71	100	100

Table 3

Mean performance on the prospective memory tasks.

	CDR 0.0		CDR 0.5	
	Standard	II	Standard	II
Focal	1.0(.00)	.95(.10)	.75(.37)	.99(.05)
Nonfocal	.59(.35)	.69(.36)	.35(.34)	.49(.40)

Note. Means with standard deviations in parentheses.

Table 4

Mean RTs of category decision of nontarget trials.

Block type	CDR 0.0		CDR 0.5	
	Standard	II	Standard	II
Control	1482 (379)	1427 (218)	1963 (830)	2088 (460)
Focal PM	1499 (380)	1500 (270)	1975 (755)	2049 (452)
Nonfocal PM	1599 (393)	1594 (312)	2085 (793)	2248 (475)

Note. Means in milliseconds with standard deviations in parentheses.

Table 5

Mean performance of category decisions of nontarget trials.

Block type	CDR 0.0		CDR 0.5	
	Standard	II	Standard	II
Control	.96 (.04)	.98 (.02)	.95 (.03)	.97 (.02)
Focal PM	.94 (.03)	.94 (.12)	.95 (.02)	.95 (.03)
Nonfocal PM	.95 (.04)	.94 (.11)	.95 (.04)	.95 (.03)

Note. Means with standard deviations in parentheses.