Published in final edited form as:
J Int Neuropsychol Soc. 2012 November ; 18(6): 986–995. doi:10.1017/S1355617712000781.

Prospective Memory Deficits Are Associated With Poorer Everyday Functioning in Parkinson's Disease

Eva Pirogovsky[1], **Steven Paul Woods**[2], **J. Vincent Filoteo**[2,3], and **Paul E. Gilbert**[4]

[1]San Diego State University - University of California San Diego Joint Doctoral Program in Clinical Psychology, San Diego, CA

[2]Department of Psychiatry, University of California San Diego, San Diego, CA

[3]Veterans Affairs, San Diego Health Care System, San Diego, California

[4]Department of Psychology, San Diego State University, San Diego, CA

Abstract

Although individuals with Parkinson's disease (PD) evidence moderate deficits in prospective memory (PM), it is not known whether PM deficits confer an increased risk of poorer everyday functioning. In the current study, 33 individuals with PD and 26 demographically similar normal controls (NC) were administered performance-based and self-report measures of PM and everyday functioning, including medication and financial management. As compared to NC, PD participants demonstrated significantly lower scores on performance-based measures of PM and financial capacity, worse performance at a trend level on performance-based medication management and endorsed significantly greater self-reported declines in PM and instrumental activities of daily living (iADLs). In the PD sample, the laboratory measure of PM significantly correlated with performance-based measures of financial capacity and medication management and a self-report measure of medication management. Self-reported PM failures significantly correlated with perceived declines in iADLs, worse medication management, and poorer health-related quality of life. Although future studies are needed to examine the incremental ecological validity of PM in PD, findings from this study extend prior research by providing preliminary evidence that PM impairment may play a significant role in a range of critical everyday functions in PD.

Introduction

Parkinson's disease (PD) is a progressive neurodegenerative disorder characterized by motor, cognitive, and psychiatric symptoms, which lead to a variety of adverse functional outcomes. Individuals with PD demonstrate impairment in basic (bADLs) and instrumental (iADLs) activities of daily living (e.g., Cahn et al., 1998). Functional disability in PD is associated with a variety of factors, such as severity of motor symptoms, depression, global cognitive decline, and older age at onset (e.g., Bouwens, Heugtne, & Verhey, 2009; Post et al., 2011; Sabbagh et al., 2005; Starkstein et al., 1992). A specific area of iADLs that has growing interest in PD is medication non-adherence, which has been associated with complex drug regimens, depression, and poorer quality of life (e.g., Grosset et al., 2009; Valldeoriola et al., 2011).

Please address all correspondence to Dr. Paul Gilbert, SDSU-UCSD Joint Doctoral Program in Clinical Psychology, 6363 Alvarado Court, Suite 103, San Diego, CA 92120. Tel: (619) 594-7409; Fax: (619) 594-3773; pgilbert@sciences.sdsu.edu.

The authors have no conflict of interest.

Few studies have examined the specific cognitive predictors of everyday functioning in PD. Cahn and colleagues (1998) found that executive dysfunction was an independent predictor of iADLs, whereas motor slowing was uniquely associated with bADLs. ADLs have also been linked to deficits in verbal fluency, visual memory, visuoperception, and inattention in PD (Bronnick et al., 2006; Maeshima et al., 1997; Muslimovic et al., 2008; Uc et al., 2005).

The majority of studies examining everyday functioning in PD have used self-report or informant-report scales, whose validity are limited by cognitive impairment, depression, anosagnosia, and reporter bias (e.g., Blackstone et al., 2011; Argüelles et al., 2001, DeBettignies et al., 1990; Marino et al; 2009). Only two studies have examined functional decline using performance-based measures (Manning et al., 2012; Shulman et al., 2006). Shulman et al. (2006) found that individuals with PD were impaired in both bADLs and iADLs. Although Manning et al. (2012) did not include a comparison group, they found that over half (54%) of PD subjects failed two performance-based medication management tasks. A few studies also have reported medication non-adherence in PD using electronic monitoring (e.g., Grosset et al., 2009).

One area of cognition that may be particularly relevant to the prediction of functional decline in PD is prospective memory (PM). PM describes the ability to perform an intended action at some designated point in the future (McDaniel & Einstein, 2000), or “remembering to remember”. PM is a multi-faceted cognitive construct that involves several consecutive phases: (1) intention formation, (2) intention retention, (3) intention initiation: detection and recognition of the cue and self-initiated retrieval of the intention, and (4) intention execution (e.g., Kliegel et al., 2002). PM is critically involved in many aspects of everyday functioning and failures can result in severe consequences (Woods et al., 2009). Indeed, PM dysfunction predicts iADL decline beyond general cognition, depression, and demographics in other populations (Twamley et al., 2008; Woods et al., 2008, 2012).

Compared to healthy adults, PD patients endorse more frequent everyday PM failures (Foster et al., 2009) and show impairment on laboratory measures of PM (e.g., Foster et al., 2009). Studies have demonstrated event-based (EB) PM (i.e., triggered by an external cue) impairment in PD, particularly for non-focal cues, that correlate with deficits in planning, strategic attentional monitoring, and working memory (Altgassen et al., 2007; Foster et al., 2009; Katai et al., 2003; Kliegal et al., 2005). Individuals with PD show a disproportionate deficit in TB compared to EB PM tasks (Costa et al., 2009; Raskin et al., 2011, but see Katai et al., 2003), which is consistent with McDaniel & Einstein’s (2000) notion that TB PM relies more heavily on strategic processes and frontostriatal systems.

Although PM impairment is a risk factor for impairment in everyday function (e.g., Woods et al., 2008), no study to our knowledge has investigated the functional correlates of PM dysfunction in PD. Thus, the current study aimed to extend the literature in two important ways: 1) extend the limited research on everyday functioning in PD using well-validated performance-based measures of medication and financial management; and 2) investigate the associations between PM and everyday functioning using a multimodal approach that included both self-report and performance-based measures. It was hypothesized that 1) individuals with PD would show poorer performance on the performance-based measures of everyday function relative to normal controls and 2) PM would be associated with everyday function measures in PD.

Methods

Participants

All participants gave verbal consent and signed the university-approved consent document. The study sample consisted of 33 PD patients (26 non-demented PD participants, 7 PD with dementia participants based on a formal diagnosis of dementia or scoring lower than 130 on the Dementia Rating Scale; DRS; Mattis, 1976). PD patients were recruited from the Parkinson's Disease Research Subject Database of the San Diego VA Health Care System / University of California at San Diego and were diagnosed by a board-certified neurologist who specializes in movement disorders using UK Brain Bank criteria (Hughes et al., 1992). Disease staging was assessed using the modified Hoehn and Yahr's (H&R; Hoehn & Yahr, 1967) PD rating scale (N=31). All PD patients were prescribed antiparkinsonian medications and were on their normal regimen of dopaminergic agents at the time of testing. Twenty eight patients were on levodopa treatment (levodopa/carbidopa or levodopa/carbidopa/entacapone), 28 were taking a dopamine agonist (Requip or Mirapex), 14 patients were on a MAO inhibitor (Azilect or Selegiline), 9 were on Amantadine, two were using an Exelon patch, and one patient was on Kemadrin. Exclusion criteria for PD participants in the study included history of neurologic conditions other than PD, major depressive disorder prior to the diagnosis of PD, severe psychiatric disorders (e.g., schizophrenia) or substance use disorders.

The normal controls (NC) were recruited from a longitudinal study at SDSU. Exclusion criteria for normal control participants in the study included a history of neurologic conditions, any major psychiatric disorders (e.g., major depressive disorder, schizophrenia) or substance use disorders. The PD and NC groups did not differ significantly in demographics or WRAT-4 scores (see Table 1). The PD group had significantly lower DRS scores and greater Geriatric Depression Scale (GDS; Yesavage et al., 1982) scores than the normal controls (see Table 1).

Procedures

Prospective Memory Measures

The Memory for Intentions Screening Test (MIST) is a standardized, performance-based measure of PM with scores ranging from 0 to 48 (Raskin et al., 2010). We used the 30-minute research version of the test (Woods et al., 2008) that includes eight PM trials balanced on the following characteristics: 1) TB cue (e.g., "In 15 minutes, tell me that it is time to take a break" or EB cue (e.g., "When I show you a post card, self-address it"); 2) 2-minute or 15-minute delay interval; and 3) verbal or physical response modality. During the MIST, participants are engaged in word search puzzles that serve as ongoing distracter tasks. Studies support the reliability (Woods et al., 2008c) and construct validity (e.g., Gupta et al., 2010) of the MIST.

The Prospective and Retrospective Memory Questionnaire (PRMQ) is a 16-item questionnaire that measures the frequency self-reported daily prospective and retrospective memory failures (Smith et al., 2000). Eight of the questions ask about the frequency of retrospective memory failures (e.g., "Do you fail to recognize a place you have visited before?") and the other eight pertain to PM failures (e.g., "Do you forget to buy something you planned to buy, like a birthday card, even when you see the shop?"). The items are rated on a 5-point scale ranging from 1 (never) to 5 (very often). The questionnaire includes equal numbers of self-cued (e.g., "Do you decide to do something in a few minutes' time and then forget to do it") and environmentally-cued (e.g., "Do you fail to mention or give something to a visitor that you were asked to pass on?") prospective and retrospective memory items. The scores for the self-cued and environment-cued PM scales range from 4 to 20. The

PRMQ has adequate psychometric properties, including internal consistency (Smith et al., 2007), and discriminative (Smith et al., 2000;), structural (i.e., Crawford et al., 2003), and ecological (e.g., Woods et al., 2008) validity.

Everyday Functioning Measures

Performance-based measures of everyday functioning

Medication Management: The Medication Management Ability Assessment (MMAA; Patterson et al., 2002) is a performance-based role-play task in which the examiner presents a standardized description of the medication regimen for four mock medications. Participants are shown four plastic pill bottles with standardized labels stating the name of the medication, the frequency and amount of medication to be taken daily, as well as whether the medication should be taken with food or on an empty stomach. Following the description of the medication regimen, there is a 1 hour delay in which the medication bottles are set aside. After the delay, participants are given the four medication bottles and prompted to walk through their day, saying when they would wake up, eat their meals, and take their medications, handing over the correct number of mock pills (beans) to the examiner. The total number of correct responses for all of the pills (scores ranging from 0–33) was used for analyses. The MMAA task is different from a PM task in that the participants are not asked to remember to take the medications at a specific time or when a specific environmental cue is present. The MMMA has shown excellent test-retest reliability (Patterson et al., 2002) and predictive validity (Patterson et al., 2002).

Managing Finances: In the Advanced Finances Test (AFT; Heaton et al., 2004), participants are handed blank checks, a checkbook register, a check to deposit, three bills to pay, and a calculator. Participants are instructed to deposit the check, pay the bills, and calculate their checkbook balance. The participants also are instructed to pay as much of their credit card bill as possible but to leave $100 in their checking account. The total score ranges from 0 to 13 points. There is evidence to support the reliability (internal consistency) and discriminative validity (Heaton et al., 2004) of the MMAA.

Self-report measures of everyday functioning

IADLs: A modified version of the Lawton & Brody Activities of Daily Living (1969) measure was used to examine IADL decline (Heaton et al., 2004). The self-report measure includes ratings for current as well as best past level of functioning for a number of daily living skills. IADLS were defined as a subset of items involving areas of functioning that are less likely to reflect motor symptoms of PD. Thus, basic ADLs (e.g., bathing, dressing) were not used in the analysis. The IADL items that were used for analyses were: 1) housekeeping; 2) finances; 3) groceries; 4) telephone use; 5) shopping; and 6) medication management. A total IADL decline score was calculated by subtracting past from current functioning and summing the difference scores on all of the IADL items (range of −18 to 0, with lower scores indicating greater severity of IADL decline; as described in Woods et al., 2008).

Medication management efficacy: The Medication Management Efficacy Scale (MMES) from the Beliefs Related to Medications Adherence (BERMA) questionnaire (McDonald-Miszczak et al., 2004) is a 20-item self-report measure asks participants to rate medication management ability, including memory abilities related to medication management (e.g., “I am good at remembering to take my medications”), on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The total score for the MMES ranges from 20–100. The BERMA shows evidence of good internal consistency, split-half reliability, and construct validity (McDonald-Miszczak et al., 2004; Woods et al., 2008).

Hr-QoL Measure: The PD Questionnaire 39-item version (PDQ-39; Peto, Jenkinson, Fiztpatrick, & Greenhall, 1995) was administered to the PD patients. This PDQ-39 contains 39 items on a five-point rating scale (never, occasionally, sometimes, often, or always) and consists of eight subscales (mobility, activities of daily living, emotional well-being, stigma, social support, cognitions, communication, and bodily discomfort). A total score using the average of the eight subscales linearly transformed into a 0–100 scale was used for the analyses. Higher scores on the PDQ-39 reflect lower Hr-QoL. The PDQ-39 is a well-validated measure of Hr-QoL in PD, showing evidence of reliability and construct validity in multiple studies (for review, see Marinas et al., 2002).

Statistical Analyses

Data were checked for normality using the Shapiro-Wilk test of normality ($p<.05$) and appropriate non-parametric statistics were used for non-normally distributed data. Based on those analyses, Mann-Whitney U tests were used to examine group differences on the non-normal MIST, 'PRMQ, MMAA, AFT, and IADL measures. A one-way analysis of variance (ANOVA) was used to examine group differences on the normally distributed MMES. Since the performance of the patients with dementia may have impacted the findings, follow-up analyses excluding the PD patients with dementia were conducted. The MIST summary score, AFT, MMES, and PRMQ scales were normally distributed in the PD group when excluding the PDD participants (PD without dementia group); therefore, group differences on these measures were examined with one-way ANOVAs. The other measures were non-normally distributed in the PD without dementia group and were analyzed using Mann-Whitney U tests. Since depression could confound relationships between PM and everyday functioning, another set of follow-up analyses examining correlations between PM and everyday functioning excluding PD patients with clinically elevated self-reported depression scores (>10 on the GDS) were conducted. The relationships between variables of interest were examined using spearman rank correlational analyses (and Mann Whitney U test and Cohens *d* effect size estimates for dichotomous variables). The critical alpha level in the current study was set at .05 and trend level findings ($p<.07$) are reported.

Results

Prospective Memory

PD participants demonstrated significantly lower scores on the MIST summary score, TB trial, EB trial and trend level lower scores on the PRMQ self-cued scale compared to the NC group (See Table 2). There were no significant correlations between any of the MIST variables and PRMQ scales ($p>.05$). An analysis examining MIST and PRMQ performance when excluding the PDD patients revealed results that were generally consistent with the above findings with the exception that no significant differences were detected between the PD without dementia and NC groups on the EB scale ($p>.07$; with a substantially smaller effect size, $d=.17$) or the PRMQ self-cued PM scale ($p>.07$).

Everyday Functioning

Analyses revealed significant differences between the PD and NC groups on the AFT, IADL, and MMES, and trend level differences on the MMAA (See Table 3). An analysis examining performance on the everyday function measures after excluding the 7 PDD patients revealed results that were generally consistent with the above findings, except that there were no significant differences between the PD without dementia and NC groups on the MMAA ($p>.07$)

Relationships Between Prospective Memory and Everyday Function

MIST summary score significantly correlated with the AFT, MMAA, and MMES in the PD group (See Table 4). Correlations between the individual EB and TB scales and functional measures were generally comparable to correlations found between the MIST summary score and the functional measures (except the correlations between EB scale and the MMAA and MMES were not significant, $p>.07$). The MIST did not significantly correlate with the IADL or PDQ-39 (See Table 4) in the PD group. In the NC group, there was a trend level correlation between the MIST summary score and AFT ($\rho= 38$, $p=.05$), and significant correlations between the MIST TB scale and the Advanced Finances Task ($\rho=.49$, $p<.05$) and between the MIST EB scale and the MMAA ($\rho=.40$, $p<.05$). There were no other significant correlations between the MIST and functional measures in the NC group ($p>.07$). A follow-up analysis was conducted comparing correlation coefficients between the MIST variables and the everyday function measures in the PD and NC group. Fisher's r to z transformation analyses found no significant differences between these correlations coefficients in PD and NC group ($p>.07$).

A follow-up analysis was conducted to examine whether the MIST correlated with any of the individual self-reported iADL items in the IADL measure. The results revealed that the MIST EB scale correlated with self-reported declines in grocery shopping ($\rho=.55$, $p<.01$) and telephone use ($\rho=.39$, $p<.05$). The MIST summary score also correlated with self–reported declines in grocery shopping ($\rho = .45$, $p<.05$) and telephone use ($\rho=.39$, $p<.05$). There were no other significant correlations between the MIST scales and individual self-reported IADLs.

PRMQ self-cued and environmentally-cued PM scales correlated with all of the self-report functional measures in the PD group, including the IADL, MMES, and PDQ-38 measures, but not AFT or MMAA (See Table 4). There were no significant correlations between PRMQ and any of the everyday functioning measures in the NC group ($p>.07$).

A follow-up analysis excluding the 7 PDD participants from the PD group found a significant correlation between the TB Scale and the MMAA ($\rho=.39$, $p<.05$) in the PD without dementia group. However, there were no other significant correlations between the MIST and functional outcome measures in the PD without dementia group. There were significant correlations between the PRMQ self-cued and the IADL scale ($\rho=.56$, $p<.01$), MMES ($\rho=.40$, $p<.001$), and PDQ-39 ($\rho=.59$, $p<.001$) in the PD without dementia. There were significant correlations between the PRMQ environmentally-cued scale and the IADL scale ($\rho=.48$, $p<.05$), MMES ($\rho=.77$, $p<.001$), and PDQ-39 ($\rho=.61$, $p<.001$) in the PD without dementia group. There were no other significant correlation between the PRMQ and functional outcome measures in the PD without dementia group ($p>.07$).

Another set of follow-up analyses examining relationships between PM and everyday functioning after excluding PD participants with clinically elevated GDS scores were conducted. There were 4 PD participants with GDS scores above 10 (12% of the PD sample). When excluding these 4 participants, there were significant correlations between MIST summary score and AFT ($\rho=.43$, $p<.05$) and MMAA ($\rho=.37$, $p<.05$), between MIST TB scale and AFT ($\rho=.53$, $p<.05$) and MMAA ($\rho=.39$, $p<.05$). There were no significant correlations between MIST EB scale and AFT or MMAA. There were no significant correlations between any of the MIST variables and MMES. There were significant correlations between PRMQ self-cued scale and the IADL scale ($\rho=.62$, $p<.01$), MMES ($\rho=.51$, $p<.01$), and PDQ ($\rho=.53$, $p<.01$). The PRMQ environmentally-cued scale significantly correlated with the IADL scale ($\rho=.46$, $p<.05$), MMES ($\rho=.74$, $p<.001$), and PDQ ($\rho=.58$, $p<.05$).

Relationships Between Everyday Function and Other Variables of Interest— All of the functional measures significantly (or at a trend level) correlated with age, GDS, DRS, disease duration, and H&R ratings (See Table 5). There were significant gender differences on the performance-based measures, but not the self-report measures of everyday function (See Table 5).

Discussion

Although there is growing evidence of the relationship between PM impairment and functional declines in various neurological populations (e.g., Woods et al., 2008a, 2008b, 2009b, 2011), this is the first study to our knowledge to investigate the functional correlates of PM deficits in PD. PD patients demonstrated significantly lower scores on a performance-based measure of PM (MIST summary score and the TB and EB scales) and endorsed more self-cued PM complaints than NC participants (PRMQ, at a trend level, with a medium effect size, d=.50). These results are consistent with previous studies that examined PM in PD patients using the performance-based and self-report PM measures used in the current study (Raskin et al., 2011; Foster et al., 2009). The results of the present study revealed that PD patients also showed significantly lower scores compared to NC participants on the performance-based and self-report measures of everyday functioning (AFT, IADL, MMES, and trend level lower scores on the MMAA, suggesting that the PD sample experienced deficits in a wide range of daily activities.

Medication management is an area of everyday function that may be particularly dependent on PM. Suboptimal medication adherence in PD has implications for poor health outcomes, lower Hr-QoL, and increased health care costs (Davis, Edin, & Allen, 2010). The present study found that overall PM (MIST summary score) impairment significantly correlated with both performance-based medication management capacity (MMAA) and self-reported medication management measure (MMES) in the PD sample. An examination of the components of PM that correlated with medication management showed that the TB scale, but not the EB scale, was related to the medication management measures. These findings are consistent with a prior study that found that TB PM, not EB PM, was associated with medication non-adherence in an HIV sample (Woods et al., 2009). Medication non-adherence in PD patients may be related to difficulty strategically allocating attention to performing ongoing daily tasks while concurrently monitoring time. Studies have found that healthy adults strategically increase the frequency of time monitoring (clock checking) as the target time to perform a PM intention approaches (Mantyla & Carelli, 2006). Costa et al. (2009) found that PD patients monitored time less frequently than healthy adults as the time to execute an intention neared, and time monitoring was associated with the number of intentions recalled in both groups, suggesting a relationship between TB PM impairment and difficulties implementing efficient time-monitoring strategies (but see Katai et al., 2003). In other words, PD patients might have difficulty strategically monitoring the time for the appropriate moment to take medication (e.g., take medication every 4 hours) while engaged in other daily tasks, which leads to delayed or missed doses.

Deficits in overall PM also related with lower scores on the performance-based measure of financial capacity (Advanced Finances Task) in the PD sample. In addition, the TB scale significantly correlated with the financial capacity measure. In contrast to the non-significant correlations between the EB scale and medication management measures, the EB scale significantly correlated with financial capacity in the PD sample. Although a prior study involving patients with schizophrenia examined relationships between PM and a global performance-based measure of everyday functioning that included a financial management component (Twamley et al., 2008), this is the first study to our knowledge to specifically investigate the relationship between financial capacity and PM in any

population. PM likely is involved in various aspects of managing finances, such as remembering to pay bills on time (TB PM) or to stop at the bank on the way home from work (EB PM).

In the NC group, there was a trend level correlation between the overall PM and performance-based financial capacity, which was driven by significant correlations between the TB scale and performance-based financial capacity. In addition, there was a significant correlation between the EB scale and performance-based medication management. There were no other significant correlations between performance-based PM and everyday functioning measures in normal controls. Follow-up analyses showed that the correlations between performance-based PM and everyday functioning were not statistically different between NC participants and PD patients. This suggests that relationships between performance-based PM and everyday function are not specific to PD, and is consistent with prior studies showing relationships between PM and everyday function in various samples, including healthy older adults (Woods et al., 2012), HIV (Woods et al., 2008), schizophrenia (Twamley et al., 2008), and MCI (Schmitter-Edgecombe et al., 2009).

The results of the present study did not show a relationship between performance on the PM task and Hr-QOL in the PD sample. Furthermore, we were surprised to find that scores on the performance-based PM task did not correlate with a self-report measure of global iADL decline, which diverges from prior studies in healthy adults (Woods et al., in press) and HIV (Woods et al., 2008). This could be related to methodological issues that result from self-report measures (e.g., self-report bias, discussed in more detail below). An alternative explanation is that PM differentially predicts across functional outcomes in PD. Thus, PM may be related to specific IADLs, but not other daily activities. We investigated this possibility by examining correlations between the MIST and the individual items in the self-reported IADL measure. MIST summary score and the EB scale correlated with self-reported declines in grocery shopping and telephone use, but the MIST did not correlate with other items on the IADL measure. EB PM may play a role in various aspects of grocery shopping, such as remembering to stop at the grocery on the way home from work. It is less clear how PM may affect ability to use the telephone. Future research studies may wish to examine relationships between PM and these aspects of everyday function.

A finding that emerged from this study was that self-reported PM complaints related to self-reported declines in everyday functioning (IADLs, medication management, Hr-QOL), but were not associated with performance-based measures of everyday function (medication management and financial capacity). In addition, self-reported PM complaints were not related to laboratory PM, as measured by the MIST. A lack of association between self-report measures and performance on objective neuropsychological testing is a common finding (Chaytor & Schmitter-Edgecombe, 2003), including discrepancies in self-reported versus laboratory PM in various populations (e.g., Woods et al., 2007; Zeintl et al., 2006). Studies in PD also have shown a divergence between self-report and objective cognition (Marino et al., 2009; Sitek et al., 2011), including a discrepancy between self-reported and laboratory PM (Foster et al., 2009). Additionally, research suggests that there are inconsistencies between subjective ratings and performance-based measures of iADL function in PD (Shulman et al., 2006). Self-reported assessment of cognition and everyday functioning may be influenced by a number of confounding factors such as depression, cognitive impairment, social desirability bias, and metacogntive deficits, which may lead to overestimation or underestimation of PM and functional abilities (Morgan & Heaton, 2009). For example, Marino and colleagues (2009) found that subjective ratings of cognition were more influenced by depressive symptoms than objective cognitive performance in a sample of PD patients. In the current study, depression significantly correlated with all of the self-report measures (PM complaints, self-report measures of everyday functioning) in the PD

sample (ρ ranging from .57 to .77). Given the limitations associated with self-report, these types of measures should be interpreted with caution and these findings emphasize the importance of including more objective measures of PM (e.g., laboratory or semi-naturalistic measures) and everyday function (e.g., performance-based measures, molar outcomes, direct observation) in future studies examining functional consequences of PM impairment.

As discussed previously, there are many predictors of everyday function impairment in PD, including motor and non-motor symptoms (e.g., Cahn et al, 1998). The current study found that all of the measures of everyday function significantly (or at a trend level) correlated with age, level of depressive symptoms, global cognitive functioning, and disease characteristics (disease duration and H&R rating). There also were significant gender differences in the performance-based measures of everyday function, but not the self-reported measures. Thus, as expected, PM was one of many predictors of functional impairment in the PD sample. The current study conducted a preliminary investigation of the relationship between PM and everyday functioning in PD; however, a limitation of the present study was that it was not powered to examine the relative contribution of PM in relation to other predictors of functional impairment in regression analyses. However, we conducted analyses examining relationships between PM and everyday functioning in the PD group after excluding PD participants with dementia and a separate analysis examining these relationships after excluding PD participants with clinically elevated GDS scores. Overall, the relationships between performance-based PM and everyday function in the PD without dementia group were comparable to the original analyses including these patients, with the exception of a lack of significant correlation between TB PM and self-reported medication management measure and between performance-based PM and performance-based financial management. The relationships between PM and everyday function after excluding PD patients with clinically elevated GDS scores were generally comparable to the original analyses, with the exception of non-significant relationships between performance-based PM and self-reported medication management. Associations between self-reported PM and self-reported everyday functioning remained significant in analyses excluding the PD with dementia participants and from analyses excluding PD participants with clinically elevated GDS scores. Among the relationships between PM and everyday function that were no longer significant after excluding those with global cognitive decline or clinically elevated depression scores, this may suggest that either global cognitive decline or clinically elevated depression may have accounted for these correlations. An alternative explanation for the lack of significant correlations is that excluding participants with global cognitive decline or depression resulted in a smaller sample size and therefore lowered the power to detect significant relationships. Overall, many of the relationships were comparable when excluding those with global cognitive decline or clinically elevated depression, suggesting that the relationship between PM and many of the everyday function measures may not be due to global cognitive decline or clinical levels of depression. In addition, there is evidence from other populations (healthy older adults, HIV, amnestic MCI, schizophrenia) that PM significantly predicts everyday function over and above other predictors of everyday function (e.g., mood, global cognitive decline, age, gender; Schmitter-Edgecombe et al., 2009; Twamley et al., 2008; Woods et al., 2008; in press). In HIV and schizophrenia, this was found using the same performance-based measure of PM that was used in this study (MIST), but in much larger study samples (Twamley et al., 2008; Woods et al., 2008, 2012). While these populations differ from PD, these prior studies provide some evidence for the validity of the current findings in a sample of PD patients. Future studies with larger sample sizes should examine the incremental ecological validity of PM relative to other known predictors of everyday function in PD. Furthermore, future studies should include other predictors of everyday function that were not assessed in the current study, such as use of compensatory strategies, motivation (especially since apathy is common in PD), and

environmental demands on the patient. Future studies also may wish to further examine the relationship between PM and deficits in medication management and financial capacity using other ecologically valid measures such as actual records of medication adherence (e.g., medical records) and financial management (e.g., late payments, bounced checks), virtual reality tasks that mimic online banking, and electronic medication monitoring.

Acknowledgments

We would like to thank Brittnie Bloom, Genevive Brusati, Shea Gluhm, and Heather Holden for their assistance with data collection. We also thank all of the participants for their contributions to this study. This work was supported by a VA Merit Award to J. Vincent Filoteo.

References

Altgassen M, Zöllig J, Kopp U, Mackinlay R, Kliegal M. Patients with Parkinson's disease can successfully remember to execute delayed intentions. Journal of the International Neuropsychological Society. 2007; 13:888–892. [PubMed: 17697419]

Argüelles S, Loewenstein DA, Eisdorfer C, Argüelles T. Caregivers' judgments of the functional abilities of the Alzheimer's disease patient: impact of caregivers' depression and perceived burden. Journal of Geriatric Psychiatry and Neurology. 2001; 2:91–8. [PubMed: 11419574]

Bainbridge JL, Ruscin JM. Challenges of treatment adherence in older patients with Parkinson's disease. Drugs Aging. 2009; 26:145–155. [PubMed: 19220071]

Blackstone B, Moore DJ, Heaton RK, Franklin DR Jr, Woods SP, Clifford DB, et al. Diagnosing symptomatic HIV-associated neurocognitive disorders: Self-report versus performance-based assessment of everyday functioning. Journal of the International Neuropsychological Society. 2011 in press. Published ahead of print on November 24, 2011. 10.1017/S135561771100141X

Bouwens SFM, van Heugten CM, Verhey FJR. Association between cognition and daily life functioning in dementia subtypes. International Journal of Geriatric Psychology. 2009; 24:764–769.

Bronnick K, Ehrt U, Emre M, De Deyn PP, Wesness K, Tekin S, Aarsland D. Attentional deficits affect activities of daily living in dementiaassociated with Parkinson's disease. Journal of Neurology, Neurosurgery, and Psychiatry. 2006; 77:1136–1142.

Cahn D, Sullivan EV, Shear PK, Pfefferbaum A, Heit G, Silverberg G. Differential contributions of cognitive and motor processes to physical and instrumental activities of daily living in Parkinson's disease. Archives of Clinical Neuropsychology. 1998; 13:575–583. [PubMed: 14590618]

Chaytor N, Schmitter-Edgecombe M. The ecological validity of neuropsychological tests: A review of the literature on everyday cognitive skills. Neuropsychology Review. 2003; 13:181–197. [PubMed: 15000225]

Contardo C, Black AC, Beauvais J, Dieckhaus K, Rosen MI. Relationship of prospective memory to neuropsychological function and antiretroviral adherence. Archives of Clinical Neuropsychology. 2009; 24:547–554. [PubMed: 19648150]

Costa A, Peppe A, Caltagirone C, Carlesimo GA. Prospective memory impairment in individuals with Parkinson's disease. Neuropsychology. 2008; 22:283–292. [PubMed: 18444706]

Crawford JR, Smith G, Maylor EA, Della Salla S, Logie RH. The Prospective and Retrospective Memory Questionnaire (PRMQ): Normative data and latent structures in a large non-clinical sample. Memory. 2003; 11:261–275. [PubMed: 12908675]

Davis KL, Edin HM, Allen JK. Prevalence and cost of medication nonadherence in Parkinson's disease: evidence from administrative claims data. Movement Disorders. 2010; 25:474–480. [PubMed: 20131374]

DeBettignies, Mahurin; Pirozzolo. Insight for impairment in independent living skills in Alzheimer's disease and multi-infarct dementia. Journal of Clinical and Experimental Neuropsychology. 1990; 12:355–363. [PubMed: 2341561]

Den Oudsten BL, Van Heck GI, De Vries J. Quality of life and related concepts in Parkinson's disease: A systematic review. Movement Disorders. 2007; 11:1528–1537. [PubMed: 17523198]

Elm JJ, Kamp C, Tilley BC, Guimaraes P, Fraser D, Deppen P, et al. Self-reported adherence versus pill count in Parkinson's disase: The Net-PD experience. Movement Disorders. 2007; 22:822–827. [PubMed: 17357141]

Foster ER, McDaniel MA, Repovîs G, Hershey T. Prospective memory in Parkinson disease across laboratory and self-reported everyday performance. Neuropsychology. 2009; 23:347–358. [PubMed: 19413448]

Grosset DG, Antonini A, Canesi M, Pezzoli G, Lees A, Shaw K, et al. Adherence to antiparkinson medication in a multicenter study. Movement Disorders. 2009; 24:826–832. [PubMed: 19191340]

Gupta S, Woods SP, Weber E, Dawson MS, Grant I. HIV Neurobehavioral Research Center (HNRC) Group. Is prospective memory a dissociable cognitive function in HIV infection? Journal Clinical and Experimental Neuropsychology. 2008; 32:898–908.

Heaton RK, Marcotte TD, Rivera Mindt M, Sadek J, Moore DJ, Bentley H, Allen McCutchan J, Reicks C, Grant I. The HIV Neurobehavioral Research Center (HNRC) Group. The impact of HIV-associated neuropsychological impairment on everyday functioning. Journal of the International Neuropsychological Society. 2004; 10:317–331. [PubMed: 15147590]

Hertzog C, Park DC, Morrell RW, Martin M. Ask and ye shall receive: Behavioural specificity in the accuracy of subjective memory complaints. Applied Cognitive Psychology. 2000; 14:257–275.

Hoehn MM, Yar MD. Parkinsonism: onset, progression, and mortality. Neurology. 1967; 17:424–442.

Hughes AJ, Daniel SE, Kilford L, Lees AJ. Accuracy of clinical diagnosis of idiopathic Parkinson's disease: a clinico-pathological study of 100 cases. Journal of Neurology, Neurosurgery, and Psychiatry. 1992; 55:181–184.

Katai S, Maruyama T, Hashimoto T, Ikeda S. Event based and time based prospective memory in Parkinson's disease. Journal of Neurology, Neurosurgery, and Psychiatry. 2003; 74:704–709.

Kliegal M, Martin M, McDaniel MA, Einstein GO. Complex prospective memory and executive control of working memory: A process model. Psychologische Beiträge. 2002; 44:303–318.

Kliegal M, Phillips LH, Kopp UA. Planning and realization of complex intentions in patients with Parkinson's disease. Journal of Neurology, Neurosurgery, and Psychiatry. 2005; 76:1501–1505.

Maeshima S, Itakura T, Nakagawa M, Nakai K, Komai N. Visuospatial impairment and activities of daily living in patients with Parkinson's disease: A quantitative assessment of the cube-copying task. American Journal of Physical Medicine & Rehabilitation. 1997; 76:383–388. [PubMed: 9354492]

Mäntylä, T.; Carelli, M. Time monitoring and executive functioning: Individual and developmental differences. In: Glickson, J.; Myslobodsky, MS., editors. Timing the future: A case for a time-based prospective memory. Hackensack, NJ: World Scientific; 2006.

Marinas J, Ramaker C, van Hilten JJ, Stiggelbout AM. Health related quality of life in Parkinson's disease: a systematic review of disease specific instruments. Journal of Neurology, Neurosurgery, and Psychiatry. 2002; 72:241–248.

Marino SE, Meador KJ, Lorin DW, Okun MS, Fernandez HH, Fesller AJ, et al. Subjective perception of cognition is related to mood and not performance. Epilepsy Behavior. 2009; 14:459–464. [PubMed: 19130899]

Mattis, S. Mental status examination for organic mental syndrome in the elderly patient. In: Bellack, L.; Katsau, TB., editors. Geriatric Psychiatry: A Handbook for Psychiatrists and Primary Care Physicians. New York: Grune & Stratton; 1976. p. 77-121.

McDaniel MA, Einstein GO. Strategic and automatic processes in prospective memory retrieval: A multi-process framework. Applied Cognitive Psychology. 2000; 14:S127–S144.

McDonald-Miszczak L, Maris P, Fitzibbon T, Ritchie G. A pilot study examining older adults' Beliefs Related To Medication Adherence: The BERMS survey. Journal of Aging and Health. 2004; 16:591–614. [PubMed: 15448274]

Moore DJ, Palmer BW, Patterson TL, Jeste DV. A review of performance-based measures of functional living skills. Journal of Psychiatric Research. 2007; 41:97–118. [PubMed: 16360706]

Morgan, EE.; Heaton, RK. Neuropsychology in relation to everyday function. In: Grant, I.; Adams, KM., editors. Neuropsychological assessment of neuropsychiatric and neuromedical disorders. 3. New York: Oxford University Press; 2009.

Muslimovic D, Post B, Speelman JD, Schmand B, de Haan RJ. CARPA Study Group. Determinants of disability and quality of life in mild to moderate Parkinson disease. Neurology. 2008; 70:2241–22747. [PubMed: 18519873]

Patterson TL, Lacro J, McKibbin CL, Moscona S, Hughs T, Jeste DV. Medication management ability assessment: results from a performance-based measure in older outptatients with schizophrenia. Journal of Clinical Psychopharmacology. 2002; 22:11–19. [PubMed: 11799337]

Peto V, Jenkinson C, Fitzpatrick R, Greenhall R. The development and validation of a short measure of functioning and well being for individuals with Parkinson's disease. Quality of Life Research. 1995; 3:241–248. [PubMed: 7613534]

Raskin, S.; Buckheit, C.; Sherrod, C. Memory for Intentions Test. Lutz, FL: Psychological Assessment Resources, Inc; 2010.

Raskin SA, Sohlberg MM. Prospective memory intervention: A review and evaluation of a pilot restorative intervention. Brain Impairment. 2009; 10:76–86.

Raskin SA, Woods SP, Poquette AJ, McTaggart AB, Sethna J, Williams RC, et al. A differential deficit in time- versus event-based prospective memory in Parkinson's disease. Neuropsychology. 2011; 25:201–209. [PubMed: 21090895]

Sabbagh MN, Silverberg N, Bircea S, Majeed B, Samant S, Caviness JN, et al. Is the functional decline of Parkinson's disease similar to the functional decline of Alzheimer's disease? Parkinsonism Related Disorders. 2005; 5:311–315. [PubMed: 15886042]

Schmitter-Edgecombe M, Woo E, Greenley DR. Characterizing multiple memory deficits and their relation to everyday functioning individuals with mild cognitive impairment. Neuropsychology. 2009; 23:168–177. [PubMed: 19254090]

Shulman LM, Gruber-Baldini AL, Anderson KE, Vaughan CG, Reich SG, Fishman PS, et al. The evolution of disability in Parkinson's disease. Movement Disorders. 2008; 23:790–796. [PubMed: 18361474]

Shulman LM, Pretzer-Aboff I, Anderson KE, Stevenson R, Vaughan CG, Gruber-Baldini AL, et al. Subjective report versus objective measurement of activities of daily living in Parkinson's disease. Movement Disorders. 2006; 21:794–799. [PubMed: 16482533]

Smith G, Della Sala S, Logie RH, Maylor EA. Prospective and retrospective memory in normal ageing and dementia: a questionnaire study. Memory. 2000; 8:311–321. [PubMed: 11045239]

Starkstein SE, Mayberg HS, Leiguards R, Preziosi TJ, Robinson RG. A prospective longitudinal study of depression, cognitive decline, and physical impairments in patients with Parkinson's disease. Journal of Neurology, Neurosurgery, and Psychiatry. 1992; 55:377–382.

Sitek EJ, Soltan W, Wieczorek D, Robowski P, Slawek J. Self-awareness of memory function in Parkinson's disease in relation to mood and symptom severity. Aging & Mental Health. 2011; 15:150–156. [PubMed: 20924825]

Twamley EW, Woods SP, Zurhellen CH, Vertinski M, Narvaez JM, Mausbach BT, Patterson TL, Jeste DV. Neuropsychological substrates and everyday functioning implications of prospective memory impairment in schizophrenia. Schizophrenia Research. 2008; 106:42–49. [PubMed: 18055178]

Uc EY, Rizzo M, Anderson SW, Qian S, Rodnitzky RL, Dawson JD. Visual dysfunction in Parkinson disease without dementia. Neurology. 2005; 65:1907–1913. [PubMed: 16282276]

Valldeoriola F, Coronell C, Pont C, Buongiorno MT, Cámara A, Gaig C, Compta Y. ADHESON Study Group. Socio-demographic and clinical factors influencing the adherence to treatment in Parkinson's disease: the ADHESON study. European Journal of Neurology. 2011; 17:980–987. [PubMed: 21199185]

Vedhara K, Wadsworth E, Norman P, Searle A, Mitchell J, Macrae N, O'Mahony M, Kemple T, Memel D. Habitual prospective memory in elderly patients with Type 2 diabetes: implications for medication adherence. Psychology, Health, & Medicine. 2004; 9:17–27.

Woods SP, Carey CL, Moran LM, Dawson MS, Letendre SL, Grant I. The HIV Neurobehavioral Research Center (HNRC) Group. Frequency and predictos of self-reported complaints in individuals infected with HIV. Archives of Clinical Neuropsychology. 2007; 22:187–195. [PubMed: 17289343]

Woods SP, Iudicello JE, Morn LM, Carey C, Dawòn MS, Grant I. The HIV Neurobehavioral Research Center (HNRC) Group. HIV-associated prospective memory impairment increases risk of dependence in everyday functioning. Neuropsychology. 2008; 22:110–117. [PubMed: 18211160]

Woods SP, Moran L, Carey C, Dawson M, Iudicello JE, Gibson S, Grant I, Atkinson JH. the HIV Neurobehavioral Research Center (HNRC) group. Prospective memory in HIV infection: Is "remembering to remember" a unique predictor of self-reported medication management? Archives of Clinical Neuropsychology. 2008; 23:257–270. [PubMed: 18243645]

Woods SP, Moran L, Dawson M, Carey C, Grant I. the HIV Neurobehavioral Research Center (HNRC) group. Psychometric characteristics of the Memory for Intentions Screening Test. The Clinical Neuropsychologist. 2008; 22:864–878. [PubMed: 18756389]

Woods SP, Dawson MS, Weber E, Gibson S, Grant I, Atkinson JH. The HIV Neurobehavioral Research Center Group. Timing is everything: Antiretroviral nonadherence is associated with impairment in time-based prospective memory. Journal of The International Neuropsychological Society. 2009; 15:42–52. [PubMed: 19128527]

Woods SP, Weber E, Weisz BM, Twamley EW, Grant I. The HIV Neurobehavioral Research Programs Group. Rehabilitation Psychology. 2011; 56:77–84. [PubMed: 21401289]

Woods SP, Weinborn M, Velnoweth A, Rooney A, Bucks RS. Memory for Intentions is Uniquely Associated with Instrumental Activities of Daily Living in Healthy Older Adults. Journal of the International Neuropsychological Society. 2011 Published ahead of print on October 28, 2011. 10.1017/S1355617711001263

Yesavage JA, Brink TL, Rose TL, Lung O, Huang V, Adey M, Leirer VO. Development and validation of a geriatric depression screening scale: a preliminary report. Journal of Psychiatry Research. 1982; 17:37–49.

Zeintl M, Kliegal M, Rast P, Zimprich D. Prospective memory complaints can be predicted by prospective memory performance in older adults. Dementia and Geriatric Cognitive Disorders. 2006; 22:209–215. [PubMed: 16899998]

Zogg JB, Woods SP, Sauceda JA, Wiebe JS, Simoni JM. The role of prospective memory in medication adherence: a review of an emerging literature. Journal of Behavioral Medicine. 2011 Epub ahead of print retrieved May 1, 2011. 10.1007/s10865-011-9341-9

Zogg JN, Woods SP, Weber E, Iudicello JE, Dawson MS, Grant I. The HIV Neurobehavioral Research Center (HNRC) Group. HIV-associated prospective memory impairment in the laboratory predicts failures on a semi-naturalistic measure of health care compliance. The Clinical Neuropsychologist. 2010; 24:945–962. [PubMed: 20661839]

Table 1

Demographic characteristics of study participants.

	PD (n = 33)	NC (n = 26)
Demographics		
Age (years)	71.2 (1.4)	69.8 (1.3)
Education (years)	16.6 (0.4)	16.4 (0.5)
Gender (M/F)	24/9	17/9
Ethnicity (% Caucasian)	100%	92%
Geriatric Depression Scale	5.2 (0.9) *	2.9 (0.4)
Dementia Rating Scale	137.3 (1.2) *	140.6 (0.5)
WRAT-4 Reading	60.7 (3.2)	65.1 (0.8)
Disease Duration (years)	11.1 (1.1)	-
Hoehn & Yahr (frequency)		-
Stage 1	1	
Stage 1.5	1	
Stage 2	13	
Stage 2.5	2	
Stage 3	10	
Stage 4	4	

Note. Data for demographics represent means and standard errors. Data for Hoehn & Yahr ratings represent frequencies. NC= Normal Controls, PD = Parkinson's disease patients. WRAT-4 Reading = Reading subtest from the Wide Range Achievement Test – Fourth Edition.

* $p < .05$.

Table 2

Performance on prospective memory measures in study participants.

Prospective Memory	PD (n = 33)	NC (n = 26)	*p*	*d*
MIST Summary Score	33.0 (16.0)	39.0 (6.0)	<. 001	1.1
MIST Time-based Scale	5.0 (3.0)	6.5 (1.0)	<.001	1.3
MIST Event-based Scale	6.0 (3.0)	7.0 (1.0)	<.05	0.63
PRMQ Self-cued Scale	11.0 (3.0)	9.5 (3.0)	0.07	0.5
PRMQ Environmentally-cued Scale	10.0 (3.0)	9.0 (2.3)	0.14	0.38

Note. Data represent medians and interquartile ranges. MIST= Memory for Intentions Screening Test. PRMQ = Prospective and Retrospective Memory Questionnaire *d* = Cohen's d effect size estimate.

Table 3

Performance on everyday functioning measures in study participants.

Everyday Functioning	PD (*n* =33)	NC (*n* =26)	*p*	*d*
Performance-based Measures				
MMAA	30.0 (7.5)	31.5 (4.0)	0.07	0.6
AFT	10.0 (6.5)	13.0 (3.25)	< .001	1.03
Self-report Measures				
IADL	−2.0 (3.5)	0.0 (0.0)	< .001	1.21
MMES*	70.0 (2.8)	82.1 (2.0)	< .001	1.01
PDQ-39	17.5 (23.8)	-	-	-

Note. Data represent medians and interquartile ranges.

*MMES data represent means and standard errors. MMAA = Medication Management Ability Assessment. AFT= Advanced Finances Test. IADL = modified version of the Lawton & Brody Instrumental Activities of Daily Living Scale. MMES = Medication Management Efficacy Scale (MMES). PDQ-39 = PD Questionnaire 39-item version. *d* =Cohen's d effect size estimate.

Table 4

Relationships between PM and everyday functioning measures in the Parkinson's disease sample.

Everyday Functioning	MIST Summary Score	MIST Time-Based Scale	MIST Event-Based Scale	PRMQ Self-cued PM	PRMQ Environmentally-cued PM
Performance-based Measures					
MMAA	0.45*	0.46**	0.31	0.13	0.11
AFT	0.58***	0.56**	0.48**	0.21	0.23
Self-report Measures					
IADL	0.26	0.21	0.21	0.60***	0.49**
MMES	0.37*	0.41*	0.28	0.54**	0.74***
PDQ-39	0.25	0.21	0.25	0.54**	0.56**

Note. Data represent Spearman's rho correlation coefficient (presented in absolute values). PRMQ = Prospective and Retrospective Memory. MMAA = Medication Management Ability Assessment. AFT = Advanced Finances Test. IADL = modified version of the Lawton & Brody Instrumental Activities of Daily Living Scale. MMES = Medication Management Efficacy Scale. PDQ-39 = PD Questionnaire 39-item version.

* $p < .05$,

** $p < .01$,

*** $p < .001$.

Table 5

Relationships between everyday functioning measures and demographic, psychiatric, cognitive, and disease characteristics in the Parkinson's disease sample.

	MMAA	AFT	IADL	MMES	PDQ-39
Demographic					
Age	0.57**	0.79***	0.47**	0.33+	0.34+
Education	0.14	0.08	0.03	0.22	0.28
Gender	1.73a**	1.65a**	0.65a	0.50a	0.22a
Psychiatric					
GDS	0.50**	0.50**	0.77***	0.62***	0.66***
Global Cognitive					
DRS	0.52**	0.68***	0.33+	0.44*	0.35*
Disease Characteristics					
H&R Rating	0.51**	0.62***	0.53**	0.62***	0.61***
Disease Duration	0.42*	0.39*	0.34+	0.36*	0.44*

Note. Data represent Spearman's rho correlation coefficient (presented in absolute values). MMES data represent Pearson r correlations (as this measure was normally distributed).

[a]Value represents Cohen's d effect size and p value based on between group Mann Whitney U test. AFT = Advanced Finances Total. MMAA = Medication Management Ability Assessment. MMES = Medication Management Efficacy Scale. GDS = Geriatric Depression Scale. DRS = Dementia Rating Scale. H&R = Hoehn & Yar.

+ p = .06

* $p < .05$,

** $p < .01$,

*** p < .001