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# Impairments in Event based Prospective Memory as a Function of Developmental Progression

**Nisha Malik, Amrita Yadava and NovRattan Sharma**
M.D.University, Rohtak, Haryana

An essential part of routine, everyday functioning is forming an intention, and remembering to execute the same.Failure to remember the intention can disrupt important tasks in people of all ages. This kind of memory has been termed as Prospective Memory (PM) and it plays a significant role when multiple tasks have to be performed simultaneously and routine actions are taken up by automated processing. The present investigation was conducted to study the developmental progression of Prospective Memory in order to identify the stage at which significant deficits in PM occur and study the relation between objective PM performance and subjective perception of PM performance/ deficits. A purposive sample of 250 respondents was selected from five developmental ages (n=50) One way ANOVA was used to analyze the significance of difference among the mean subjective and objective PM scores of the five groups. A significant effect of age was evinced for both the subjective and objective PM scores.Results indicated that a significant decline in objective PM occurred in adulthood (26-40 yrs) and the memory deficit increased progressively into old age(61-75yrs). Subjective PM was found to be similar in adolescents and young adults and a decline was observed with the onset of adulthood, but no significant variation was observed across the adult age span(26-75 yrs). However, subjective judgment of PM was at variance with actual performance.

**Keywords:** Prospective Memory, Developmental Progression, Retrospective Memory.

Prospective Memory or PM is a specific kind of memory, which may by defined as remembering to remember (Winogard, 1988) or remembering to perform an intended action. It involves forming an intention and then realizing it at some appropriate time or in response to some external cue, in the future (Harris, 1984).However, all self-initiated intention cannot be deemed as PM. In PM the individual is engaged in other activities that are so demanding that constantly thinking of the intention to be carried out is not possible. The future time frame for executing the intended activity is limited so that successful completion of a delayed intention can be ascertained. Also, there are no explicit reminders for execution of the intended response (Maylor, 1996; McDaniel & Einstein, 2007).

Research into the nature of PM has implicated two distinct components for successful prospective realization of an intention, i.e. remembering to remember and remembering content (Carlesimo,Casadio & Caltagirone, 2004). This fact receives support from some researchers who posit a strong relationship between PM and Retrospective Memory (RM) (Khan, Sharma & Dixit, 2007). However, controversial views have also been expressed, where some researchers are of the opinion that there is no difference between the two (Crowder, 1996, Dobbs & Reeves, 1996), while others have proposed a qualitative difference (Koriat, Ben-Zur & Nussbaum, 1990). Foley (2007) found that performance of healthy and cognitively impaired adults was better on PM tasks as compared to that on RM tasks. However, onset of dementia was accompanied by deterioration in both types of memory. Einstein and McDaniel (1990) distinguished between two types of PM i.e. event based and time based. Event based PM is remembering to perform an action when some external event is presented while time based PM is remembering to perform an action at a particular time.

Salthouse, Berish and Siedlecki (2004) reported that PM had a significant relationship

with cognitive abilities while that with personality traits was weak. Executive functions such as planning and monitoring appear to be critical to successful event-based prospective memory (Marsh & Hicks, 1998). Einstein, McDaniel, Richardson, Guynn and Cunfer (1995) have shown that PM is affected by attention, planning and monitoring and retrospective memory. Working memory also plays an important role in PM as presence of the relevant activity in the working memory, at the relevant time is necessary (Della Sala & Logie,1993).

Researches investigating age related impairments in PM have yielded contradictory results. Craik (1986) proposed that PM would decline with age. However, a number of researchers have failed to observe any decrement(Cherry & LeCompte,1999;Crawford,Smith, Maylor, Della Sala, & Logie, 2003; Einstein & McDaniel,1990) while others have reported a robust decline in PM in later adulthood (Logie & Maylor,2009; Maylor, 1996; Wang, Kliegel, Yang & Liu,2006; Zimmerman & Meier,2006; Zollig, West, Martin, Altgassen, Lemke & Kliegel 2007).The contradictory findings have been attributed to variation in response(self-initiated vs. automatic), task (cued vs. non-cued; focal vs. non-focal cues and regular vs. irregular cues, laboratory vs. naturalistic), working memory load, motivational factors and the use of compensatory strategies (Henry, MacLeod, Phillip & Crawford, 2004; Kliegel, Jager & Phillips, 2008; McDaniel & Einstein, 2007; Uttl, 2008; 2011). Uttl (2008) reported that younger adults tend to perform better on prospective memory tasks in most conditions. However, older adults might demonstrate similar or better performance, as compared to younger adults, in naturalistic studies and tasks where retrieval is automatic, reflexive and obligatory.Meta-analysis indicated that the contradictory findings of researchers regarding the age related decline in PM could be attributed to methodological problems and conceptual confusions that have plagued PM research (Uttl, 2011). Aberle, Rendell, Rose, McDaniel and Kliegel (2010) also reported that the variability of age differences in laboratory prospective memory tasks may be due in part to differences in the features of the prospective memory task. However, increases in motivation to perform the prospective task seem to help remedy prospective memory deficits in young adults in the naturalistic setting

Comparison of subjective measures of PM have also yielded contradictory findings. Crawford et al. (2003) in a questionnaire based study showed no influence of age and gender on PM scores. No relationship was observed by Foley (2007) between subjective PM appraisal and PM performance in healthy older adults while a negative association was observed in cognitively impaired older adults. Zeintl, Kliegel, Rast, Zimprich (2006) reported that older adults appear to be heterogeneous with regards to the association between objective and subjective prospective memory. The researchers proposed that prospective memory complaints could serve as a valid criterion in the assessment of prospective memory ability for older adults (with relatively few depressive symptoms and memory concerns). A probable explanation for this fact could be that older subjects recruit some compensatory strategies to overcome the dysfunctional effect of aging on PM. As a consequence, the decline in routine PM is not subjectively (self-reported) or objectively (in routine task performance in naturalistic settings by oneself or others) perceived. Cuttler and Graf (2009) suggested that obsessive checking may develop to compensate for prospective memory failures.

Perusal of the literature relating to PM deficits across the developmental stages revealed that there were very few studies relating to PM deficits and these studies had considered some of the developmental stages i.e. adult – old, adolescent- adult, young old – old old (Brooks & Gardiner 1994; Kliegel & Jäger, 2006; Kliegel, McDaniel & Einstein 2000; Rendell & Craik, 2000; Zolliget al. 2007). A study by Dobbs and Rule (1987) assessed PM across a broad range of developmental stages (30–39, 40–49, 50–59, 60–69 and 70+ yrs), but here also the lower end of the age continuum i.e. adolescents and young adults were not considered. Zimmerman and Meier (2006) assessed the rise and decline of PM across life span, where the age of the sample ranged from 4-6yrs to 65 to 75 yrs. However,

the adult group, that is, 27-55 yrs was not represented.In view of the confounding effects of methodological and conceptual variations, it was felt that comparison of PM across the entire developmental span (adolescent to old) on a uniform index could provide insight into the developmental progression of PM.

The main objective of the present study was to identify the developmental stage at which significant deficits in PM set in and determine whether perceived (Subjective) PM could be considered as a viable indictor of PM performance (Objective) in a non-routine situation. An event based task was selected for the study as greater age effects have been reported on event based rather than time based tasks (Henry et al., 2004).Further, irregular non focal cues were used as regular focal cues that rely upon automatic, reflexive and obligatory responses and greater age effects have been reported when the prospective cue to the ongoing task are non focal in comparison with its focal cues (McDaniel & Einstein, 2007; Kliegel, Jäger, Phillips, 2008).

It was hypothesized that:

- Subjective PM would be significantly related to Objective PM.
- Subjective PM would remain invariant across the developmental groups
- Objective PM (performance on an event based PM task) would decline progressively with age.

## Method

### *Design:*

A multi group design with five independent groups was used in the present investigation where the groups were formulated on the basis of developmental stages,with 50 respondents in each group(Adolescent,Young Adult, Adult,Middle Age,Old Age).Subjective and Objective PM of each respondent was assessed.

### *Sample:*

A purposive sample of 250 respondents were selected from various developmental ages (n=50) i.e. Adolescence (13 -17 years),Young Adult (18 - 25 years), Adult (26-40years), Middle Age(41-60 years), Old Age (61 - 75 years). Minimum education qualification of the adult respondents was matriculation while the adolescents were students of 9th and 10th grades. There respondents were taken from the general population of Sonepat city (Haryana).The adolescent and young adult respondents were selected from schools and colleges. For the remaining three groups,the respondents were contacted at their individual residences. Respondents who voluntarily agreed to participate in the study were included in the sample.

### *Tools:*

*Standard Progressive Matrices (SPM):* SPM test was used to obtain a measure of general intelligence as earlier research has implicated its confounding effect on memory. This test has been developed by Raven in 1938. The test consists of 60 problems divided into five sets (A, B, C, D, E) each made up of 12 problems. The five sets provide five opportunities to grasp the technique required to solve the problems and provide five progressive assessments of a person's capacity for intellectual activity. The total score provides an index of general intelligence.

*Prospective and Retrospective Memory Questionnaire (PRMQ):* PRMQ is a subjective measurement of PM and RM which provides an assessment of prospective and retrospective memory slips experienced in daily life. It has been developed by Crawford et al. (2003).There are 16 items in the questionnaire,eight of which assess PM and eight assess RM. Respondent has to rate each item on a 5 point scale ranging from very often (to be scored as 5) to never (to be scored as 1). The scores for PM and RM are calculated separately and range from 8 to 40 where a lower score is indicative of better memory. The reliabilities of the three scores, i.e. the total score (the sum of ratings across all 16 items); the prospective score (the sum of ratings across the 8 prospective items) and the retrospective score (the sum of ratings across the 8 retrospective items) yielded Cronbach's alphas of .89, .85 and .80, respectively, which indicated a high degree of internal consistency of the

PRMQ. Kliegel and Jager (2006) reported that PM performance was predicted by PM subscale of PRMQ and not RM subscale. Therefore, for the present study, only PM subscale (8 items) was used for assessing Subjective PM.

*Prospective Memory Task:* A self-constructed, event based task was used for assessing Objective PM. Initially, a pool of 200 statements was prepared, in which simple general knowledge facts were stated either correctly or falsely e.g. 'Chandigarh is the Capital of Haryana and Himachal Pradesh', 'Pratibha Patil is the third women president of India'. Among these statements, the name of an Indian state figured in 20 statements. For standardization of the task,30 respondents (age ranging from 20-25 years were given the 200 statements and asked to respond to each statement as true (yes) or false (no).For the final task 100 statements(responded to by minimum 25% and maximum 75 % subjects) were selected where the name of a state of India was mentioned in 10 of the statements. For performance of the task the subjects were required to respond Yes/No to each statement. Further the subjects were to encircle the serial number of the statements figuring the name of an Indian state .They were also informed that there was no time limit, but they should try to complete the work as quickly as possible.For assessment of PM performance, each omission (failure to encircle the serial number of statement with the name of an Indian state) was given a score of 1 while a correct response was not given any score. Thus, the minimum possible score was zero and maximum possible score was ten, where a lower score was indicative of better PM performance.

*Procedure:* Initially, Standard Progressive Matrices (SPM) was administered to a large number of subjects in a group setting (n=10) such that 50 respondents with average intelligence were selected for each group. Prospective and Retrospective Memory Questionnaire (PRMQ) and Prospective Memory Task were administered to each subject in an individual setting. The sequence of the two tasks was varied in a random manner. On an average, a subject took 20 minutes to complete the two tasks.

## Results and Discussion

The purpose of this study was to assess impairments in Subjective and Objective (Event-based) indexes of PM as a function of aging. For this purpose, 250 respondents were selected from five age groups i.e. Adolescent: 14-17 years, Young adult: 18-25 years, Adult: 26 - 40 years, Middle age: 41-60 years, Old age: 61 - 75 years. As intelligence has been reported to have an impact on memory (Alloway, 2010; Kuwajima & Sawaguchi, 2010), subjects with average intelligence were taken in order to control the confounding effects of intelligence.

On Subjective PM, mean score comparisons across the age groups showed that the young adult group had the lowest mean score (13.44) while that of the old age group was the highest (16.32). The mean scores of the adolescent, adult, middle age and old age groups (13.60, 14.74, 15.84, 16.32) were higher than that of the young adult group. Since higher PM scores were indicative of poorer performance, the mean scores show that subjective PM improved from adolescent to young adult and then declined progressively with age. Comparison of the objective PM performance across age groups showed a similar trend. The adolescent group had the best performance (1.94) while that of old age group was the poorest (8.96).The mean score of young adult group (2.20) was slightly higher than that of the adolescent group (1.94) while the scores of adult, middle age and old age groups (4.78, 7.82, 8.96 respectively) were higher than that of adolescent and young adult. Thus, in case of Objective PM, performance was nearly the same in adolescent and young adult groups, but for the higher age groups there was a progressive decline as the developmental stages progressed.

However, the variation in the mean Subjective PM scores across the various age groups was only 2.88(score range 8-to-40) while it was 7.02 (score range 0 to 10) on the Objective PM score. Subjectively, the adolescents also reported PM lapses (mean Subjective PM score:13.60) and even their Objective PM performance was less than perfect (i.e. 1.94). On the other hand, the Subjective PM scores of the adult (14.74) and old

age (16.32) groups were slightly higher than the adolescents, yet their Objective PM performance showed a drastic decline.In adults it dropped to nearly half (4.78) while it was negligible in old age (8.96).These results receive support from a study by Zhao, Yang, Qin and Guo (2003) who studied age related differences in PM performance and self-assessment and observed that performance and self-assessment of children and elders was not as good as young persons. In order to determine whether perceived (Subjective) PM could be considered as a viable indicator of PM performance (Objective) on a laboratory task (a non-routine, event based task) the association between the Objective and Subjective PM scores was analysed. Correlations were computed for the entire sample of 250 respondents as well as separately for each group. The obtained value of correlation between the Subjective and Objective PM scores for the entire sample (r =0.179; p>0.05) was not found to be significant.

Group wise analysis of the relationship revealed a significant positive association between the Subjective and Objective PM scores only in young adults (r: 0.275) and old age (r: 0.284)respondents Thus, these results partially verify the first hypothesis, which predicted that Subjective PM would be related to Objective PM. Some researchers have reported that PM difficulties experienced in everyday lives are related to laboratory based assessment (Thompson, Henry, Withall, Rendell, & Brodaty, 2011) and PM deficit observed in laboratory settings may be a valid indicator of difficulties experienced in executing delayed intentions in everyday life (Will et al., 2009) while others posit Subjective and Objective measures as two separate domains, which need to be assessed and addressed separately (Chan,Wang, Ma, Hong,Yuan,et al., 2008). The present results also indicate that subjective awareness of decline in PM is not always parallel to objective performance and subjective perceptions of PM performance/deficits are not a viable index of actual self- initiated intention (PM performance) at least in adolescents, adults and middle aged persons.

**Table 1. Significance of difference among the PM (objective and subjective) scores of the five developmental groups on ANOVA**

| Variable | Sources of variance | Sum of Squares | Mean square variance | F value |
|---|---|---|---|---|
| Subjective PM | Between groups | 334.224 | 83.556 | 4.492** |
| | Within group | 4557.540 | 18.602 | |
| Objective PM | Between groups | 2039.400 | 509.850 | 84.134** |
| | Within group | 14.84 | 6.060 | |

df = 4,245 ** p<0.01

**Table 2. Significance of mean difference between the Subjective PM scores of the five age groups on Tukey's test.**

| Groups | Adolescent (13.60) | Young Adult (13.44) | Adult (14.74) | Middle Age 15.84) | Old Age (16.32) |
|---|---|---|---|---|---|
| Adolescent | | 0.16 | 1.14 | 2.24 | 2.72* |
| Young Adult | | | 1.30 | 2.4* | 2.88** |
| Adult | | | | 1.10 | 1.58 |
| Middle Age | | | | | 0.48 |
| Old Age | | | | | |

*p<0.05; **p<0.01; Mean values in parenthesis

In order to identify the developmental stage, at which the significant deficits in PM set in, the differences among the mean scores on Subjective and Objective PM were analyzed by applying one way ANOVA.

Table 1 shows the F value for both Subjective and Objective PM scores across the various developmental stages. Since, both the F values were found to be significant ($p<0.01$) the differences between the mean group scores were analyses by Tukey's post hoc test in order to determine which groups differed significantly.

Although, the mean Subjective PM scores of all the groups (except for the young adult) were higher than the preceding age groups.Only three of the mean comparisons i.e. adolescent-old age, young adult -middle age and young adult-old age were significant. Comparisons between the other groups showed that there were no significant mean differences between all the remaining groups.Thus, no significant variation was evident in self-reported PM in adults, middle age and old age groups. Therefore, the second hypothesis, which predicted that Subjective PM would remain invariant across the developmental groups, was verified except for the two younger age groups. These results indicate that Subjective PM is similar in adolescents and young adults and declines with the onset of adulthood, but it does not vary significantly across the adult age span(26-75 yrs).

These results receive support from a number of earlier studies where PM was assessed by the Prospective and Retrospective Memory Questionnaire across large healthy samples covering the whole adult life span and indicated that everyday prospective memory performance was not impaired in old age (Crawford et al., 2003; Kliegel & Jäger, 2006; Rönnlund, Mäntylä, & Nilsson, 2008; Smith, Della Sala, Logie, & Maylor, 2000; Zeintl et al., 2006).

However, on the Objective PM scores all the comparisons, except those between the two successive extreme groups (Adolescent-Young Adult; Middle Age-Old Age), were significantly at the 0.01 level. Since, the mean scores of all the groups were higher than the preceding age groups; these results show that there was a progressive decline in Objective PM Scores as the developmental stages progressed from young adult to old age. These results verify the third hypothesis, which stated that Objective PM (performance on an event based PM task) would decline progressively with age. A number of researches show that there is a continual improvement of prospective memory from childhood into young adulthood, but that a decline begins in adulthood(Kvavilashvili, Kornbrot, Mash,Cockburn, & Milne, 2009; Smith, Bayen & Martin, 2010). The present results are in contradiction with those of Einstein and McDaniel (1990) who did not observe reliable age related deficits in PM performance andMaylor (1996) who reported significant differences in PM between 50-60 and 70-80 yrs participants.Wang, Altgassen, Liu, Xiong, Akgün and Kliegel (2011) did not observe age differences in PM performance of 13-20 yrs respondents when focal cues were used. However, they reported significant differences between adolescents and young adults when the task employed non focal cues. Thus, it is probable that the earlier observed age related

**Table 3.Significance of difference between the Mean Objective PM scores of the five age groups on Tukey's test.**

| Groups | Adolescent (1.94) | Young Adult (2.20) | Adult (4.78) | Middle Age (7.82) | Old Age (8.96) |
|---|---|---|---|---|---|
| Adolescent | | 0.82 | 2.84** | 5.88** | 7.02** |
| Young Adult | | | 2.02** | 5.06** | 6.20** |
| Adult | | | | 3.04** | 4.18** |
| Middle Age | | | | | 1.14 |
| Old Age | | | | | |

**p<0.01; Mean values in parenthesis

invariance in PM performance could be an artifact of the nature of task, cognitive processing demands(automatic/reflexive vs. self - initiated, secondary task overload) or motivational factors (importance, relevance).

**Conclusions and Limitations**

The present research had been conducted to identify the developmental stage at which significant deficits in PM set in and determine whether perceived (Subjective) PM could be considered as a viable indictor of PM performance (Objective) in a non - routine situation. The main findings which emerge from the present investigation is that PM has an inverted U shaped developmental progression, where it improves (at least the subjective perception) from adolescence to young adulthood and then declines progressively from adulthood (26-40 yrs) to old age. Earlier researchers have reported that an inverted U shaped relationship where PM of a young adult has generally been reported as better than that of adolescents. Thus, it is evident that the decline in PM performance starts in adulthood.

Comparison of the mean scores on subjective and objective PM provided support to the contention that subjective awareness of the decline in PM is not parallel to the objective decline with the progression of age. This fact was collaborated by the correlation analysis of the Objective and Subjective PM scores. Although, mean analysis did not reveal significant differences in the PM scores (of both Objective and Subjective) between the adolescents-young adults and middle age-old age groups, the correlations between the two indices were significant only for the young adult and old age groups, indicating that their subjective appraisal of PM performance was in congruence with their actual performance. Thus, it appears that self evaluation of every day PM deficits cannot be considered as an index of performance on non routine, self-initiated prospective activities despite of age related memory dysfunction, the older subjects did not perceive any major deficit in prospective memory related actions/tasks while the judgments' of the younger groups were equally erroneous. A probable explanation could be that the compensatory strategies recruited by older subjects to overcome the dysfunctional effect of aging on PM helps them to continue with their routine tasks and therefore, the decline in PM is not subjectively (self-reported) or objectively (in routine task performance in naturalistic settings by oneself or others) perceived. A role of alternative strategies (use of external aids, automatic processing) for dealing with age related memory dysfunction has been implicated by a number of researchers (Einstein et al.,1995; Henry et al., 2004; Uttl, 2008; West & Bowry, 2005. Electronic device such as phones using the android operating system can be used as external aids for time as well as event based prospective memory tasks. Earlier research has shown that PM is related with executive functions and better prospective memory has been reported to lead to a higher likelihood of setting goals and priorities and being more organized thereby implicating a relationship between memory and organization Thus, PM assumes importance in academics where an individual needs to schedule multiple tasks,and execute them at the appropriate moment. Awareness of PM deficits may help in organization and execution of important intentions as alternative strategies such as visualization of the situation,setting alarm or reminder help in compensating PM deficits.

A major limitation of the present study is that the PM task was self–paced and the variation in the time taken by the respondents, which could have been a more accurate index of performance along with the number of omissions, was not considered. Further, inclusion of a task requiring reflexive automatic responses could have provided insight into the role and utility of compensatory strategies used by older respondents, in PM related performance.

Thus, it can be concluded that judgment of PM performance may be at variance with actual performance, may be, because older individuals develop more effective alternative strategies for compensating the age related decline in memory. These results implicate the utility of intervention programs for dealing with age/disease related memory loss. Furthermore, comparison of meta-cognitive processes in individuals, with and without subjective PM lapses, could provide insight into the strategies, which are effective in compensating for cognitive dysfunction

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**Nisha Malik** F.C. College for Women, Hisar, Haryana

**Amrita Yadava,** Professor, Department of Psychology, M.D. University, Rohtak, Haryana. Email : amrita.psydept@gmail.com

**NovRattan Sharma**, Professor, Department of Psychology, M.D. University, Rohtak, Haryana 124001. E mail : sharmanr5@gmail.com (corresponding author)