Prospective memory problems in patients with neurological disorders: assessment and cognitive rehabilitation

Prof. David Man, PhD

Definitions of Prospective Memory

Prospective memory (PM) refers to remembering to do things in future time points or respond when occurrence of a particular event

The cognitive ability of remembering to carry out planned intentions or actions at future points in time

A process of:
formation, retention, delayed initiation and execution intentions

A key component in multitasking situation
• Core in daily living (ADL, IADL)
PM’s impact on daily living

- Prospective memory has a major impact on individuals’ ADL as well as quality of life.
- It leads to difficulty in making plan and performing the future task in everyday life such as remembering to meet the teacher at 2 p.m., remembering to buy grocery items in shop.
- More negative effects in social life, vocational activities and instrumental activities of daily living (Fleming et al, 2008)

Retrieved from http://hawaii.sys.i.kyoto-u.ac.jp/home/research/computational-cognitive-psychology
Significant activation in both the cue identification and intention retrieval PM conditions in anterior prefrontal cortex (BA10), with activation bilaterally in lateral BA10 and deactivation in medial BA10 (see Fig. A and B). Medial BA10 appeared to be more active in the cue identification PM condition (see blue activation in Fig.C). (Simons et al., 2006)

Components of PM

I. Prospective Component
   – Remembering at an appropriate moment that one must do something
     (Kvavilashvili & Ellis, 1996)

II. Retrospective Component
   – Recalling what is to be done
     (Kvavilashvili & Ellis, 1996)
Key sub-types of PM

I. **Event-based PM** (e.g. buying a book when seeing a bookshop)
   Event-based tasks are those that must be carried out in association with a particular event (for example passing on a message when you see a particular colleague)
   (Einstein and McDaniel, 1990)
   Involves an environmental cue to initiate an action
   (Guynn, Einstein, & Breneiser, 2004)

II. **Time-based PM** (e.g. attend an appointment at 11am)
   Time-based tasks are those that must be carried out at a particular time or after a certain amount of time (Einstein and McDaniel, 1990)
   Requires a self-initiated strategy to monitor the environment to recognize the time to react
   (Einstein & McDaniel, 2005)

III. **Activity-based** (e.g. take medication after meals)

PM deficit in neurological disorders

- Head injury
- Dementia
- Mild cognitive impairment
- Parkinson’s disease

(Costa, Peppe, Caltagirone, & Carlesimo, 2008; Kliegel et al., 2011; Shum, Levin, & Chan, 2011; van den Berg, Kant, & Postma, 2012)
Relationships between stroke and PM

Some studies in the past 11 years

<table>
<thead>
<tr>
<th>Year</th>
<th>Studies</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>Prospective Follow-Up Study Between 3 and 15 Months After Stroke: Improvements and Decline in Cognitive Function Among Dementia-Free Stroke Survivors &gt;75 Years of Age.</td>
<td>Ballard, C., Rowan, E., Stephens, S., Kalaria, R., &amp; Kenny, R.</td>
</tr>
<tr>
<td>2009</td>
<td>Impairments in prospective and retrospective memory following stroke.</td>
<td>Kim, H., Craik, F., Luo, L., &amp; Ween, J.</td>
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</tbody>
</table>

Prospective memory problems in dementia

- Prospective memory as an early indicator of dementia  
  (Huppert & Baardsall, 1993)
- High prevalence of PM impairment in elderly and early-stage dementia  
  (Huppert, Johnson & Nickson, 2001)
- Reduced PM function in age-related decline, MCI and dementia  
  (Farina, Young, Tabet & Rusted, 2013; Thompson, Henry, Rendell, Withall & Broadaty, 2010; 2011)
- Affecting prospective memory and retrospective memory in MCI  
  (Costa, Caltagirone, Carlesimo, 2011) AD and vascular dementia  
  [and similar pattern of functional impairment ]  
  (Livner, Laukka, Karisson, Bäckman, 2009)
The assessment and rehabilitation of prospective memory problems in people with neurological disorders: A review

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People with neurological disorders often report difficulty with prospective memory (PM), that is, remembering to do things they had intended to do. This paper briefly reviews the literature regarding the neuropsychology of PM function, concluding that from the clinical perspective, PM is best considered in terms of its separable but interacting mnemonic and executive components. Next, the strengths and limitations in the current clinical assessment of PM, including the assessment of component processes, desktop analogues of PM tasks, and naturalistic PM tasks, are outlined. The evidence base for the rehabilitation of PM is then considered, focusing on retraining PM using retrospective memory strategies, problem-solving training, and finally, electronic memory aids. It is proposed that further research should focus on establishing the predictive validity of PM assessment, and retraining promising rehabilitation techniques.

Keywords: Brain injury; Assessment; Rehabilitation; Everyday memory.

Available PM Tests

PM tests

PM tasks - standardized tests

Technological assessments

Paper-and-pencil tests

Laboratory tests

Computer-based tests

Flash-based programs;
Virtual reality;
Prospective remembering video procedures (PRVP)

Self-rated questionnaires

Functional assessment
Paper-and-pencil Tests

Three common PM assessment - Laboratory Tests (Shum, Fleming, & Neulinger, 2000)

1. The Rivermead Behavioral Memory Test (RBMT) (RBMT; Wilson, Cockburn, & Baddeley, 1985; Wilson, Cockburn, & Baddeley, 2003)

2. The Cambridge Behavioural Prospective Memory Test (Groot et al., 2002) with its revised version, the CAMPROMPT (Wilson et al., 2005), The Cambridge Prospective Memory Test (CAMPROMT) (Wilson et al., 2005)

3. The Memory for Intentions Screening test (MIST) (Raskin, 2009)

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RBMT

- Although it contains three within-session event-based PM tasks, there is not enough evidence to support its reliability and validity of the PM items separately (Shum et al., 2002).

- The validity is also further limited by its lack of time-based tasks and long-term tasks which extend beyond assessment session (Mathias & Mansfield, 2005; Shum, Ungvari, Tang, & Leung, 2004).
MIST (Raskin, 2004)

- Comprises four time-based and four event-based tasks intermixed with on-going tasks plus a long-term task (asking a tested person to phone back in 24 hours).
- Internal consistency and test-retest reliability for the scores are reportedly good and it was also found to be sensitive to PM deficits (Raskin, 2009).
- No alternative version is developed to minimize the practice effects after repeated assessments.
- It takes around 30 – 40 minutes to administer, which is again too long and difficult to incorporate into a standard neuropsychological assessment (Radford et al., 2011).

CAMPROMPT

- In the CAMPROMPT, there are three time-based and three event-based PM tasks which take over 30 minutes to complete.
- Good reliability and validity has been reported by the authors.
- No correlation was found between the short term PM performance in the test and the long-term PM tasks in daily life. (Fish, Evans, Nimmo, Martin, Kersel, Bateman, Wilson, & Manly, 2007)
Cambridge Prospective Memory Test

Schematic representation of administering the test (Time line)

- **Execution (client)**
  - Object location (E)
  - Take key (T)
  - Give book (E)
  - Give message (E)
  - Change task (T)
  - Ring garage (T)

- **Instruction (tester)**
  - Object location (E)
  - Take key (T)
  - Give book (E)
  - Give message (E)
  - Change task (T)
  - Ring garage (T)

- **Event-based (E)**
- **Time-based (T)**

- **Timeline**
  - Start Quiz
  - End of Quiz

- **Time**
  - 20 min
  - 5 min

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Scoring

- 8 scoring criteria
- Total score: 36 (event-based + time based)

<table>
<thead>
<tr>
<th>Scoring criteria</th>
<th>Score</th>
</tr>
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<tbody>
<tr>
<td>Client spontaneously carries out some tasks</td>
<td></td>
</tr>
<tr>
<td>Correct task</td>
<td>A= 6</td>
</tr>
<tr>
<td>Wrong task ‡ Prompt ‡ Correct task</td>
<td>B= 4</td>
</tr>
<tr>
<td>Wrong task ‡ Prompt ‡ Wrong task</td>
<td>C= 2</td>
</tr>
<tr>
<td>No response</td>
<td></td>
</tr>
<tr>
<td>Prompt ‡ Correct task</td>
<td>D= 4</td>
</tr>
<tr>
<td>Prompt ‡ Wrong task ‡ Prompt ‡ Correct task</td>
<td>E= 2</td>
</tr>
<tr>
<td>Prompt ‡ Wrong task ‡ Prompt ‡ Wrong task</td>
<td>F= 1</td>
</tr>
<tr>
<td>No response</td>
<td></td>
</tr>
<tr>
<td>Prompt ‡ 'No' ‡ Prompt ‡ Correct task</td>
<td>G= 1</td>
</tr>
<tr>
<td>Prompt ‡ 'No' ‡ Prompt ‡ 'No' ‡ Wrong task</td>
<td>H= 0</td>
</tr>
</tbody>
</table>
Paper-and-pencil Tests

Self-rated/self-report type of questionnaires

1. The Prospective Memory Questionnaire (PMQ; Hannon, Adams, Harrington, Fries-Dias, & Gibson, 1995)

2. The Prospective and Retrospective Memory Questionnaire (PRMQ; Smith, Della Sala, Logie, & Maylor, 2000)

3. The Comprehensive Assessment of Prospective Memory (CAPM; Waugh, 1999; CAPM-SF, Man et al, 2012; Cantonese Version—ongoing study)

4. The Royal Prince Alfred Prospective Memory Test (Radford, Lah, Say & Miller, 2010)
Comprehensive Prospective Memory – Cantonese version (CAPM-CV)

Man et al. (2013)

1. 3.
2. 5.
3. 7.
4. 9.
5. 11.
6. 13.
7. 15.
8. 17.
9. 19.
10. 21.
11. 23.
12. 25.
13. 27.
### The Royal Prince Alfred Prospective Memory Test (RPA-ProMem; Radford, Lah, Say & Miller, 2010)

- Featuring both time-based (x2) and event-based tasks (x2)
- Measured over short- (within-session) or long-term retention (a week following the test session) intervals
- Three alternative forms of the test
- The “everyday” functional relevance (face validity) of test items is a key concern.
- Designed to be brief and easily administered
### Royal Prince Alfred Prospective Memory Test (RAA-ProMem): Test Items and Scoring Criteria

#### Scoring for All Test Forms

<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Item 1</strong></td>
<td>Current response, up to 2 minutes delay for ahead of time</td>
<td>Tactful response, 3 minutes delay for ahead of time</td>
<td>Current response, 2 minutes delay for ahead of time</td>
</tr>
<tr>
<td><strong>Item 2</strong></td>
<td>Current response, 2 minutes delay for ahead of time</td>
<td>Tactful response, 3 minutes delay for ahead of time</td>
<td>Current response, 2 minutes delay for ahead of time</td>
</tr>
<tr>
<td><strong>Item 3</strong></td>
<td>Tactful response, 2 minutes delay for ahead of time</td>
<td>Tactful response, 3 minutes delay for ahead of time</td>
<td>Tactful response, 2 minutes delay for ahead of time</td>
</tr>
<tr>
<td><strong>Item 4</strong></td>
<td>Tactful response, 3 minutes delay for ahead of time</td>
<td>Tactful response, 3 minutes delay for ahead of time</td>
<td>Tactful response, 3 minutes delay for ahead of time</td>
</tr>
</tbody>
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#### RAA-ProMem Test Items

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1. Return this postcard (date to be passed, 1 week from now)</td>
<td>Postcard sent, correct day, correct information (error date postcard sent, no date received)</td>
</tr>
<tr>
<td>2. Return this postcard (date to be passed, 1 week from now)</td>
<td>Postcard sent, correct day, incorrect information</td>
</tr>
<tr>
<td>3. Return this postcard (date to be passed, 1 week from now)</td>
<td>No postcard sent (up to 2 weeks)</td>
</tr>
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*IOT Conference 21 March 2015*
Rehabilitation of PM

- Retraining approaches
  - repeated practice of simple PM tasks
  - limited generalization
  - increasing self awareness, promoting compensatory strategy use

- Supporting the retrospective components of PM task
  - Errorless learning combined with other memory techniques such as SR, or vanishing cues
• Supporting the executive component of PM tasks
  – Overlapping with executive functions
  – Goal management training (GMT) and using structured group exercise
    • Think about own experiences
    • Discover strategies (stop and think, break down goals into sub-goals, generating to-do list etc.)
    • Use of homework exercise, recording daily success/errors to promote generalization

• Supporting mnemonic and executive aspects of PM tasks
  – Memory aids
  – Electronic organizers (Google calendar)
  – Smart phone
Virtual reality (VR)-based community living skills training for people with acquired brain injury: A pilot study

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(Received 1st January 2009; revised 3rd September 2009; accepted 23rd September 2009)

Abstract
Primary objective: The purpose of the present study was to test the feasibility and effectiveness of a newly-developed virtual reality (VR)-based computerized living skills training program for people with acquired brain injury (ABI). Methods: A small-sample, pre- and post-assessment experimental design was adopted to initially test the efficacy of the VR-based training program. Feasibility was also investigated through interviewing clinicians. Differences were documented in terms of program completion, virtual environment enjoyment, and perceived self-efficacy. Results: Clinically significant improvements were found in self-efficacy and perceived self-efficacy, and no significant changes were found in the post-assessment virtual environment enjoyment. Conclusions: Preliminary results suggested positive changes in ABI subjects. The proposed virtual reality (VR) community living skills training program in video games setting is a feasible and promising intervention.

Keywords: Brain injury, rehabilitation, video games, virtual reality, community living skills.

Virtual reality-based prospective memory training program for people with acquired brain injury

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Abstract: Acquired brain injuries (ABI) may impair cognitive functions and lead to long-term disabilities including prospective memory (PM) failure. Prospective memory serves to remember to occur at a specified time later. PM problems would be a challenge to an ABI patient’s successful community reintegration. While retrospective memory (RM) has been extensively studied, treatment programs for prospective memory are rarely targeted. The development of a treatment program for PM, which is consistent with, can be cost-effective and improve to the patient’s environment. A 3-week virtual reality (VR)-based cognitive rehabilitation program was developed using virtual reality PM activity as training content. Twenty-five subjects were randomized to participate in a prospective memory computerized experimental study to evaluate its treatment effectiveness. Results suggest that significant better changes were seen in both VR-based and non-VR PM outcome measures, related cognitive abilities, such as bahavioral flexibility, and semantic fluency. VR-based training may be successful in ABI patients. An encouraging improvement has been shown. Large-scale studies of a virtual reality-based prospective memory (VRPM) training program are indicated.

Keywords: Acquired brain injury, prospective memory rehabilitation, virtual reality.
Thank you!

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