# Validation of Virtual Reality for Measuring Prospective Memory in Young and Older Adults

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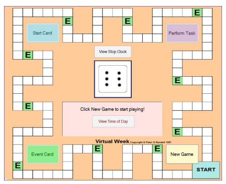
## Introduction

- Prospective Memory (PM) consists of forming an intention for future action and remembering to perform that action at the appropriate time
- PM is crucial for independent living, especially in older adulthood, where failures in PM can yield significant negative outcomes (Einstein & McDaniel, 1920; Park et al., 1997; Hering et al., 2018)




Rose et al., 2015, *Frontiers of Human Neuroscience*

### How is Prospective Memory measured?

Conventional measures include:

(1) **Relatively demanding ongoing task**

(2) **Embedded PM tasks**

Dependent Measures:

(1) Performance accuracy

(2) Time deviation measures

### How does Ecological Validity Affect PM Assessment?

- Inconsistent age differences between naturalistic and lab-based measures
- Are naturalistic & lab-based measures capturing different aspects of PM? Age Prospective Memory Paradox; Rendell & Craik (2000); Lewis-Peacock et al. (2016); McDaniel & Einstein, (1990)
- What cognitive abilities can account for age differences in prospective memory performance?

**Can Virtual Reality measure *true* prospective memory in younger and older adults?**

## Methods

Participants: 59 Notre Dame students (Age 18-30, mean=19.4) & 52 older adults (Age 56-83, mean=70.4) were screened for exclusionary cognitive and physiological criteria* and completed:

- **Two (2) Job Simulator Scenarios**

(1) Role-playing videogame narrative
- Short-order cook
- Convenience store clerk

**Ongoing Task**

(2) Seven tasks/scenario to be memorized & executed
- Event-Based Cues
- Time-Based Cues

**Cue Type**

- Regular occurrence
- Irregular occurrence

**Task Regularity**

**PM tasks**


- **Real-World Breakfast Task****

1. Cooking a breakfast & Setting the Table
1. 5 Breakfast Items; Time-Based Cues
2. Setting the Table Repeatedly

- **Operation Span Task** [1]
  Unsworth et al (2005) *Behavior Research Methods*
- **Psychomotor Vigilance Task** [2]
  Drummond et al. (2005) *Sleep*
- **Big Five Inventory** [3]
  Goldberg (1990) *Journal of Personality & Social Psychology*

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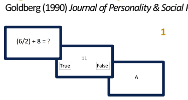


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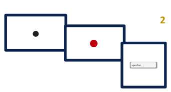

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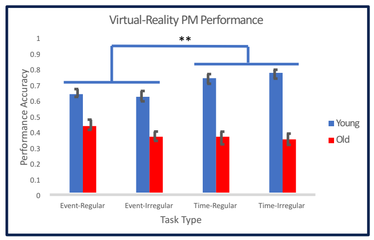
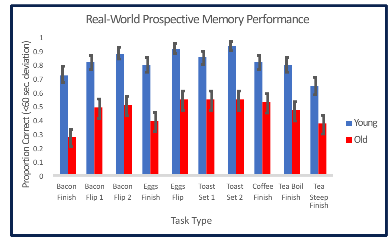
*Telephone Interview for Cognitive Status (TICS) & Virtual Screening Questionnaire
** Adapted from Dresden Breakfast Task (Altgassen, Koban, & Kliegel, 2012)


## AGE DIFFERENCES IN PROSPECTIVE MEMORY




*Younger adults significantly outperformed older adult in each task type*
$F(1,109) = 108.9$, $p < 0.001$, $\eta_p^2 = 0.500$

*Cue Type x Age interaction was driven by larger age differences in time-based tasks*
$F(1,109) = 13.35$, $p < 0.001$, $\eta_p^2 = 0.109$

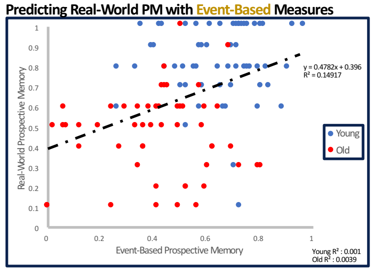



*Younger adults outperformed older adults on all 4 task types*
$F(1,109) = 90.55$, $p < 0.001$, $\eta_p^2 = 0.454$

*Main effect of task with no interactions*
$F(9,101) = 13.35$, $p < 0.001$, $\eta_p^2 = 0.276$

*Age differences in performance were largest in those tasks with intermediary steps*
(e.g.) Bacon: $t(109) = 5.39$, $p < 0.001$, $\Delta M = 0.460$

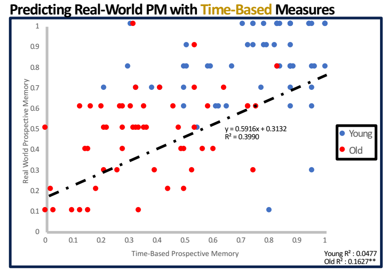
### Predicting Real-World PM with Event-Based Measures




*VR Event-Based PM significantly predicted Real-World PM across age groups*
$R^2 = 0.149$, $p < 0.001$

*However, the correlation becomes insignificant when controlling for age in the correlation*
$r = .045$, $p = 0.644$

### Predicting Real-World PM with Time-Based Measures

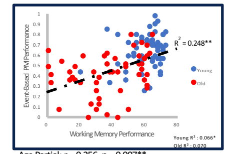



*VR Time-Based PM significantly predicted Real-World PM across age groups*
$R^2 = 0.400$, $p < 0.001$

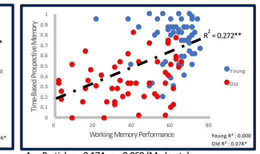
*Time-based VR performance was still a significant predictor even when controlling for variance driven by age group*
$r = 0.312$, $p < 0.001$

## What drives age differences in PM?

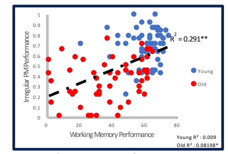
### Working Memory




Age Partial: $r = 0.256$, $p = 0.007$**



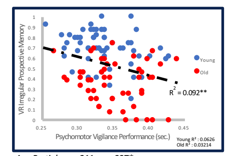

Age Partial: $r = 0.174$, $p = 0.069$ (Moderate)




Age Partial: $r = 0.221$, $p = 0.02$*


Age Partial: $r = 0.241$, $p = 0.011$*

### Attentional Vigilance




*Age Partial: $r = -.211$, $p = .027$**

### Conscientiousness

*No significant relationship with PM performance when controlling for age*

### Multiple Regression Analyses

**Predicting Event-Based Performance**

***Model 1: Age***

$F(1,109) = 43.06$, $p < 0.001$

$R^2_{adj} = 0.277$

***Model 2: Modulating Variables + Age***

***Step 1: WM/PVT/Conscientiousness***

$F(3,107) = 12.49$, $p < 0.001$

$R^2_{adj} = 0.239$, $p < 0.001$

***Step 2: WM/PVT/Conscientiousness/Age***

$\Delta R^2 = 0.084$, $p < 0.001$

$F(1,106) = 13.64$, $p < 0.001$

**Predicting Time-Based Performance**

***Model 1: Age***

$F(1,109) = 99.84$, $p < 0.001$

$R^2_{adj} = 0.473$

***Model 2: Modulating Variables + Age***

***Step 1: WM/PVT/Conscientiousness***

$F(3,107) = 16.91$, $p < 0.001$

$R^2_{adj} = 0.303$, $p < 0.001$

***Step 2: WM/PVT/Conscientiousness/Age***

$\Delta R^2 = 0.183$, $p < 0.001$

$F(1,106) = 39.26$, $p < 0.001$

## Conclusions

- Significant relationships between VR and Breakfast Task suggest enhanced ecological validity in the prior compared to conventional lab-based paradigms
- Working memory capacity yielded highest predictive power compared to PVT & BFI—however, models were unable to account for all age diff. in VR

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