



# Dual task effects on implicit probabilistic sequence learning in young and old adults

Katherine R. Gamble<sup>1</sup>, James H. Howard, Jr.<sup>1,2,3</sup>, Darlene V. Howard<sup>1</sup>

<sup>1</sup>Department of Psychology, Georgetown University; <sup>2</sup>Department of Psychology, The Catholic University of America; <sup>3</sup>Department of Neurology, Georgetown University Medical Center



## Introduction

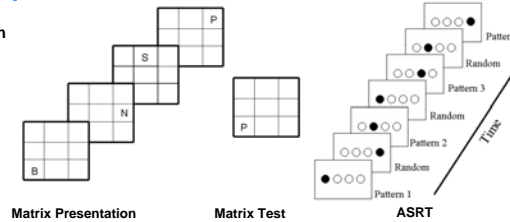
- **Implicit motor sequence learning** occurs when people respond to a series of stimuli, and unknowingly learn a pattern embedded within the stimulus sequence
- The **Alternating Serial Reaction Time (ASRT)** task is a measure of sequence learning, modified from the SRT and contains a subtle second-order regularity (Howard and Howard, 1997)
  - Sequence learning can be assessed continuously, and
  - Recognition measures indicate a lack of explicit knowledge
- **Dual tasks** have been used:
  - **concurrently** with sequence learning to look at the effects of divided attention or at parallel learning, with mixed results showing either impaired learning or no effect (Allen, Baddeley & Hitch, 2006; Deroost, Coomand & Soetens, 2009; Jiménez & Vázquez, 2005; Rowland and Shanks, 2006)
  - **sequentially** with implicit category learning, and show improved learning in young adults (Filoteo, Lauritzen & Maddox, 2010)
- **Goal of present study:** To determine if a *sequentially* presented working memory (WM) task affects implicit learning of a probabilistic sequence in young and older adults
- **Sequence learning assessed via:** ASRT, which requires continuous updating of information during learning
- **Dual task:** Matrices task from Mitchell, Johnson, Raye & D'Esposito (2000), presented sequentially to tax the frontal lobes in task-switching

## Participants and Task Conditions

### Sequential Dual Task Condition

• Participants saw the Matrix Presentation, were given the Matrix Test after a 3s delay, and then completed a block of the ASRT

• 12 young and 12 old adults

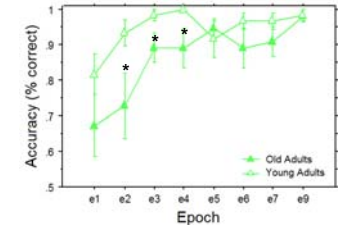


### Control Condition

• Participants completed a block of the ASRT

• 12 young and 12 old adults

## Matrices Task Test Accuracy

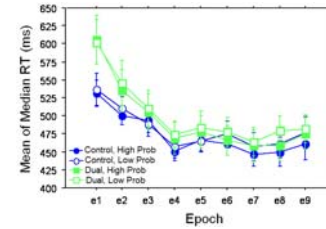
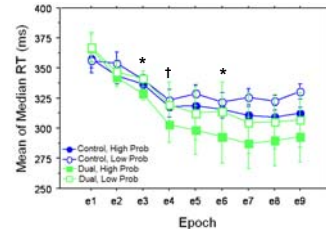


- Young adults were more accurate than old (main effect of age,  $p = .036$ )
- Older adults showed more improvement over time (age x epoch interaction,  $p < .001$ )

## Young adults

## Old adults

### ASRT Reaction Time

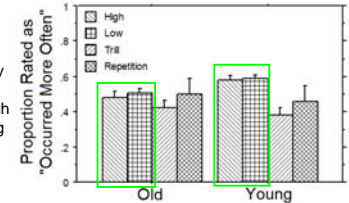


- Skill-learning (main effect of epoch,  $p < .001$ )
- Sequence learning (main effect of triplet type,  $p < .001$  & triplet type x epoch interaction,  $p < .001$ )
- Dual group shows more sequence learning than control group on some epochs (marginal triplet type x epoch x condition interaction,  $p = .08$ )

- Skill-learning (main effect of epoch,  $p < .001$ )
- Sequence learning (main effect of triplet type,  $p = .004$  & triplet type x epoch interaction,  $p = .02$ )
- No group differences in sequence learning (triplet type x epoch x condition interaction,  $p = .52$ )

## Test of Implicitness

- Sensitive measures of explicit awareness showed that no participants were aware of the sequence they implicitly learned
- Participants did not rate high probability triplets as having occurred more frequently than low probability triplets



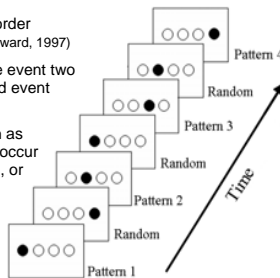
## Alternating Serial Reaction Time Task

• The ASRT task is a probabilistic 2<sup>nd</sup> order sequence learning task (Howard and Howard, 1997)

• One event predicts the location of the event two trials later, with a randomly determined event between them

• Learning occurs within patterns, such as 1r2r3r4r, where triplets of trials would occur with High frequency, 1r2, 2r3, 3r4, 4r1, or Low frequency, eg: 1r3 or 2r4

• 50 trials/block, 15 blocks/session, 3 sessions



## Matrices Task

• Adapted from Mitchell et al. (2000)

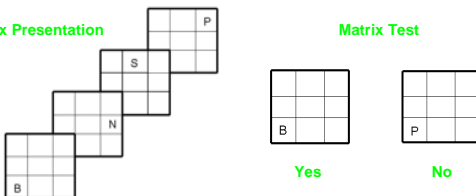
• Participants in the dual task condition saw 3 (older adults) or 4 (young adults) matrices, one at a time, for 1500 ms each

• Participants were instructed to "Remember both the letter and the location"

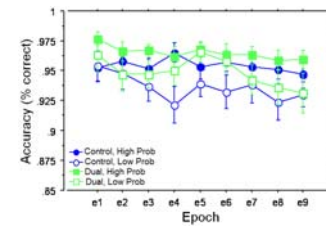
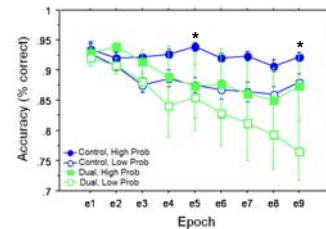
• Memory for the letter and location together were tested – participants responded "yes" if a letter and location were exactly as seen previously, and "no" if otherwise

Matrix Presentation

Matrix Test



## ASRT Accuracy



- Sequence learning (main effect of triplet type,  $p < .001$  & triplet type x epoch interaction,  $p < .001$ )
- Dual group shows more sequence learning than control group on some epochs (triplet type x epoch x condition interaction,  $p = .018$ )

- Sequence learning (main effect of triplet type,  $p < .001$ )
- No group differences in sequence learning (triplet type x epoch x condition interaction,  $p = .32$ )

## Discussion & Implications

- The sequential dual task affected implicit sequence learning in young, but not older adults
  - A sequential dual task improved learning in young adults compared to those completing the ASRT alone, similar to findings of Filoteo et al.
- Filoteo et al. suggest that a sequential WM task "removes" the frontal lobes, allowing the procedural-system to control task performance
  - Young adults in our task may similarly have had their frontal lobes behaviorally "removed" in the dual task condition, allowing the striatum to take over and carry out sequence learning
- Older adults did not show group differences in learning, suggesting that the dual task group was not affected by the frontal lobe "removal"
  - Young and old adults may be using different brain regions for ASRT learning, such that a "removal" of the frontal lobes may not affect learning in old adults, perhaps due to age-related PFC volume decreases

23<sup>rd</sup> Annual Convention of the American Psychological Association, 2011  
Supported by: NIH/NIA Grants RO1AG036863 & R37AG15450

kr27@georgetown.edu