



# OLDER ADULTS REVEAL IMPLICIT LEARNING OF SUBTLE THIRD-ORDER SEQUENTIAL STRUCTURE

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## BACKGROUND AND PURPOSE

IMPLICIT SEQUENCE LEARNING is non-conscious acquisition of regularities within a series of stimuli

### TASKS

- Serial Reaction Time (SRT) (Nissen & Bullemer, 1987)
- Alternating SRT (ASRT) (Howard & Howard, 1997)
- Better reaction time and accuracy to pattern vs. random stimuli

### EFFECT OF AGE

Order	Frequent event	Example
0 <sup>th</sup>	Single item	2 in 4231324321
1 <sup>st</sup>	Pairs	32 in 4231324321
2 <sup>nd</sup>	Triplets	1r2 in 1r2r3r4r
3 <sup>rd</sup>	Quadruplets	1rr2 in 1rr2rr3rr4rr

- No age differences in learning low-order sequential structure (Frensch & Miner, 1994; Howard & Howard, 1989)
- Age-related learning deficits appear with 2<sup>nd</sup> order structure (Howard et al., 2004)
- Older adults did not learn 3<sup>rd</sup> order structure (Howard et al., 2004)

### PURPOSE

- Is there an age-related limit to the level of structure that can be learned implicitly?

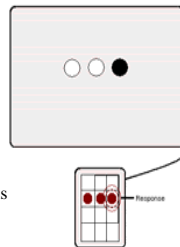
## METHOD

### PARTICIPANTS

- 12 Younger adults (M=20.0 ± 1.5 years)
- 12 Older adults (M=71.6 ± 5.4 years)

### ASRT TASK

- Stimuli at 1 of 3 locations
- Press corresponding button



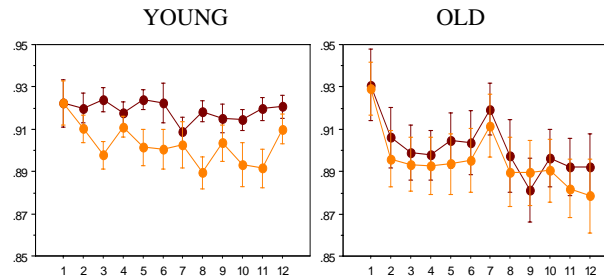
- 6 sessions over 2 days
- 10 blocks/session
  - 190 trials/block
    - 10 practice
    - 20 sequence repetitions

- 3<sup>rd</sup> order structure
  - (1rr2rr3rr or 1rr3rr2rr)
  - 1, 2, 3: repeating pattern trials
  - r: randomly determined trial

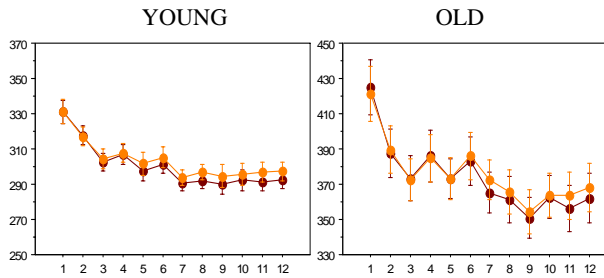
- Analyses compare the last trial of high (e.g. 1232) vs. low (e.g. 1223) frequency quadruplets

## RESULTS: IMPLICIT LEARNING

### ACCURACY (prop correct)



### REACTION TIME (ms)



● high-frequency  
○ low-frequency

## RESULTS SUMMARY

### ACCURACY

- Younger adults learn more than older adults ( $p < .05$ )
- Implicit learning in both groups ( $p$ 's  $< .03$ )

### REACTION TIME

- No group differences in learning ( $p > .60$ )
- Implicit learning in both groups ( $p$ 's  $< .04$ )

### EXPLICIT AWARENESS

- No individual had explicit awareness of the regularity

## DISCUSSION

- Results are consistent with previous studies showing age-related deficits in implicit sequence learning of high order structure for accuracy (Howard et al., 2004)
- However, both age groups showed learning of the 3<sup>rd</sup> order structure on both behavioral measures
- Thus, older adults remain sensitive to highly complex, subtle regularities in their environment, albeit to a lesser degree than younger adults

## REFERENCES

- Frensch, P. A., & Miner, C. S. (1994). Effects of presentation rate and individual differences in short-term memory capacity on an indirect measure of serial learning. *Memory and Cognition*, 22(1), 95-110
- Howard, D. V., & Howard, J. H., Jr. (1989). Age differences in learning serial patterns: direct versus indirect measures. *Psychology and Aging*, 4(3), 357-364
- Howard, D. V., Howard, J. H., Jr., Japikse, K., DiYanni, C., Thompson, A., & Somberg, R. (2004). Implicit sequence learning: effects of level of structure, adult age, and extended practice. *Psychology and Aging*, 19(1), 79-92
- Howard, J. H., Jr., & Howard, D. V. (1997). Age differences in implicit learning of higher order dependencies in serial patterns. *Psychology and Aging*, 12(4), 634-656
- Nissen, M. J., & Bullemer, P. (1987). Attentional requirements of learning: Evidence from performance measures. *Cognitive Psychology*, 19, 1-32

## RESULTS: NO EXPLICIT AWARENESS

### POST-EXPERIMENT INTERVIEW

“Did you notice a regularity?”

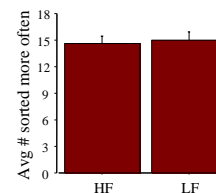
- 4 young and 7 old indicated they noticed something

“Describe the regularity.”

- No subject produced a sequence presented during the test

### CARD SORT TASK

- 81 cards of 4 consecutive trials
- Sort: more vs. less often
- No individual sorted more HF vs. LF quadruplets into the more often category



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