Age-related differences in spatial memory formation and brain activations in a new virtual Morris water maze task

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https://en.wikipedia.org/wiki/Spatial_memory
What is spatial memory?

- Spatial memory is the ability to remember where things are relative to yourself or your environment.

- One of the cognitive effects of aging is impaired long-term spatial memory.
The Morris Water Maze

http://mikeclaffey.com/psyc170/notes/notes-memory.html
A Virtual Morris Water Maze

- A new virtual Morris water maze was used to assess differences in spatial memory and spatial learning performance among age groups.
Hypothesis

- A new virtual water maze task will be sensitive to age-related changes in spatial learning in humans.

- These age-related changes in spatial memory will be associated with differences in brain region activations during a well-rehearsed phase of the task.
Methods: behavior

- Younger adults (18-30 years), N=21
- Older adults (60-79 years), N=19
  - Divided into “good-performing” and “poor-performing” spatial learners based on the group’s median performance cutoff
- 24 hidden trials – platform hidden
- 3 probe trials - platform absent
- 6 control trials - platform visible
Methods: brain activity

- 4 hidden and 6 visible trials in mock scanner
- 16 hidden and 8 visible trials in fMRI scanner

https://wiki.ucl.ac.uk/display/BECS/Physiology+of+fMRI+Brain+Imaging
Visible Trials: control

- Significant differences between younger and poor older spatial learners (p=0.045)

- Mean control trial pathlength was used as a covariate for hidden trials
• Both the young (p<0.001) and good-performing older participants (p=0.002) outperformed the poor-performing older group
Probe Trials: how well do they know where the platform is?

- Young outperformed poor-performing older adults (p=0.024)
- Performance was better in the second and third trials compared to the first for all participants (p<0.001)
Hidden trials: in the scanner

- Young
- Old: good-performing
- Old: poor-performing

• Learned the platform was always in the same place
  - \( p = 0.025 \) (older poor > young) – less of a difference between young and good older performers, but still impaired
Young had greater activity in the posterior parahippocampal gyrus than all older participants

- Memory encoding and recognition of scenes
All older participants had greater medial frontal gyrus activity than the young.

• Cognitive planning and control
Older good performers had greater left medial PFC but lower right orbitofrontal PFC activations than older poor performers.

- Environmental feature analysis or familiarization

- Sustaining a stable goal representation
Summary

• Some older adults may have an impaired cognitive ability or face special difficulties when forming spatial memory of a new environment.

• Older participants relied more than young on regions of the prefrontal cortex when completing a spatial memory task.

• Performance of older participants correlated with different activations within the prefrontal cortex.
Future Steps

- Directly compare rodent and human models of age-related memory decline by using the same task.
- Identify differences in the use of neural resources associated with age-related changes in spatial memory.

Acknowledgements

- CVM Department of Biomedical Sciences
  - Dr. Kathy Magnusson
- Georgia Institute of Technology, School of Psychology
  - Dr. Scott Moffat
  - Jimmy Zhong
  - Cherita Clendinen
- Georgia Institute of Technology, School of Architecture
  - Dr. Matthew Swarts

Funding:
- NIH Grant K18 AG048706 to Dr. Magnusson
- CVM Pilot Project funds to Dr. Magnusson
- OSU URSA-Engage
- OSU Life Scholars
Questions?