Opportunities for defining brain structural changes in the oldest old

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There are a lot of ways to look at brain structure with MRI

- Standing up
- Sitting down
- Head to the side
- Glasses on the face
- Glasses on top of the head
Cortical Thickness

- Cortical thickness
- ~2 mm thick
- Variable thickness

_myers, psychology, 2004_
Methods

- High-resolution anatomical scan
  - T1-weighted

- Freesurfer
  - Pial surface
  - white matter boundary
Cortical thinning occurs with aging

Salat et al, 2004, Cerebral Cortex
Thickness of cortex can relate to behavior

Cortical thickness in Medial Temporal Lobe relates to Memory performance.

e.g., Dickerson et al., 2008, Neuroimage:
• Cortical thickness
• Example: cortical thickness in the visual cortex
  – Relationship to function
  – Relationship to aging
  – Plasticity of cortical thickness in adulthood
Early Visual processing areas
Central vision is processed in different part of V1 than peripheral vision.
Central vision is different than peripheral vision

- Central vision has higher acuity than peripheral vision.
Central vision is different than peripheral vision

• Central vision has higher acuity than peripheral vision.
Central vision is different than peripheral vision

- Central vision has higher acuity than peripheral vision.
- Central vision is attended more often than peripheral vision.
Central vision is different than peripheral vision

- Central vision has higher acuity than peripheral vision.
- Central vision is attended more often than peripheral vision
  - Typically when you pay attention to an object you direct central vision there
  - Use central vision for reading, manipulating tools, tasks requiring moment-to-moment control
  - Use peripheral vision for tasks requiring vigilance, e.g. detecting threats
Central vision is different than peripheral vision

- Central vision has higher acuity than peripheral vision.
- Central vision is attended more often than peripheral vision.
Central vision is different than peripheral vision

- Central vision has higher acuity than peripheral vision.
- Central vision is attended more often than peripheral vision.
- Central vision distractors are more effectively ignored (e.g., Chen and Triesman, 2008).
Central vision is different from peripheral vision in cortex
Central vision is different from peripheral vision in cortex

- Noninvasive methods like functional imaging can distinguish central from peripheral visual cortex

- How does the structure of peripheral cortex differ from central cortex?
Segment V1 by eccentricity

Measure cortical thickness as a function of eccentricity
Central cortex is thicker than peripheral cortex

Younger adults
Cortical thickness in central V1 relates to behavioral performance

• Visual task
  – (Gabor discrimination for a central stimulus)

\[ r = -0.46 \]
\[ p = 0.02 \]
What would this predict for Older vs. younger adults?

- Central vision is attended more often than peripheral vision throughout the lifespan.
- Some studies show that functional use of peripheral vision declines with age.
  - (e.g., Drance et al., 1967; Haas et al., 1986; Ball et al., 1990)
Age-related thinning selective to Peripheral V1

Suggests that thinner cortex relates to decreased functional use of peripheral vision.

Are such age-related changes permanent? Or can they be affected by experience?
Age-related macular degeneration
Effects of visual deprivation

• In healthy vision
  – Central vision is attended more often than peripheral vision
    • Use central vision for reading, manipulating tools, tasks requiring moment-to-moment control

• After Macular Degeneration
  – Central vision is attended less often than peripheral vision
    • Use peripheral vision for reading, manipulating tools, tasks requiring moment-to-moment control
Patients with macular degeneration have thicker cortex devoted to processing peripheral inputs.

Suggests that experience relying on peripheral vision as an adult leads to thicker primary visual cortex.

Burge et al, 2016, Scientific Reports
Summary

• Using vision as a model for defining and characterizing brain structure:

• Cortical thickness relates to behavior:
  – In healthy young people, central visual representations are thicker than peripheral representations, consistent with respective functions.

• Selective cortical thinning with aging:
  – Selective thinning of peripheral visual cortex, consistent with age-related functional loss in peripheral vision

• Adult cortical plasticity:
  – Peripheral representations are thicker following long-term central vision loss, and increased use of peripheral vision.
Future Directions
McKnight Neuroimaging Core & Brain Aging Registry

• Enrolling oldest old (85+) cohort of 200 participants
• Within this oldest old cohort, how does cortical thickness relate to behavior?
  • We already know cortical thickness declines with age overall, but which aspects relate to which functions?

• Relate to different modalities of data
  • Does perfusion moderate these effects?
  • Do connection patterns moderate the effects?
  • Relate cortical thickness data to genetic and epigenetic data from this sample.
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