Cerebral Metabolic Factors Associated with Cognitive Aging

Adam J. Woods, PhD

Cognitive Aging and Memory Clinical Translational Research Program
Institute on Aging
Evelyn F. and William L. McKnight Brain Institute
University of Florida
Magnetic Resonance Spectroscopy (MRS)

• A technique that exploits the magnetic properties of certain nuclei to study brain chemistry
  – Proton: 1H
  – Phosphorous: 31P
  – Sodium: 23Na
  – Carbon: 13C

• Clinical and Research Applications
Clinical Applications: 1H MRS
Cerebral Metabolites from 1H-MRS

- **N-Acetyl aspartic acid (NAA):**
  - Neuron integrity

- **Choline (Cho):**
  - Cell membrane integrity/demyelination/inflammation

- **Creatine (Cr):**
  - Brain energy metabolism

- **Myo-Inositol (mI):**
  - Glial cell integrity

- **Glutamate/Glutamine (GLX):**
  - Neurotransmitter concentration
Active Brain Study Successful Aging Cohort

- $n = 71$ (Female = 43)
- Mean age $= 73.2 \pm 8.8$
- Range $= 48$-92 years
- Education $= 16 \pm 8.8$
- No history of neurodegenerative disease, brain injury, or major psychiatric disorders
Voxel Placement (3cm³)

Frontal

Posterior
Change in cortical thickness with age

Left Hemisphere

Right Hemisphere
Cerebral metabolic changes with age: Frontal

**Choline***

![Graph showing correlation between Choline and age with R2 = 0.04]

**Creatine***

![Graph showing correlation between Creatine and age with R2 = 0.05]

**NAA***

![Graph showing correlation between NAA and age with R2 = 0.36]

*p < 0.05
NIH Toolbox: Cognitive

• NIH-funded development
• Battery of 8 core cognitive tests assessing six cognitive domains
  • Fluid Cognition
    – Attention
    – Executive Function
    – Working Memory
    – Processing Speed
    – Episodic Memory
  • Crystalized Cognition
    – Language
• Norms for 8-85 years of age
NIH Toolbox: Cognitive Aging

Fluid Score*

Crystalized Score

\[ R^2 = 0.343 \]

\[ R^2 = 3.07E-5 \]

\*p<.05
NIH Toolbox: NAA

Fluid Score*

Crystalized Score

*p<.05
NIH Toolbox: Choline

Fluid Score*

Crystalized Score

*p<.05
Future Directions

• Focused enrollment of participants 85+ years of age

• Leverage multimodal imaging expertise across sites
  – Structural neuroanatomy (T1)
  – Functional brain response (BOLD)
  – White matter connectivity (DTI/HARDI)
  – Cerebral perfusion (ASL)
  – White matter hyper-intensities (FLAIR)

• Relationship to a broader battery of cognitive measures

• Additional markers and nuclei
  – GABA (1H)
  – 31P
Collaborators

• University of Florida
  – Ron Cohen, PhD
  – John Williamson, PhD
  – Eric Porges, PhD
  – Damon Lamb, PhD
  – Erik Middlebrooks, MD
  – Huaihou Chen, PhD
  – Kenneth Heilman, MD
  – Natalie Ebner, PhD
  – Amanda Garcia
  – Talia Seider
  – Vaughn Bryant
  – Lindsey Richards
  – Nicole Nissim

• University of Miami
  – Clinton Wright, MD

• University of Arizona
  – Gene Alexander, PhD

• University of Alabama at Birmingham
  – Kristina Visscher, PhD