The Science of Mental Vitality:
Can We Slow the Aging Process?

Denise C Park
University Distinguished Chair of Brain Science
Regents Research Scholar
Center for Vital Longevity
University of Texas at Dallas

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The Scientific Challenge of the 21st Century

- Developing interventions to slow the rate that the mind ages.
- Right now someone develops Alzheimer’s disease every 72 seconds in the U.S. By 2050, there will be a million cases a year and a case diagnosed every 33 seconds.
- By the age of 85, the risk of A.D., is nearly 50%.
- Yearly treatment costs are three times more per year than other illnesses of people the same age.
Preserving Cognitive Function

“For every dollar spent now on research, taxpayer would receive a tremendous return in future saving on Medicare and Medicaid: 12 to 1 by 2015 and 30 to 1 by 2025.”

Sheldon Goldberg, President Alzheimer’s Association

“A research advance that delayed the onset of Alzheimer's by just five years would translate by 2050 into a 5.3 million (40%) reduction in disease prevalence and roughly $515 billion (44%) in annual savings for Medicare & Medicaid.”

The Lewin Group
Goals for Tonight’s Talk

- What happens to the mind with age?
- How does the mind adapt to the aging process?
- Is it possible to protect your mind from some of the negative consequences of aging? How?
The Aging Mind

Processing Capacity

World Knowledge

Age Groups

n = 350

Park, Lautenschlager, Hedden, Davidson, Smith & Smith, 2002. Psychology and Aging
Brain Shrinkage Occurs with Age

Brain regions that reduce in volume with age

Brain regions that are preserved with age

Raz, Lindenberger, Rodrigue, Kennedy, Head, et al, 2005
Cerebral Cortex
The White Matter Becomes More Porous

White Matter Changes with Age and Alzheimer's

- YOUNG
- OLD
- DAT

FA

D

Head et al., 2004
The Brain’s Response to Neural Aging

- The use of functional magnetic resonance imaging
- Allows us to see how the brain’s function changes in response to the neural degradation that occurs.
Imaging Boone Pickens’ Brain
The Brain at Rest: The Default Network

Raichle et al., 2001
Suppression of the Resting State When the Brain Is Challenged

Park et al., 2010, Frontiers in Human Neuroscience
What We Know So Far

BAD NEWS
- Speed of processing, working memory, long term memory decline with age
- The brain shrinks!
- White matter becomes porous.
- Difficulty switching out of resting/daydreaming state.

GOOD NEWS
- Knowledge is preserved
- Frontal activation compensates for neural decline in other areas.
- The brain is capable of remodeling itself.
Scaffolding Theory of Cognitive Aging

Proposed by Park & Reuter-Lorenz, 2009, Annual Review of Psychology
What Is a Scaffold?

- According to Encarta: It is a “supportive structure”
- According to Park & Reuter-Lorenz, neural scaffolds can be developed that protect the mind from the neural insults of aging.
THE STAC MODEL

Neural Challenges
- Shrinkage
- White Matter Changes
- Cortical Thinning
- Dopamine Depletion

Aging
- Dedifferentiation of Ventral Visual Area
- Decreased Medial Temporal Recruitment
- Increased Default Activity

Functional Deterioration

Compensatory Scaffolding
- Frontal Recruitment
- Neurogenesis
- Distributed Processing
- Bilaterality

Scaffolding Enhancement
- New Learning
- Engagement
- Exercise
- Cognitive Training

Level of Cognitive Function
An Example of Scaffolding in a word judgment task.
Is this word...

- Living or nonliving?
- Ghost
- Virus
- Sponge
Age Differences in Brain Patterns when Judging a Word

$p<.05$, FWE correction
A-beta plaques detected with PET

Individual levels of A-beta vary dramatically among individuals

Warmer colors indicate greater levels of A-beta counts
Greater precuneus Aβ is associated with decreased prefrontal activation

“Is there water in the picture?”
Aβ amount associated with cognitive performance in healthy adults

High Amyloid Burden in Precuneus Predicts Slower Mental Speed

- Low Amyloid
- High Amyloid

Digit Symbol (total correct items)

Precuneus Amyloid (SUVR)
Scaffolding Enhancement Is Promoted by Training and Cognitive Activity

- What evidence is there that you can change your own brain function through various activities?
Neurogenesis in senescent rats

![Graph showing neurogenesis in control and enriched conditions. The graph compares the number of new cells (Neuronal, Glial, Other) between control and enriched groups. The enriched group shows a significantly higher number of new cells, especially in the Neuronal category.](image-url)
The Juggling Study

- Scan the brain before training
- Learn to juggle over 90 days
- Another scan was performed at the end of juggling.
- A third scan was performed three months later after nonpractice of juggling.

- Boyke, Driemeyer, Gaiser, Buchel, May (JON, 2008)
Figure 2. Time point (before intervention, after intervention) by group (jugglers, controls) interaction analysis, testing for greater changes in the jugglers group

Exercise and Aging

Colcombe et al., 2003

Age-Related Declines

Map of gray matter showing regions that shrink with age. Clusters with largest peaks are evident in the frontal/prefrontal cortex (BA 46, 9, 6), parietal cortex (BA 40, 21, 5), and temporal cortex (BA 21, 38).

Map of white matter showing greatest age-related changes in the anterior white matter tracts and the more posterior tracts in the parietal lobes.

Amelioration by Fitness

Map of gray matter revealing regions that show preservation with cardiovascular fitness. Clusters with largest peaks are in frontal/prefrontal cortex (BA 46, 9, 6), parietal cortex (BA 40), and temporal cortex (BA 21, 22, 38).

Map of white matter showing regions of relative preservation from age-related decline with fitness. Most regions that show age-related decline also show sparing with fitness.

Colcombe et al., 2003
The Synapse! Program

- Attempts to create a “scaffolding environment” to promote maintenance of cognitive health.
- Synapse!: Engagement for 15 hours of week for three months.
- Learning to quilt: visuospatial, motor, memory, social stimulation
- Learning digital photography:
- Combination group
- Addition of exercise conditions
Learning To Quilt
Building a Neural Scaffold
Practical Advice for Maintaining a Healthy Mind

- Maintain a regular program of cardiovascular fitness.
- Prevent brain shrinkage and white matter lesions: get prompt treatment for diabetes, depression, and any source of frailty that limits mental, physical, or cognitive activity.
- Stay Engaged....
Continuously Challenge Your Mind

- Learn new and different things
  - Language, piano, dancing
  - Unsupported travel to a foreign country

- The critical importance of variety and constant challenge

- Move to a new environment
What about Brain Software?

- Does it help?
  - Maybe

- Video games and WII
  - Importance of staying outside your comfort zone.
Do Not Underestimate Social Engagement

- A partner as neuroprotective
- The cognitive demands of socializing and meeting new people
The role of work in preserving the mind is poorly understood but the possibility that it is neuroprotective should be considered.
Stay on Top of New Technology

“Gadgets” offer tremendous cognitive and physical support.

Provide mechanisms of neurocognitive engagement and support for everyday tasks.

Stay gadget-literate and be open to new technology.
The 21st Century

- A period of unprecedented challenge and risk that has long been predicted by demographers and other gerontologists.

- Phenomenon is global and will hit East Asian countries even harder than western countries.

- The triple threat of increased longevity, increasing prevalence of Alzheimer’s, and increased medical care costs needs to be managed.

- Need to move from older adults as threat to older adults as resource and learn how to extend the working life of the aging mind.
The Center for Vital Brain Aging
Amyloid Deposits Vary Across Brain Region and Age Group

- Parietal Lobes
- Occipital Lobes
- Anterior Cingulate
- Posterior Cingulate
- Temporal Lobes
- Frontal Lobes
- Precuneus
Findings

- Reported significant increase in volume in right h/MT/V5, left hippocampus, and left and right nucleus acumbens.

- These effects disappeared after three months.
Typical mid sagittal and transverse 11C-PIB PET images