Hearing Loss in Older Adults: A Public Health Perspective

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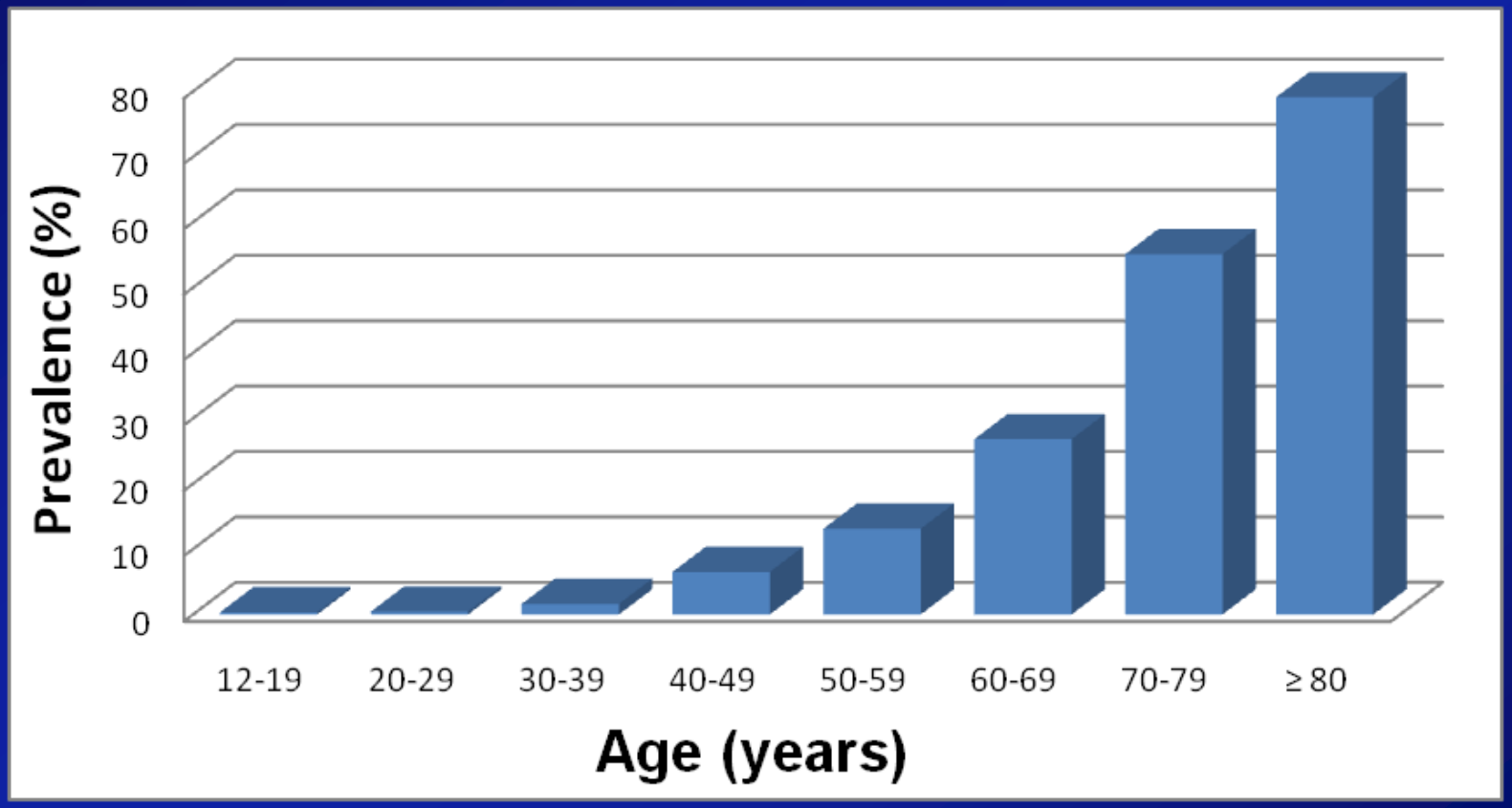
Disclosures

- Research grants: NIH, Eleanor Schwartz Charitable Foundation, American College of Surgeons, Triological Society
- Scientific Advisory Board for Pfizer and Autifony Therapeutics
- Consultant for Cochlear Ltd & Gerson Lehrman Group
- Speaker honoraria from Amplifon & Med El

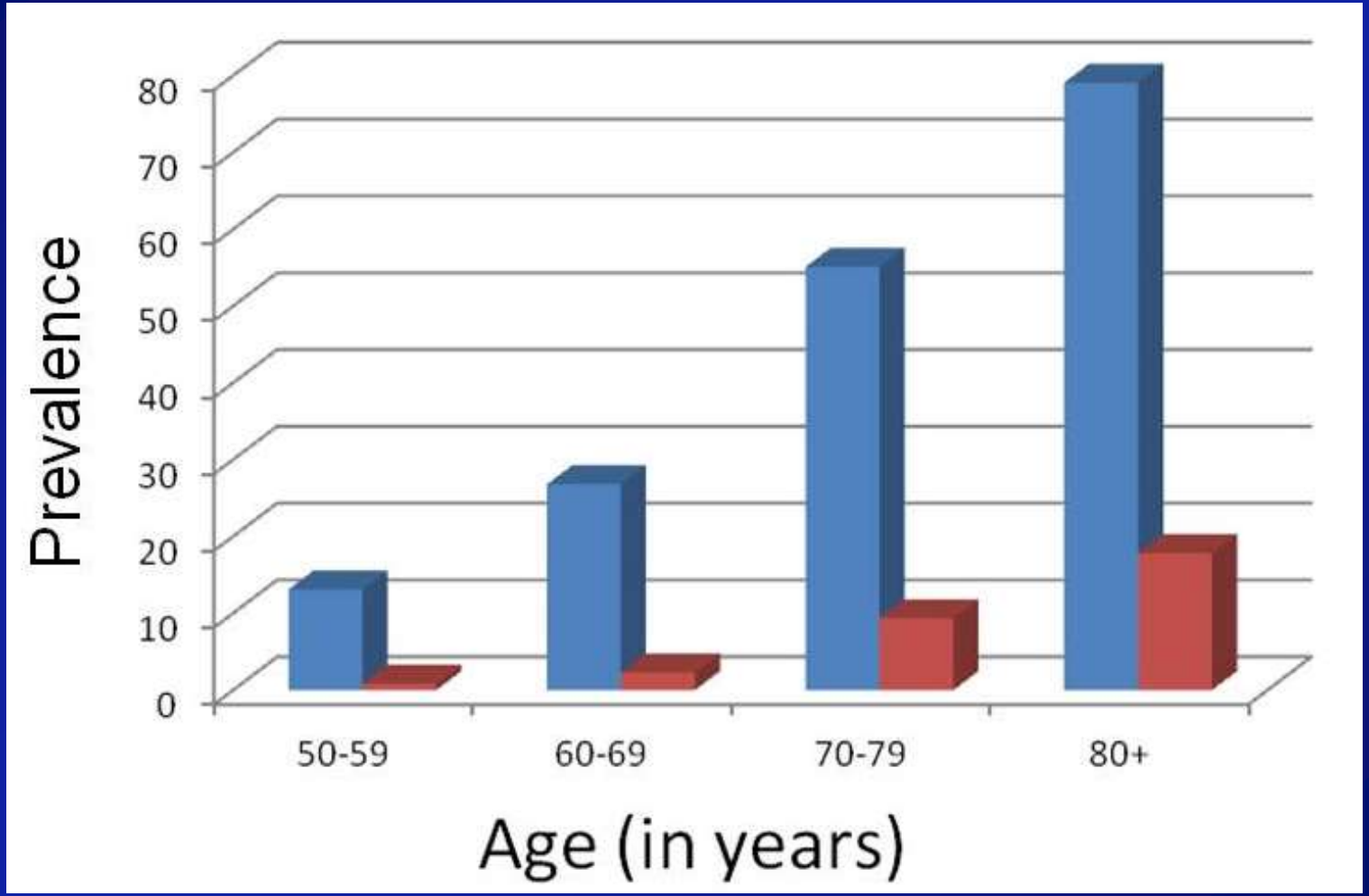
Prevalence of Hearing Loss in the United States, 2001-2008



Hearing loss defined as a better-ear PTA of 0.5-4kHz tones > 25 dB

Lin et al., Arch Int Med. 2011

Hearing Loss & Hearing Aid Use
Prevalence in the U.S. , 1999-2006



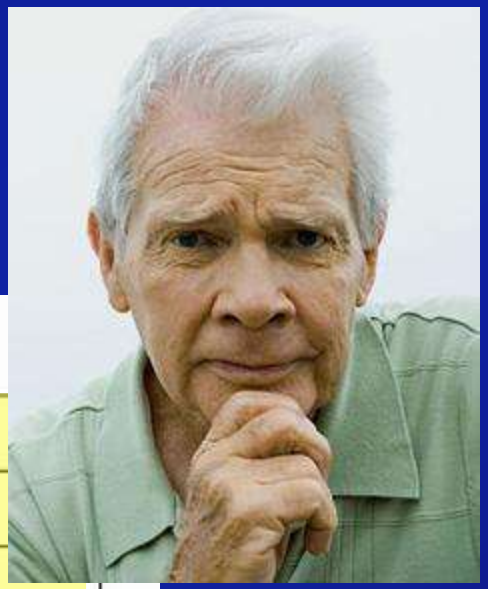
Chien W et al, Arch Int Med, 2012

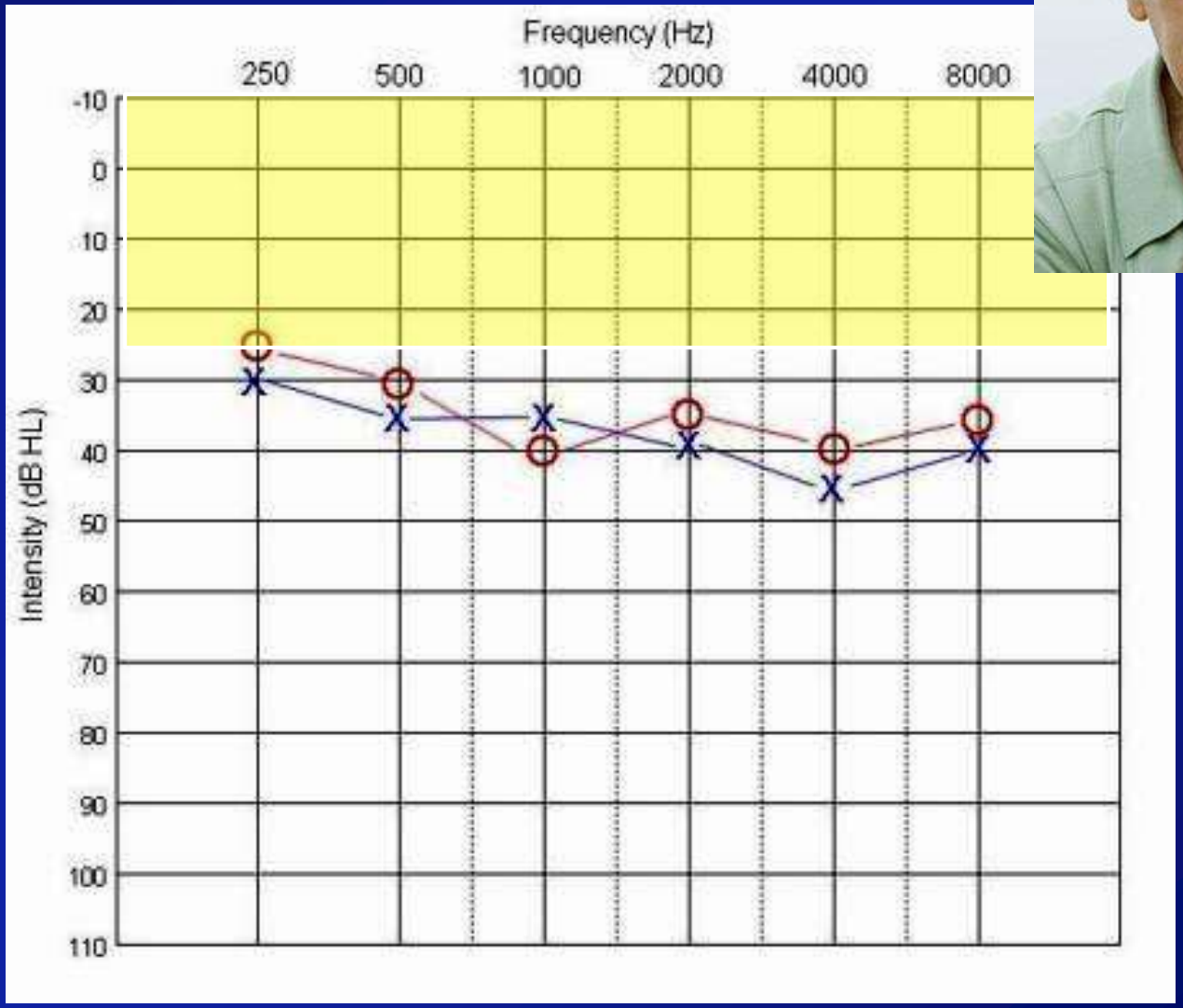
Age-Related Hearing Loss (ARHL)

Basic Questions

- What are the consequences of ARHL for older adults?
- What is the impact of treating ARHL on older adults?
- How can ARHL be effectively addressed in the community?

John Smith, 12 y.o.





Age-Related Hearing Loss (ARHL)

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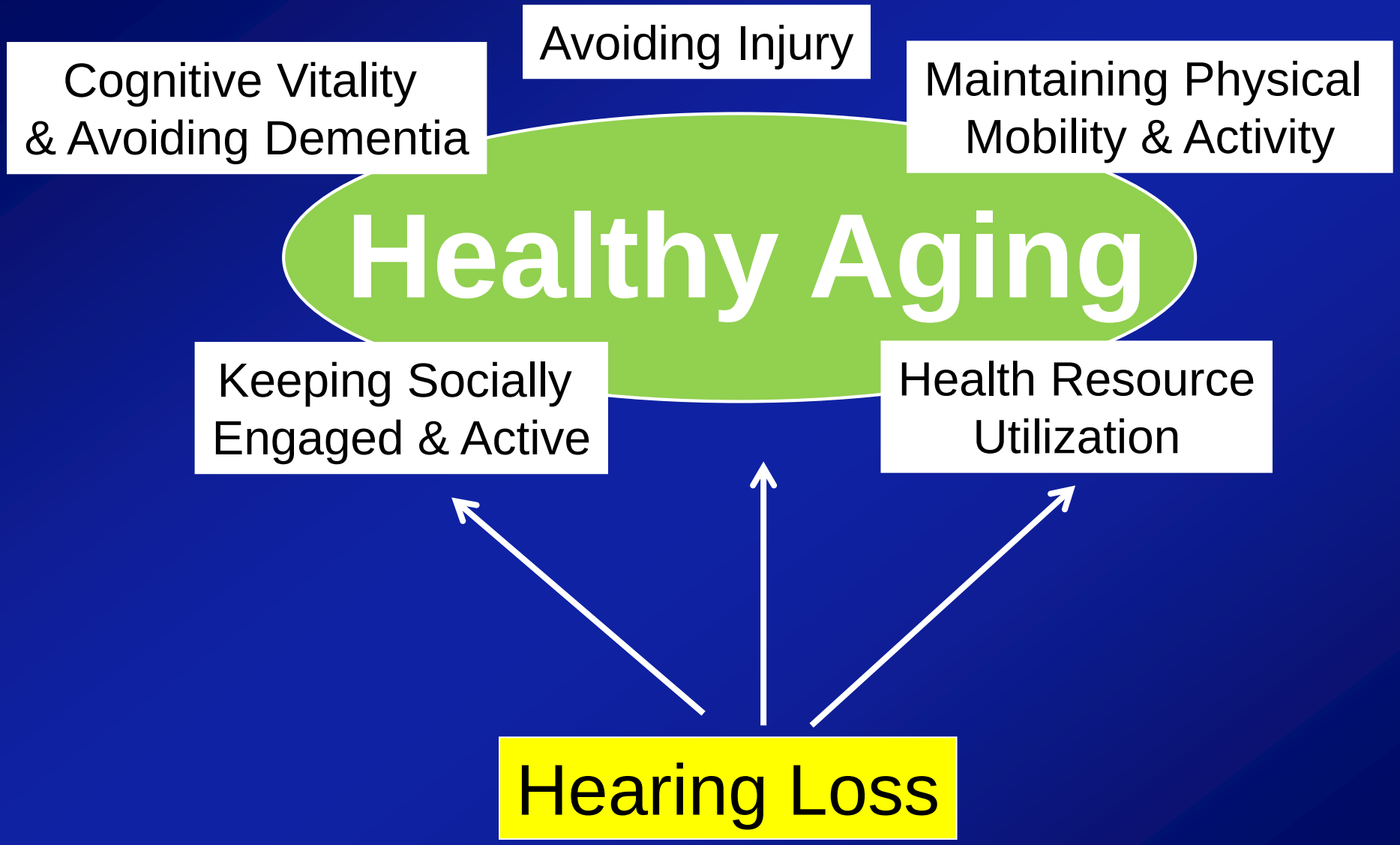
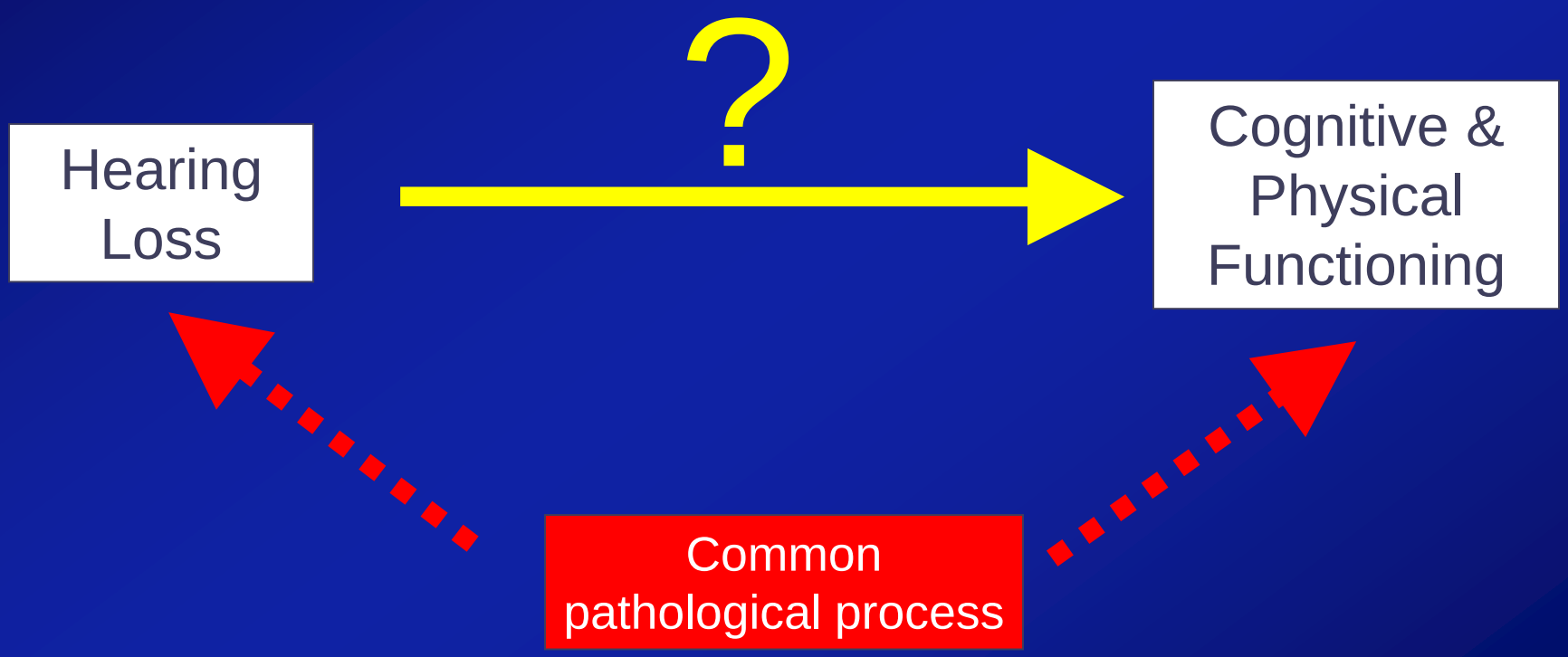
- How can ARHL be effectively addressed in the community?

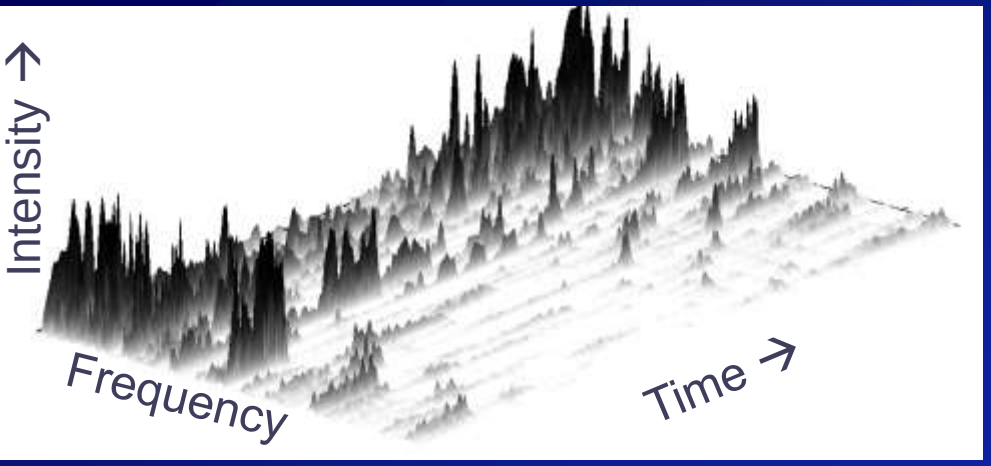
Healthy Aging



Hearing Loss & Healthy Aging

Common Cause or *Modifiable Risk Factor*

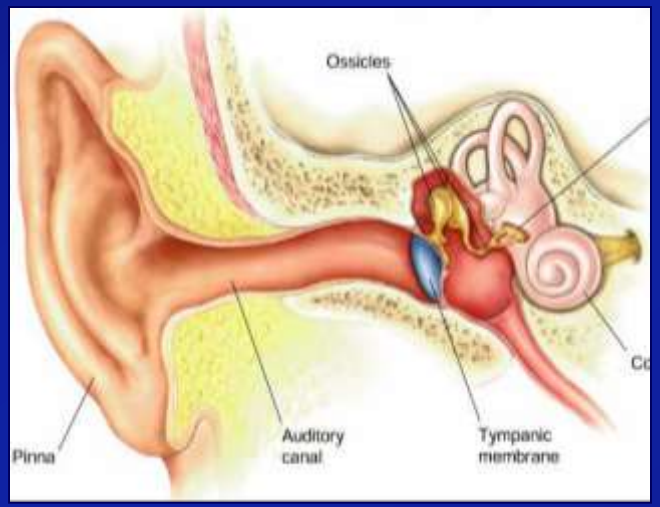




Hearing Loss & Cochlear impairment

Decreased sensitivity & distortion in sound encoding

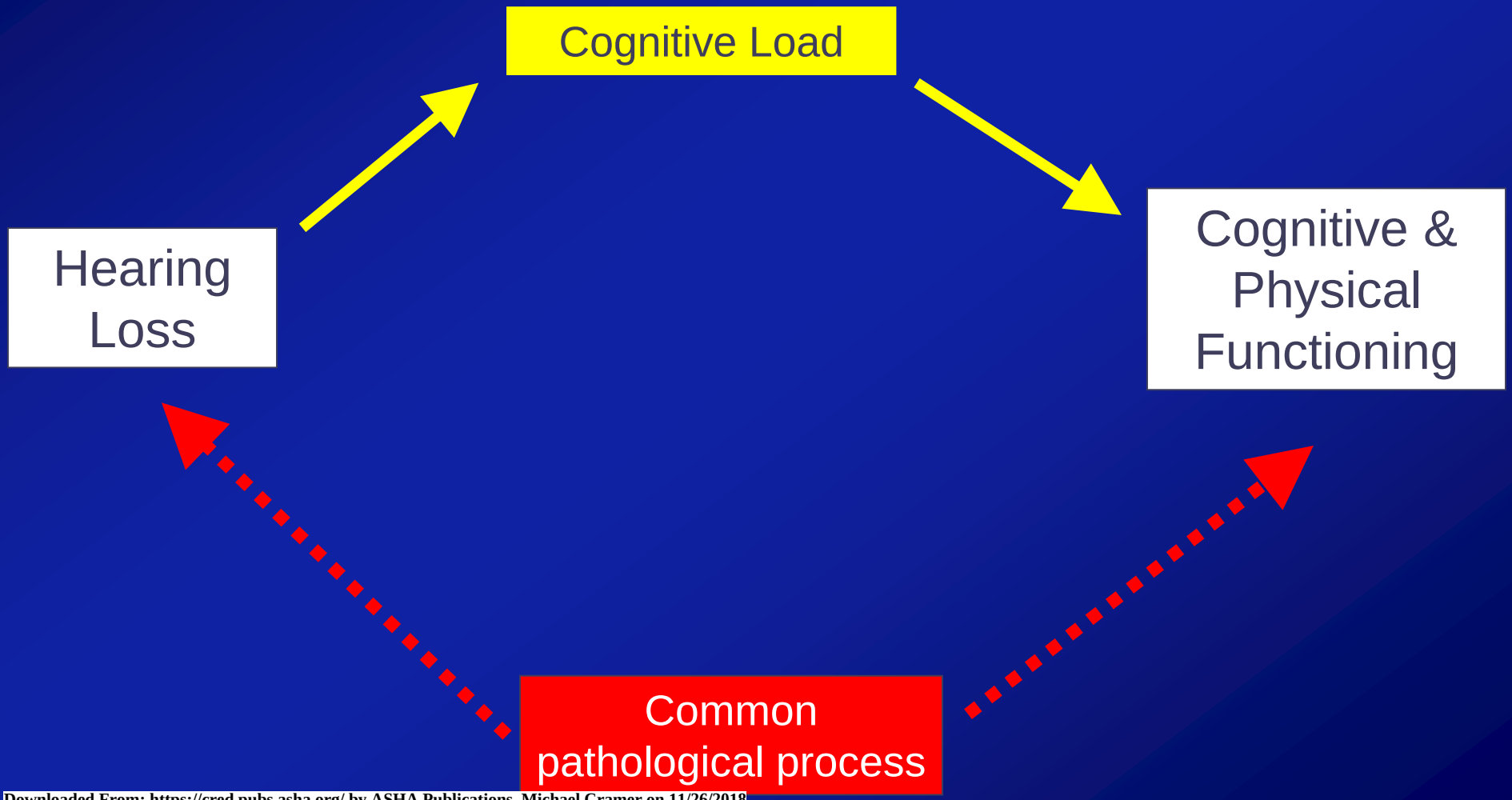
“Sunday”



“Effortful listening”

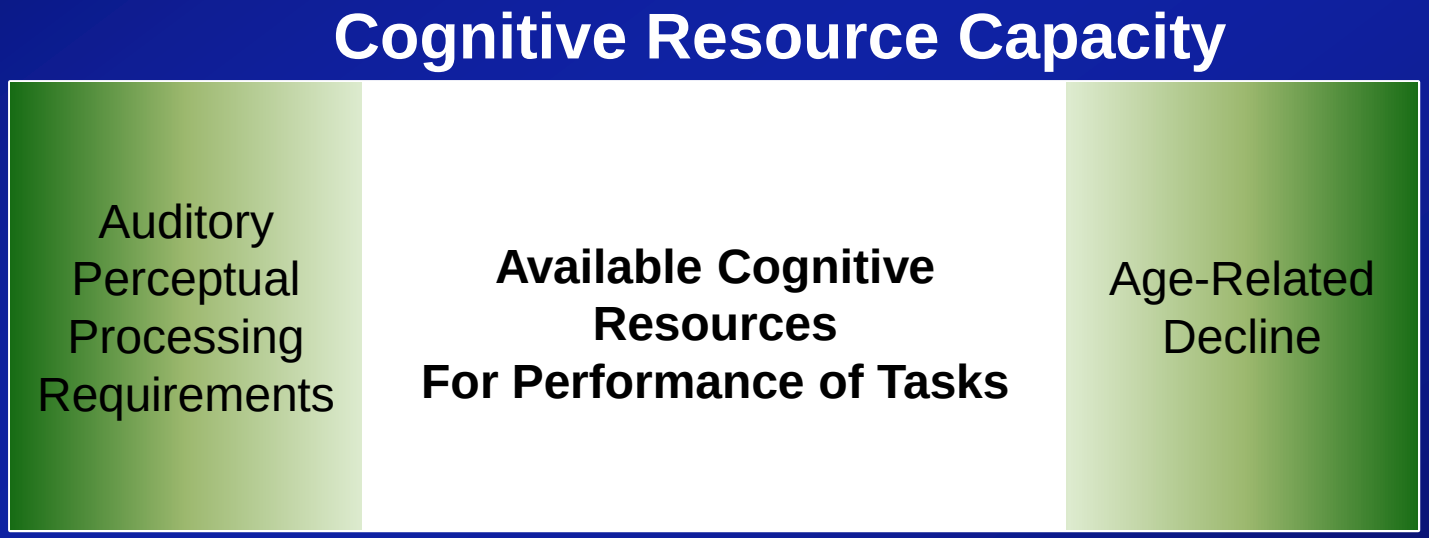
Hearing Loss & Healthy Aging

Common Cause or *Modifiable Risk Factor*



Hearing Loss & Cognitive Load

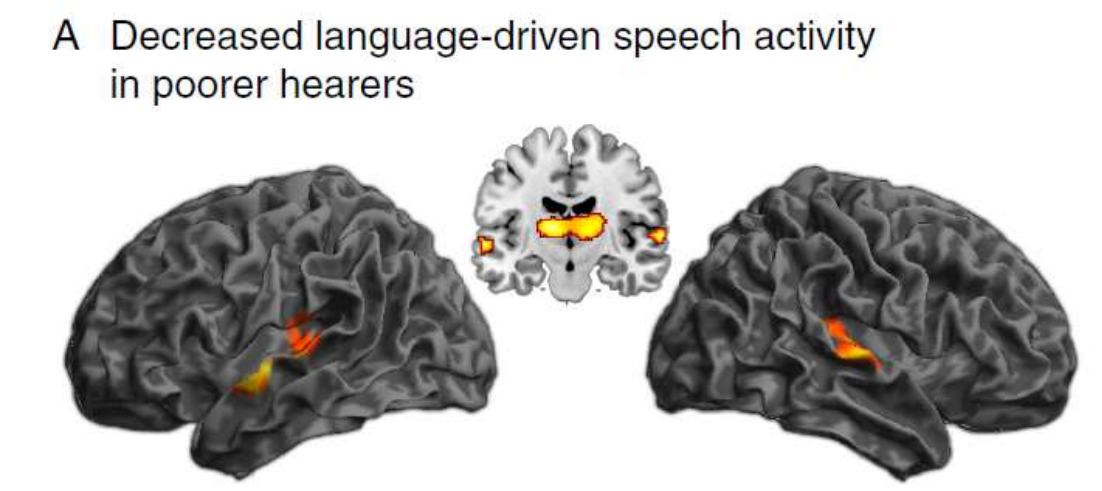
- Kahneman model of shared attention and resource capacity (D. Kahneman, Attention & Effort,1973)



Hearing Loss & Cognitive Load

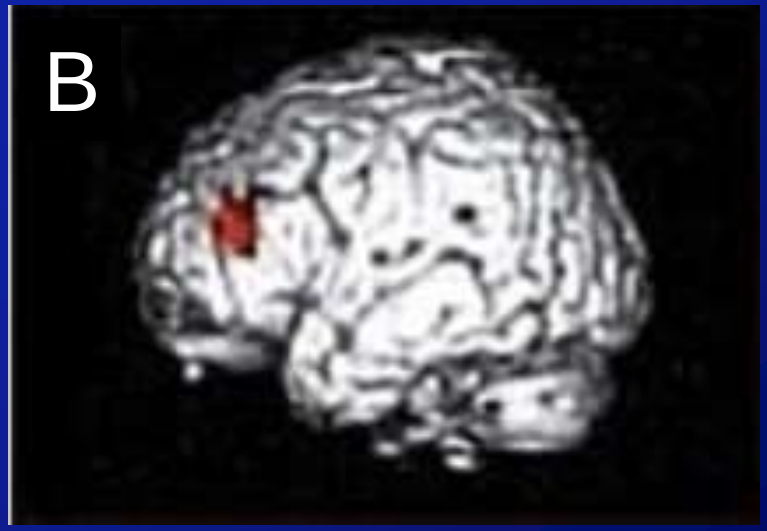
Poorer hearing is associated with:

A. Reduced language-driven activity in primary auditory pathways



Peelle et al, J. Neurosci, 2011

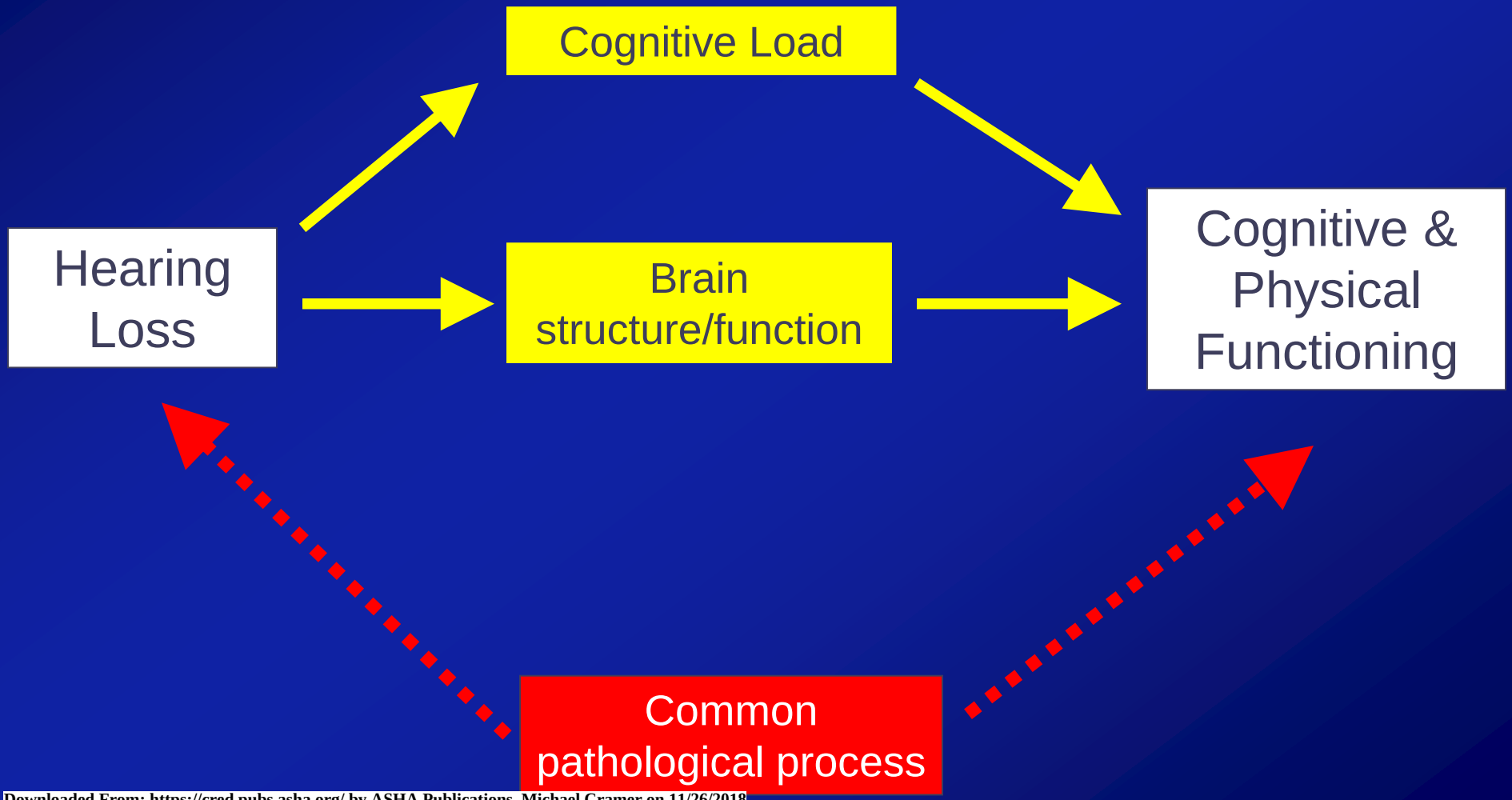
B. Increased compensatory language-driven activity in pre-frontal cortical areas



Grossman et al, Brain Lang, 2002

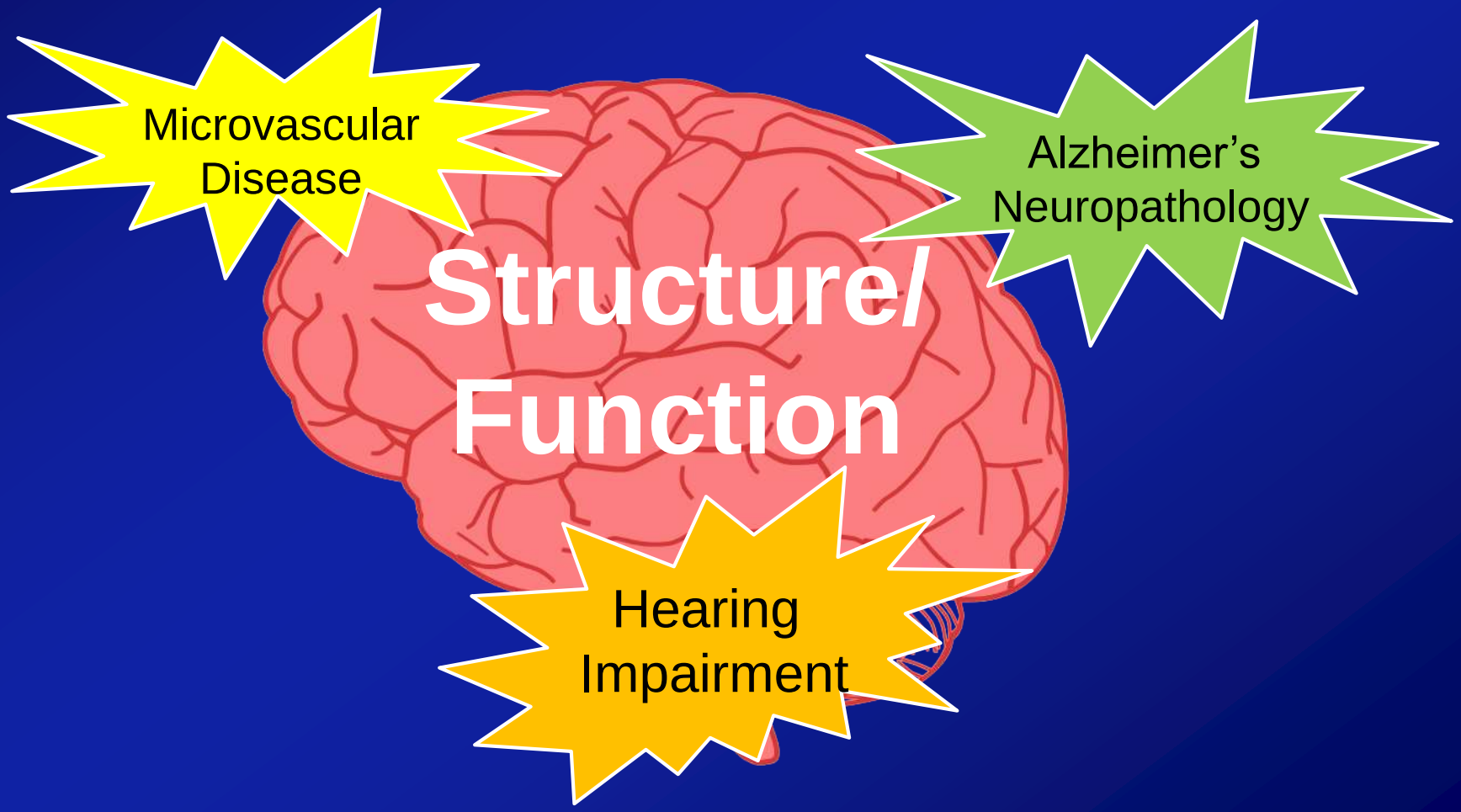
Hearing Loss & Healthy Aging

Common Cause or *Modifiable Risk Factor*



Double Hit Theoretical Model

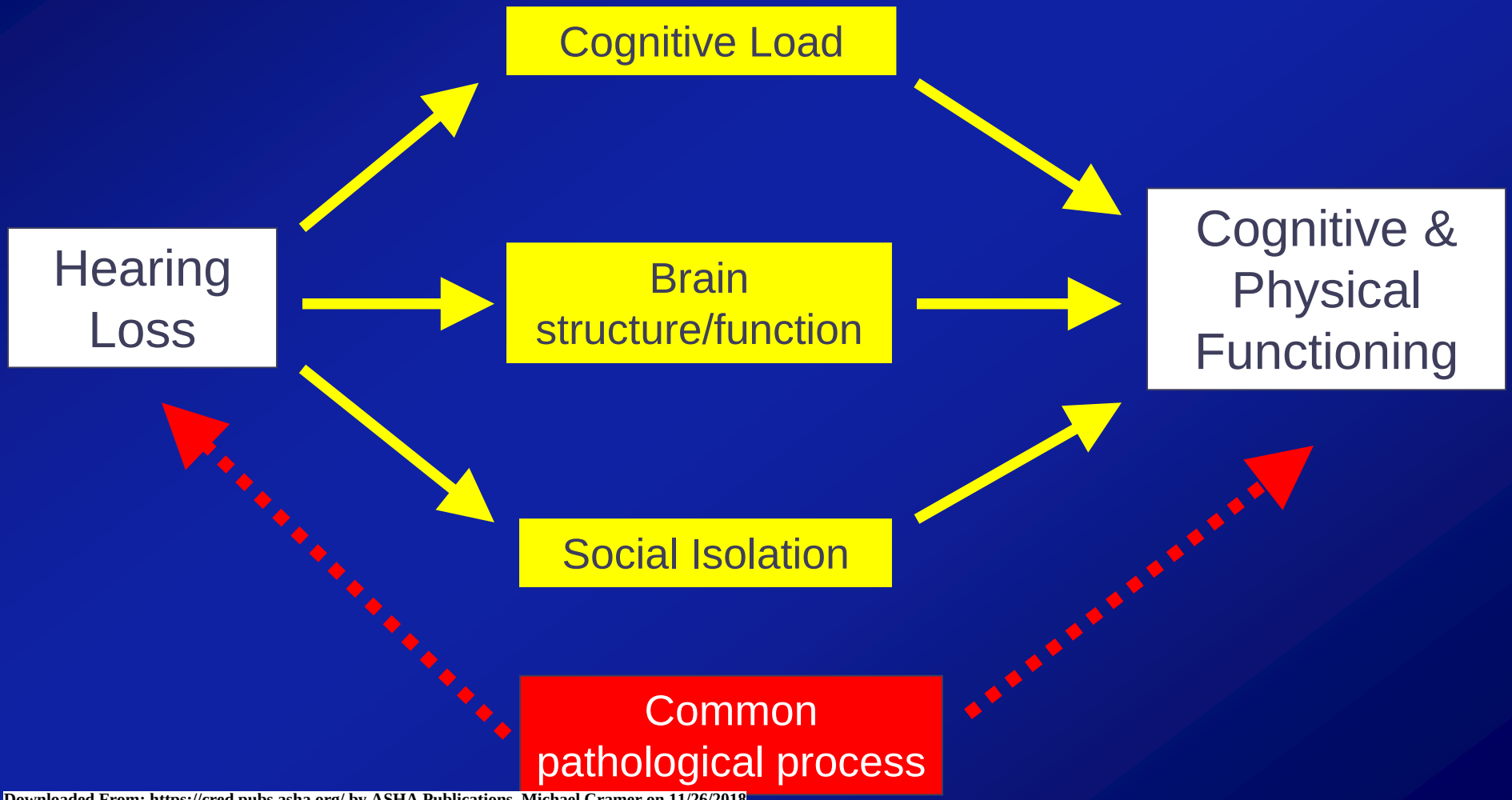
Hearing Loss & Brain Structure/Function



F. Lin & M. Albert, Aging & Mental Health, 2014

Hearing Loss & Healthy Aging

Common Cause or *Modifiable Risk Factor*



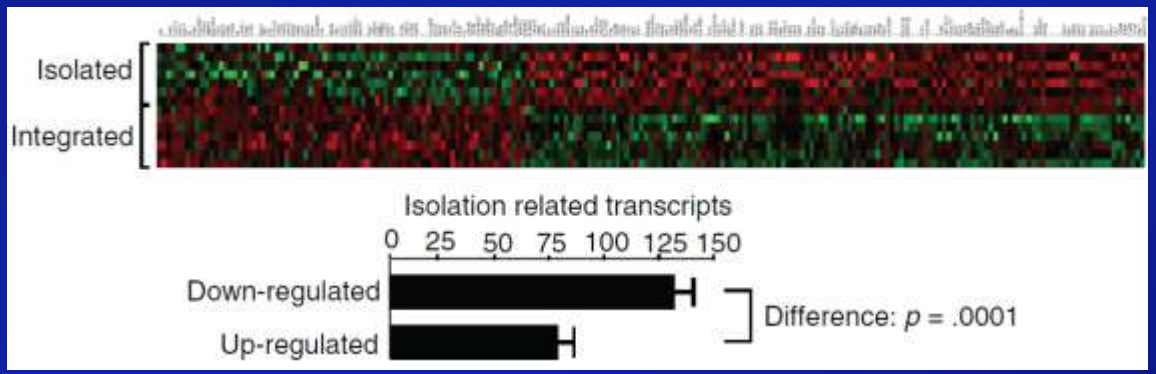
Social Isolation

Cognitive & Physical Functioning

Health Behavioral Pathways
- Smoking
- Adherence to medical tx
- Diet
- Exercise

Psychological Pathways
- Self-esteem
- Self-efficacy
- Coping
- Sense of well-being

Physiologic Pathways
- HPA axis response
- Immune system fxn
- Cardiovascular reactivity

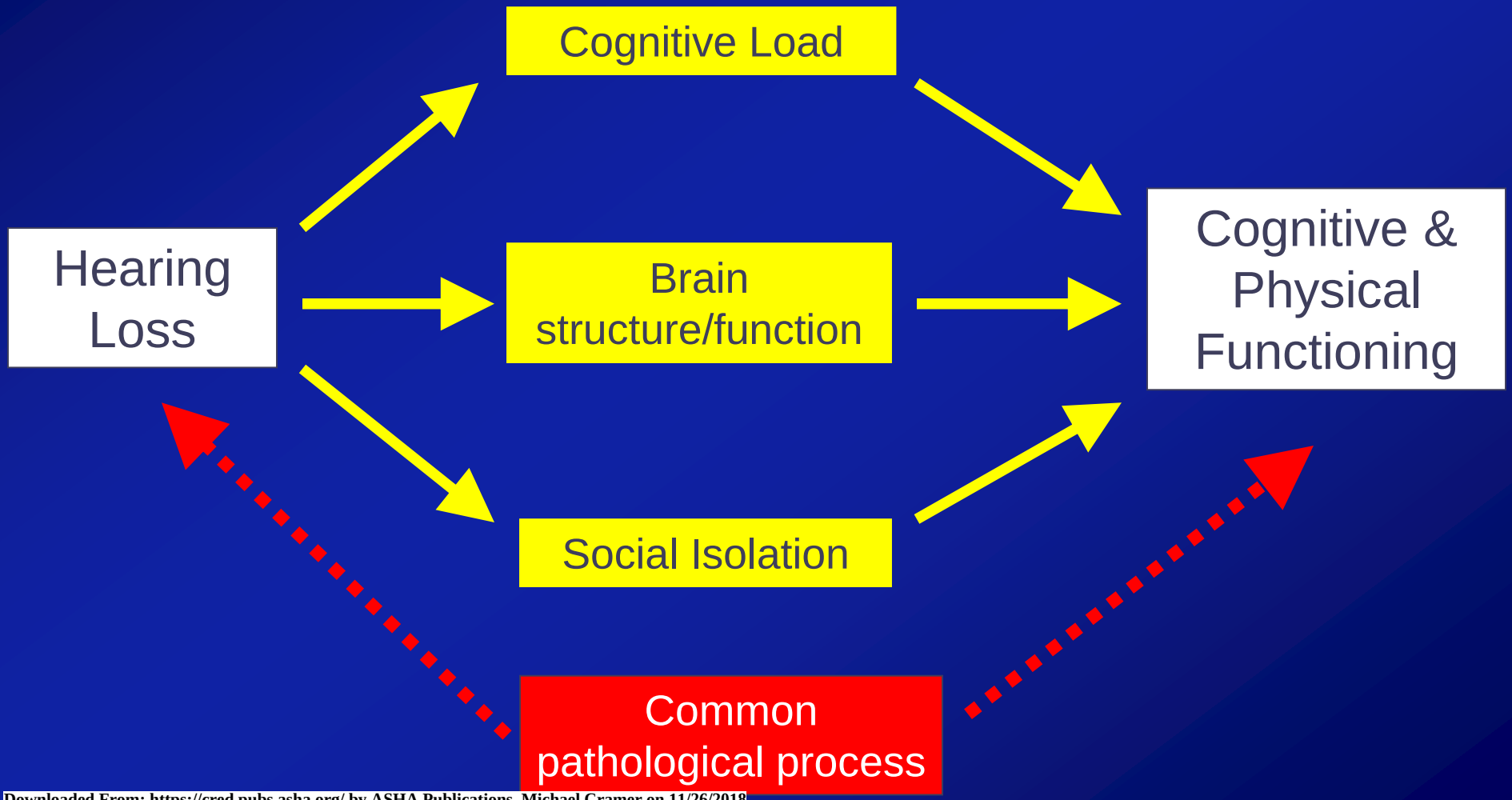


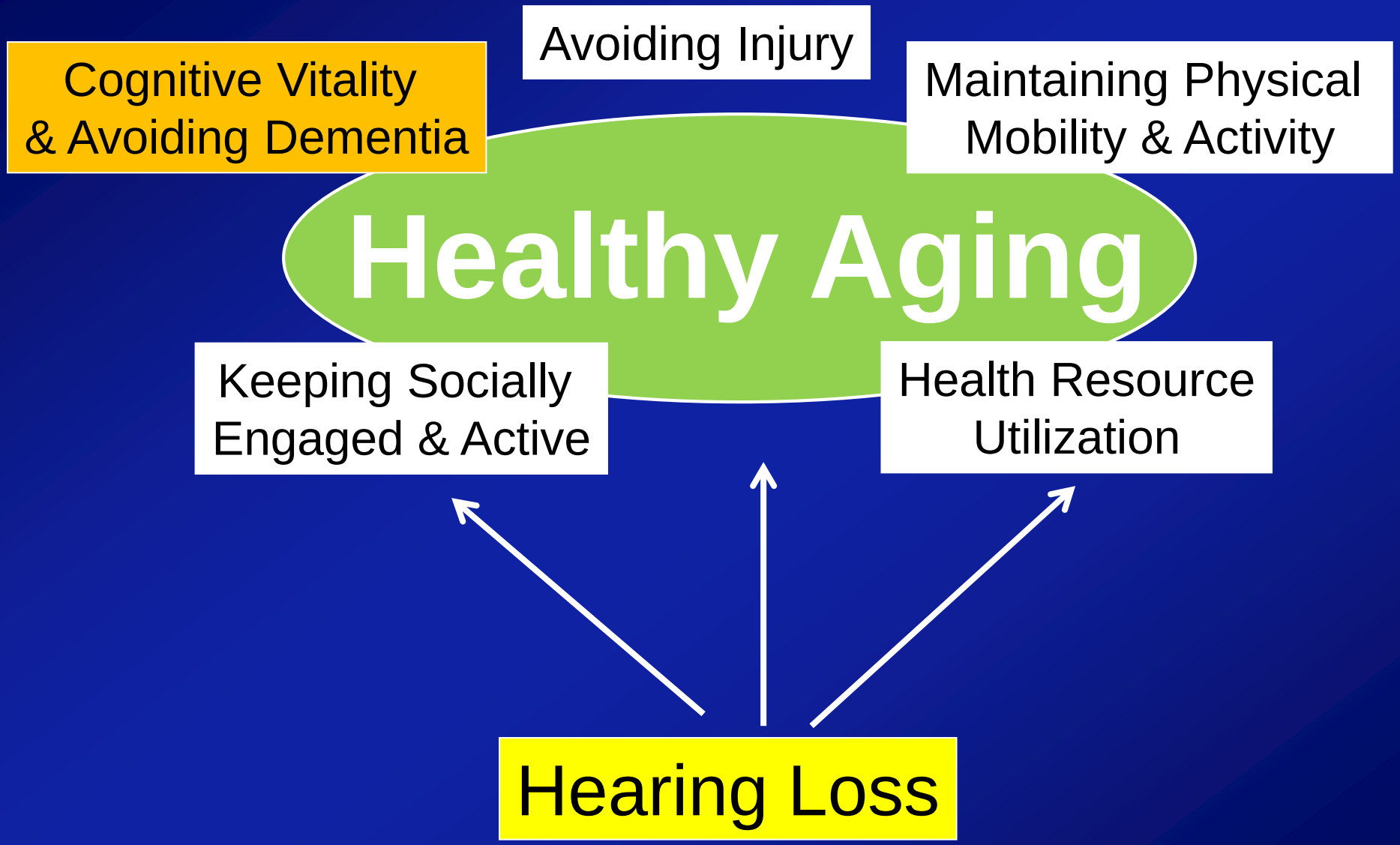
Social isolation is associated with upregulation of pro-inflammatory genes & increased inflammation

Cole & Cacioppo, Genome Biology, 2007

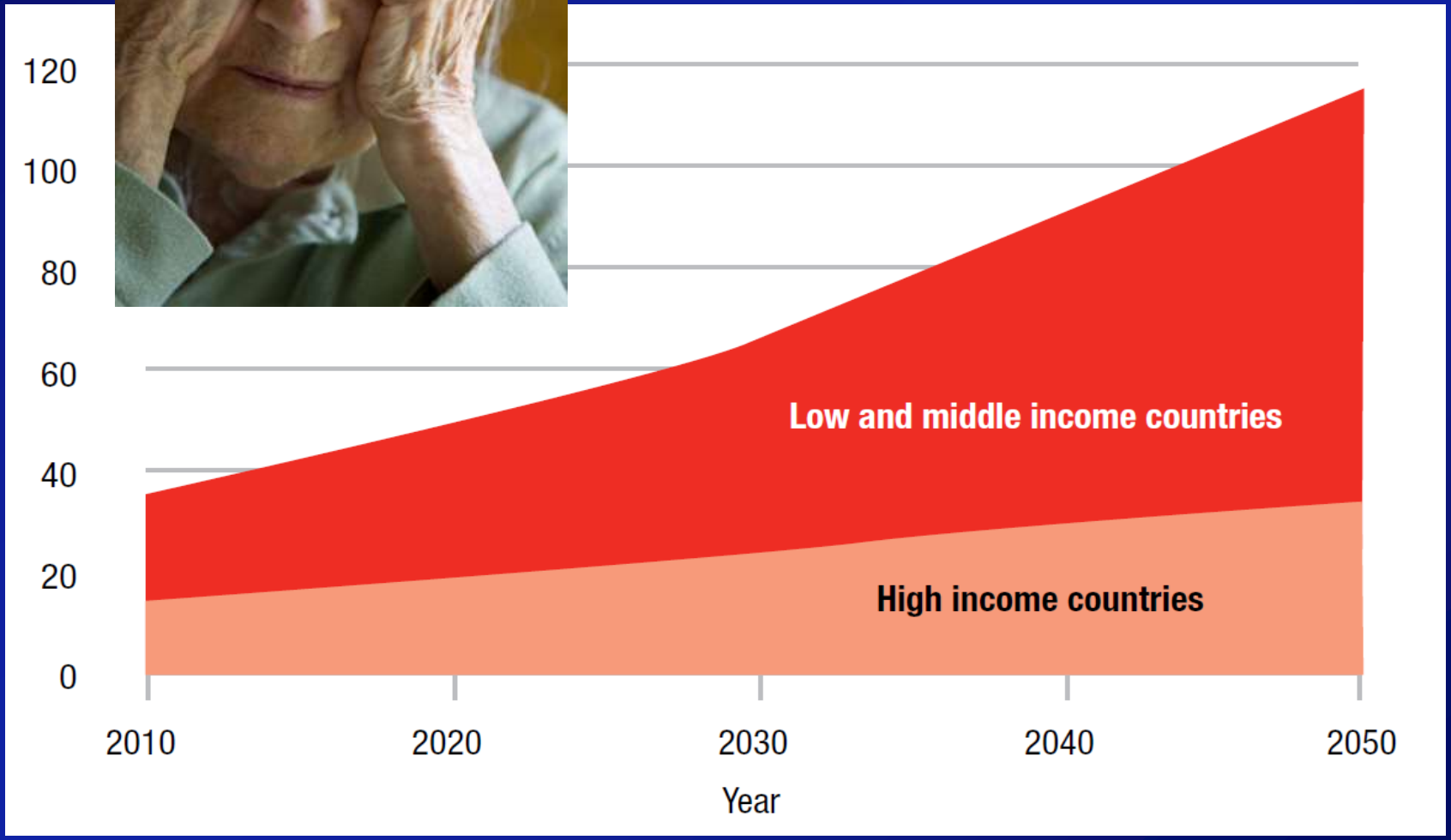
Hearing Loss & Healthy Aging

Common Cause or *Modifiable Risk Factor*





Projected Worldwide Prevalence of Dementia 2010-2050



Alzheimer's Disease International, 2009

Hearing Loss & Cognition

Background

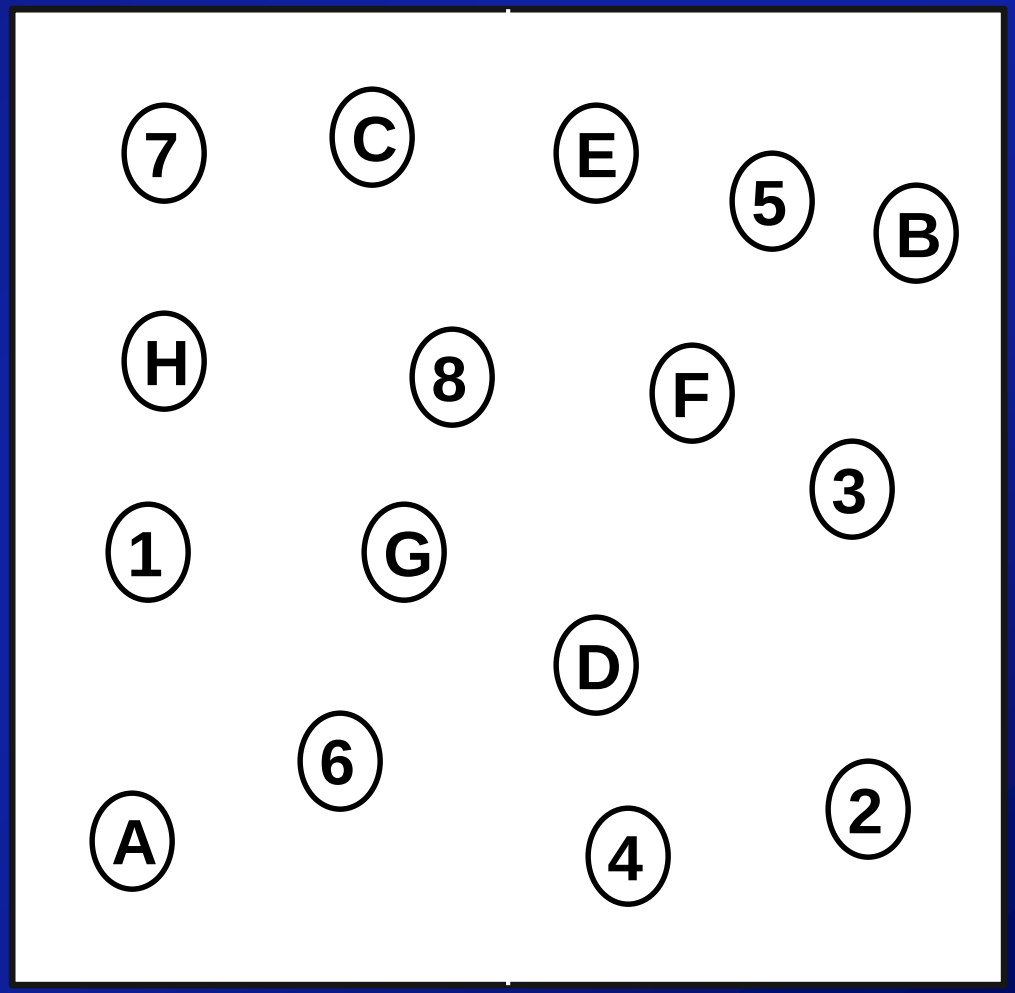
- **Memory**
  - Free and cued selective reminding test (FCSRT)
- **Executive Function**
  - Trail Making B
  - Stroop Mixed
  - Digit symbol substitution
- **Psychomotor/processing speed**
- **Verbal function & language**

These tests are not dependent on hearing.

Hearing Loss & Cognition

Executive Function: Trail Making B

Trail Making B



Hearing Loss & Cognition

Executive Function: Stroop Mixed

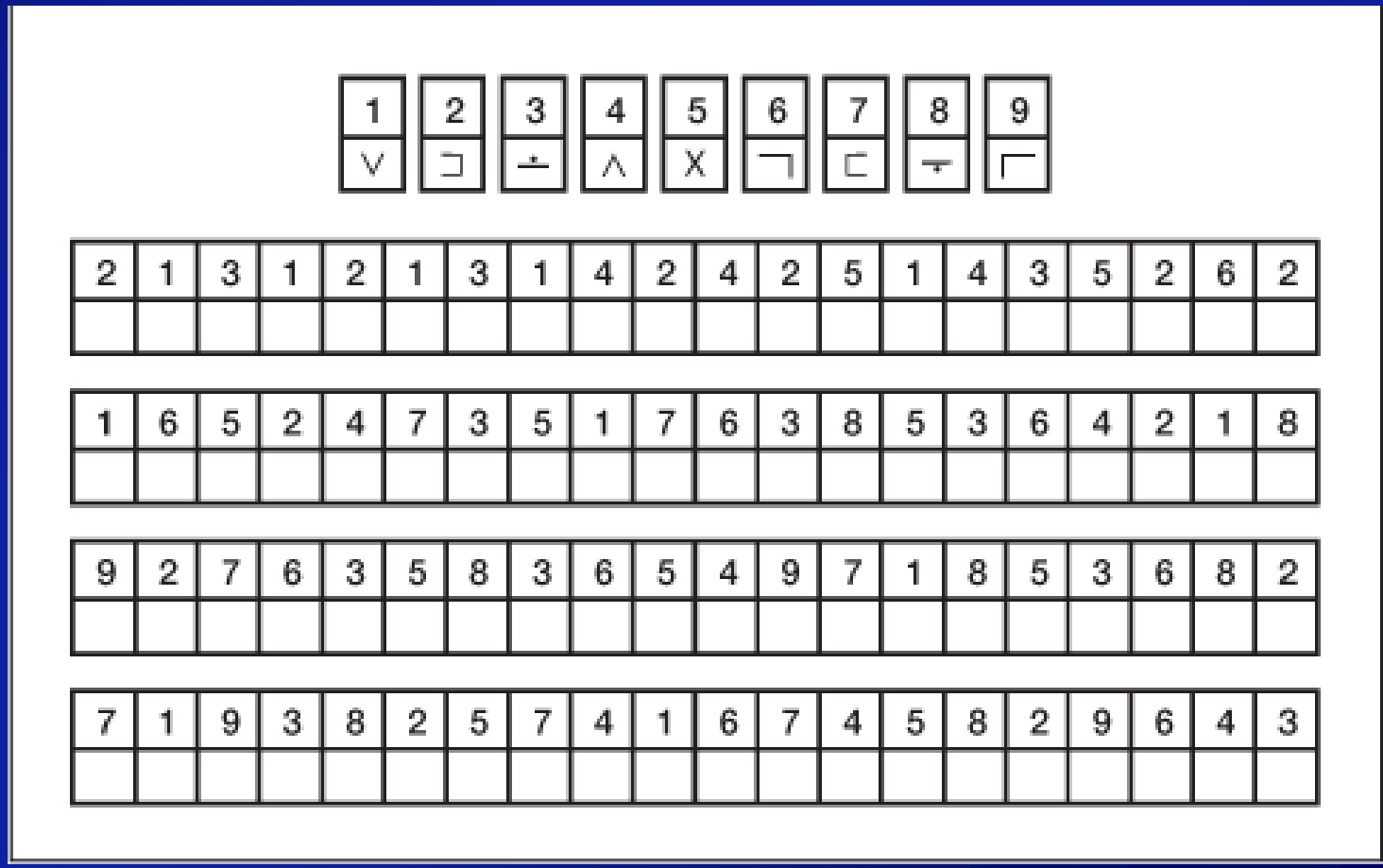
Stroop Mixed

GREEN	RED
RED	YELLOW
RED	BLUE
GREEN	BLUE
BLUE	GREEN
BLUE	YELLOW
GREEN	BLACK

Hearing Loss & Cognition

Executive Function: Digit Symbol Substitution Test (DSS)

DSS: Digit Symbol Substitution Test



Hearing Loss and Cognition

Cross-Sectional Studies

NHANES N = 605 adults 60-69 years

Lin, J. Geront. Med. Sci., 2011

	Age (per year) β[a] (95% CI)	P	Hearing loss (per 25 dB) β[b] (95% CI)	P	Δ Age (years) equivalent to 25 dB of hearing loss
Digit Symbol Substitution Test	-0.55 (-0.92 – -0.18)	<.01	-3.86 (-7.15 – -0.56)	.02	7.0

BLSA N = 347 adults >60 years

Lin et al., Neuropsych., 2011

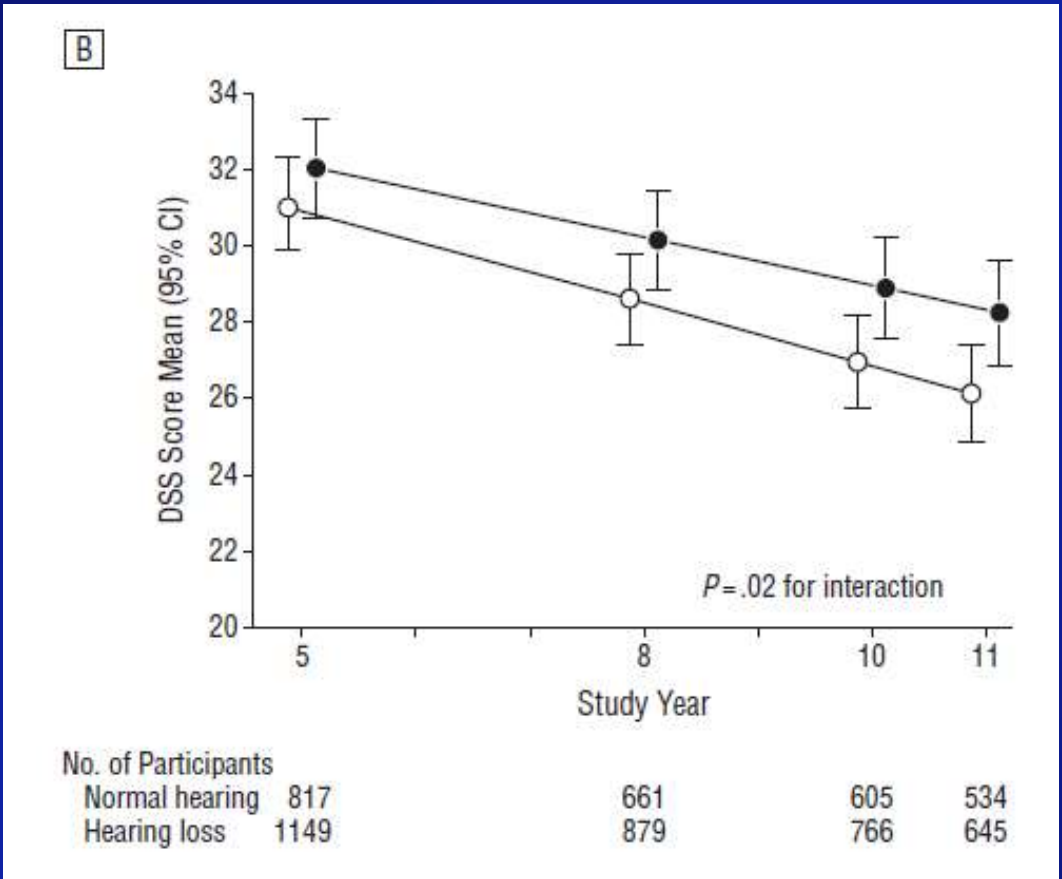
Stroop Mixed	-0.33 (-0.48 – -0.18)	<.001	-2.27 (-4.14 – -0.40)	.02	6.8
Trail Making B	-0.00011 (-0.00018 – -0.000044)	.001	-.00074 ($-0.0015 – 2.74x10^{-6}$)	.05	6.7

Models adjusted for [illegible] n, diabetes, smoking, hypertension

Hearing Loss & Cognitive Decline

HealthABC

Adjusted 3MS & DSS scores by years of follow-up and hearing loss status in 1,966 adults > 70 years followed for 6 years



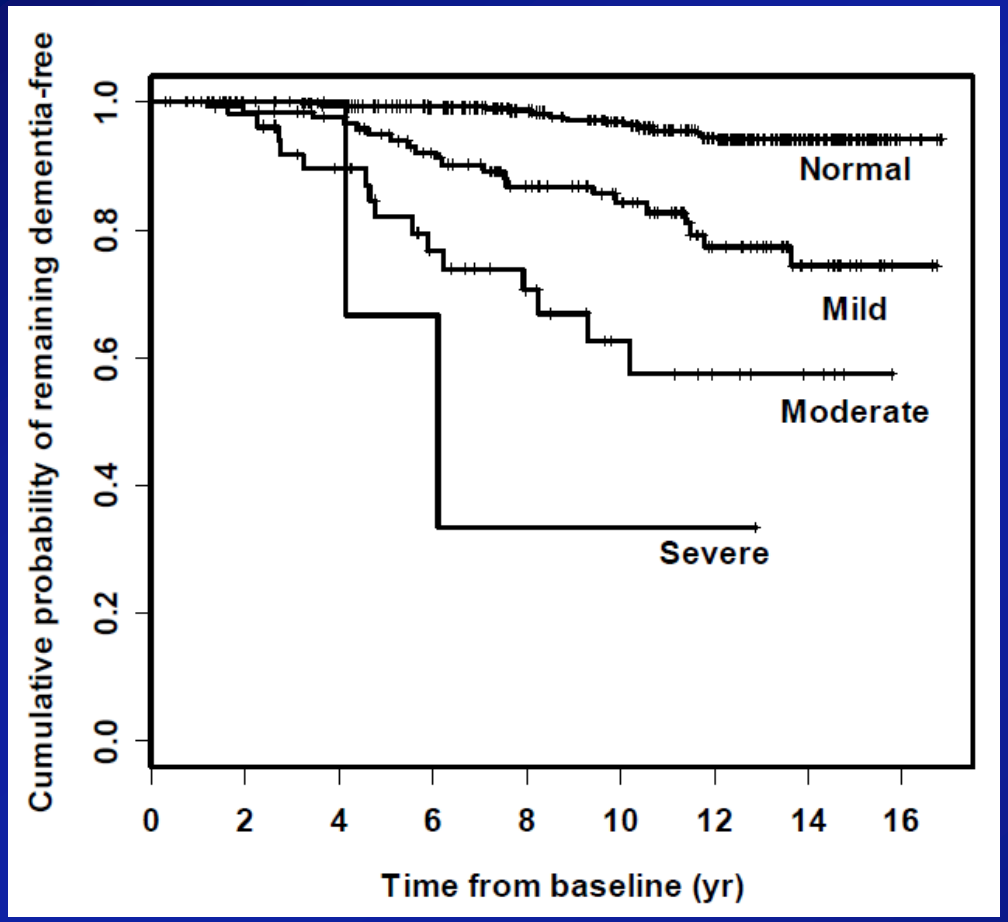
42% faster rate of cognitive decline in DSS scores in HL vs. NH

Adjusted for age, sex, race, education, study site, smoking status, hypertension, diabetes, and stroke history

Lin et al. JAMA Int Med. 2013

Hearing Loss & Incident Dementia

Dementia incidence in 639 adults followed for >10 years in the BLSA



Risk of incident all-cause dementia (compared to normal hearing)[a]

	HR	95% CI	p
Mild	1.89	1.00 – 3.58	0.05
Moderate	3.00	1.43 – 6.30	.004
Severe	4.94	1.09 – 22.4	.04

[a] Adjusted for age, sex, race, education, DM, smoking, & hypertension

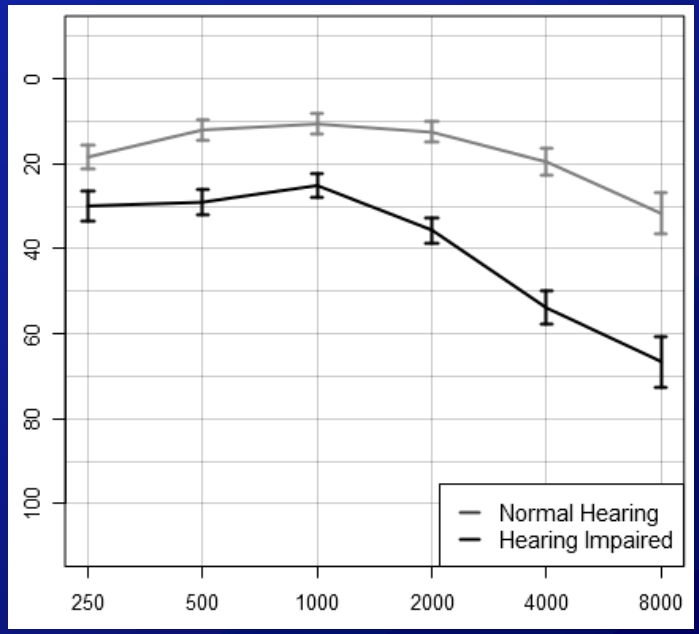
Lin et al., Arch Neuro., 2011

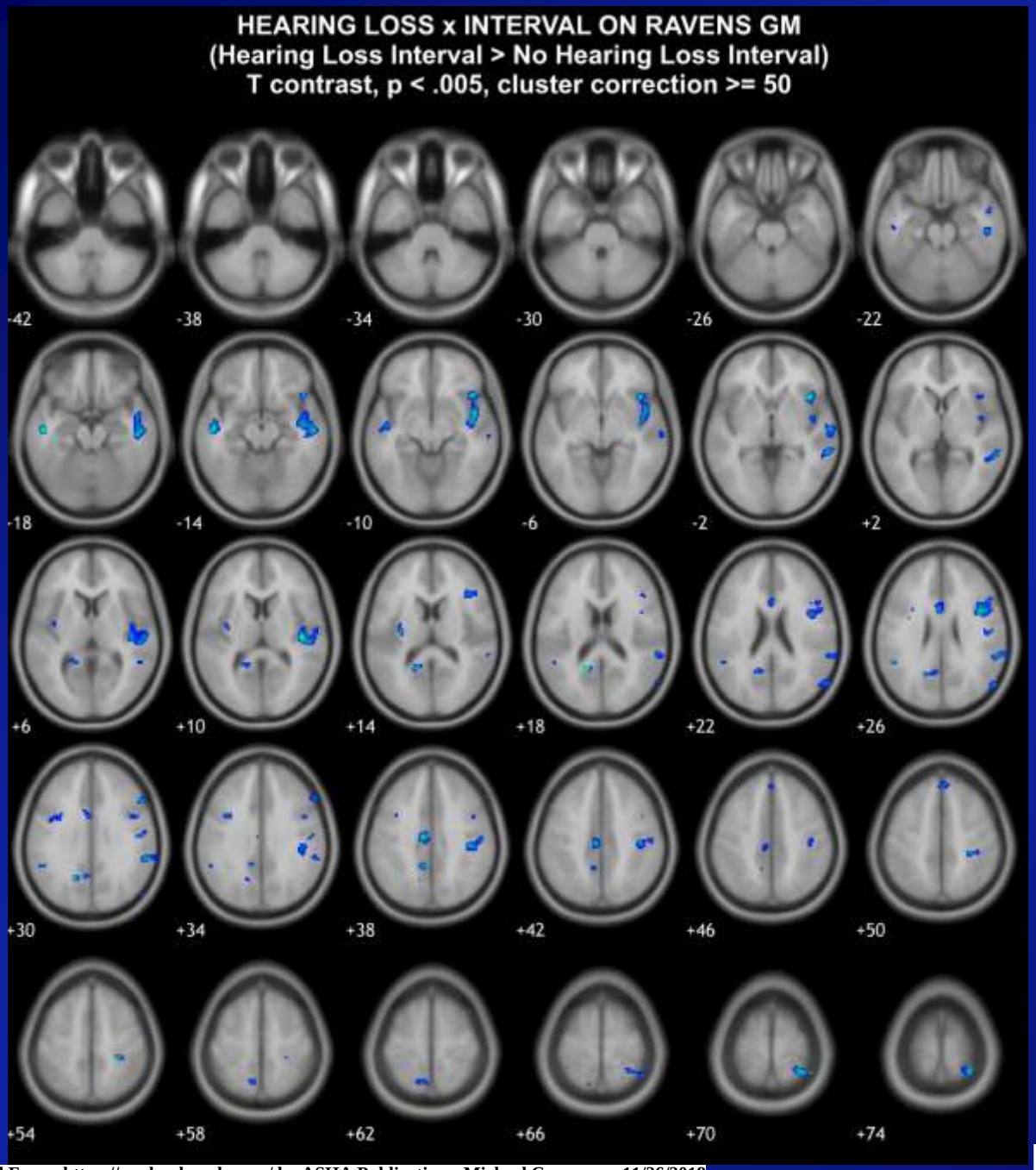
Hearing Loss & Accelerated Brain Volume Decline

BLSA

- **Hypothesis**: Hearing loss is associated with accelerated atrophy in the superior, middle, and inferior temporal gyri

- 126 participants (56-86 yrs) in the neuroimaging substudy of the BLSA
  - Mean follow-up duration of 6.4 years
  - 1.5T MRI performed annually





L

Voxel-Based Analyses

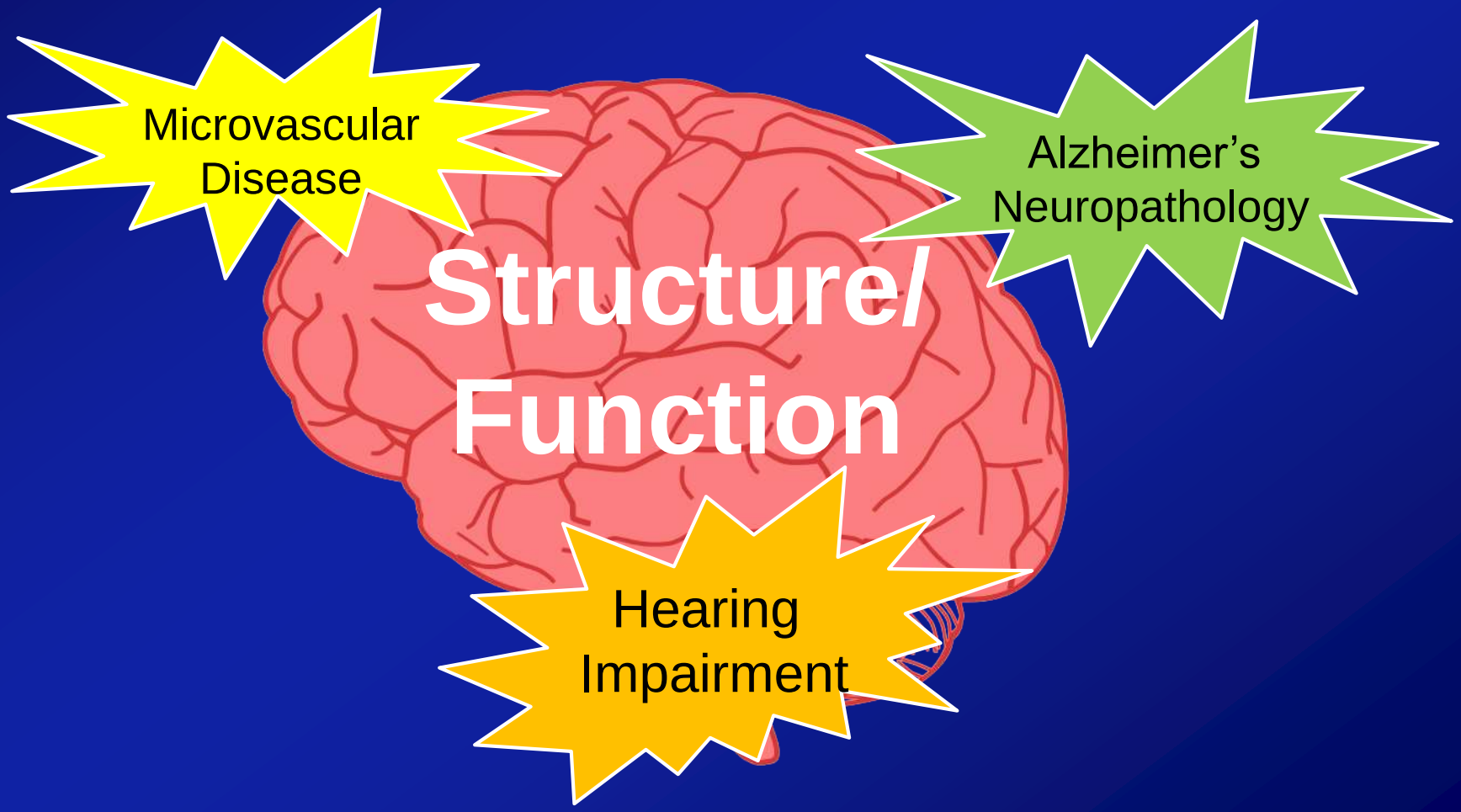
Difference in mean gray matter volume change in those with HL vs. NH

Faster decline in brain volume in HL vs. NH

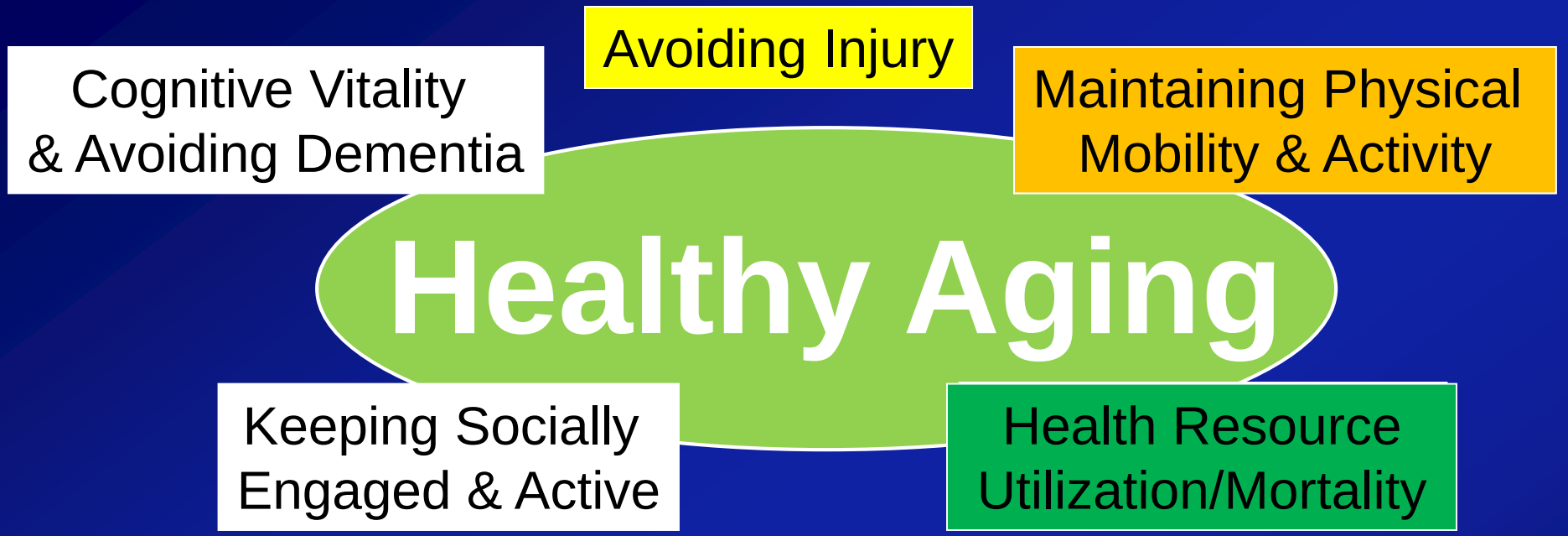
Lin et al., Neuroimage 2014

Double Hit Theoretical Model

Hearing Loss & Brain Structure/Function



F. Lin & M. Albert, Aging & Mental Health, 2014



Avoiding injury

- Increased falls (Viljanen et al , JGMS 2009; Lin et al. Arch Int Med 2012)

Physical mobility/functioning

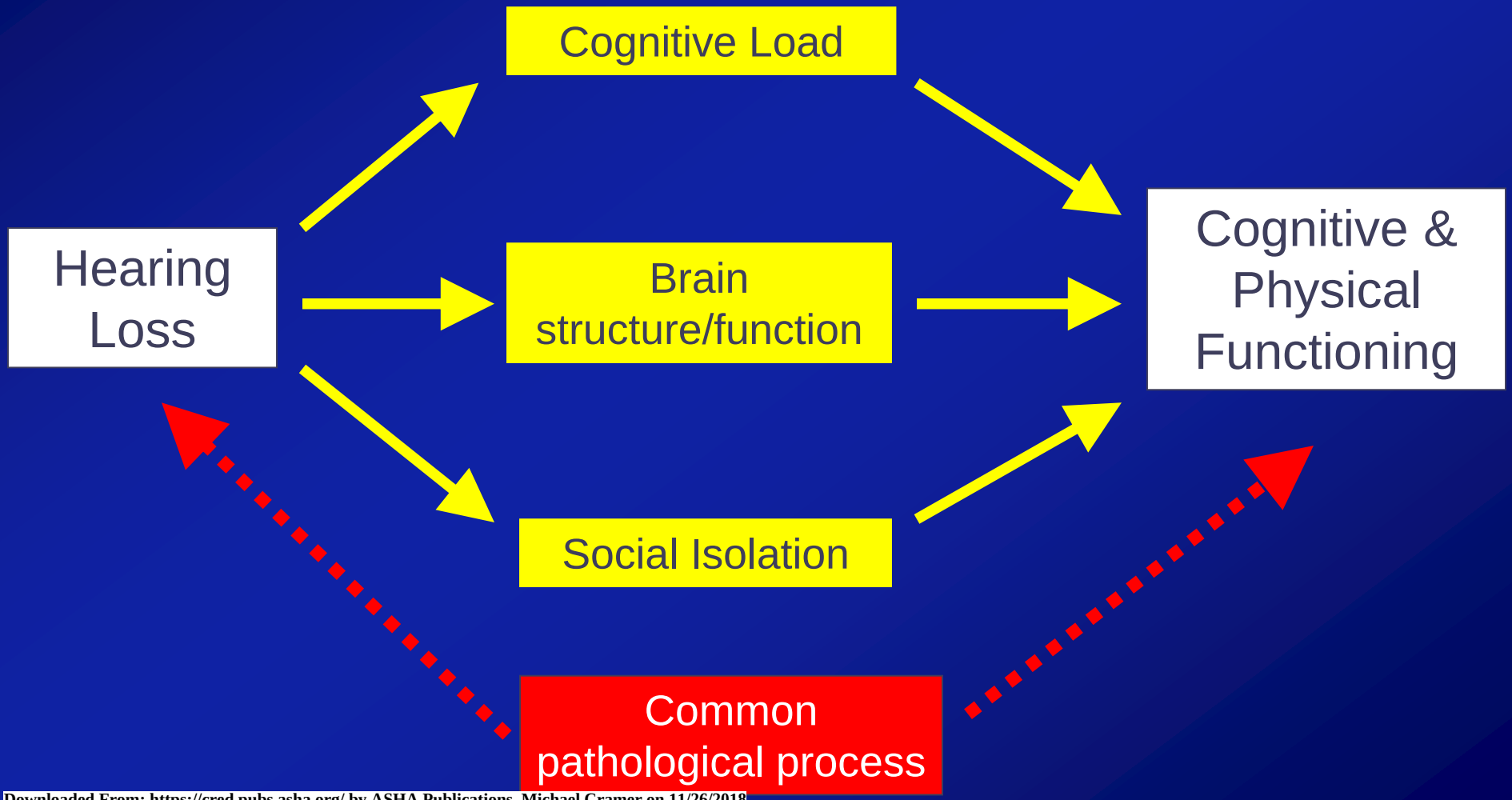
- Reduced walking speed (Viljanen et al. JAGS 2009; Li et al., Gait & Posture 2012)
- Accelerated decline in physical functioning (Chen et. al. JAGS, 2015)
- Driving ability (Hickson et al. JAGS 2009; Picard et al 2008)

Health resource utilization/mortality

- Increased odds of hospitalization (Genther et al, JAMA, 2013; JGMS 2015)
- Increased mortality (Karpa et al Ann Epi 2010; Fisher et al. 2013; Genther et al, JGMS 2014)

Hearing Loss & Healthy Aging

Common Cause or *Modifiable Risk Factor*



Age-Related Hearing Loss (ARHL)

Basic Questions

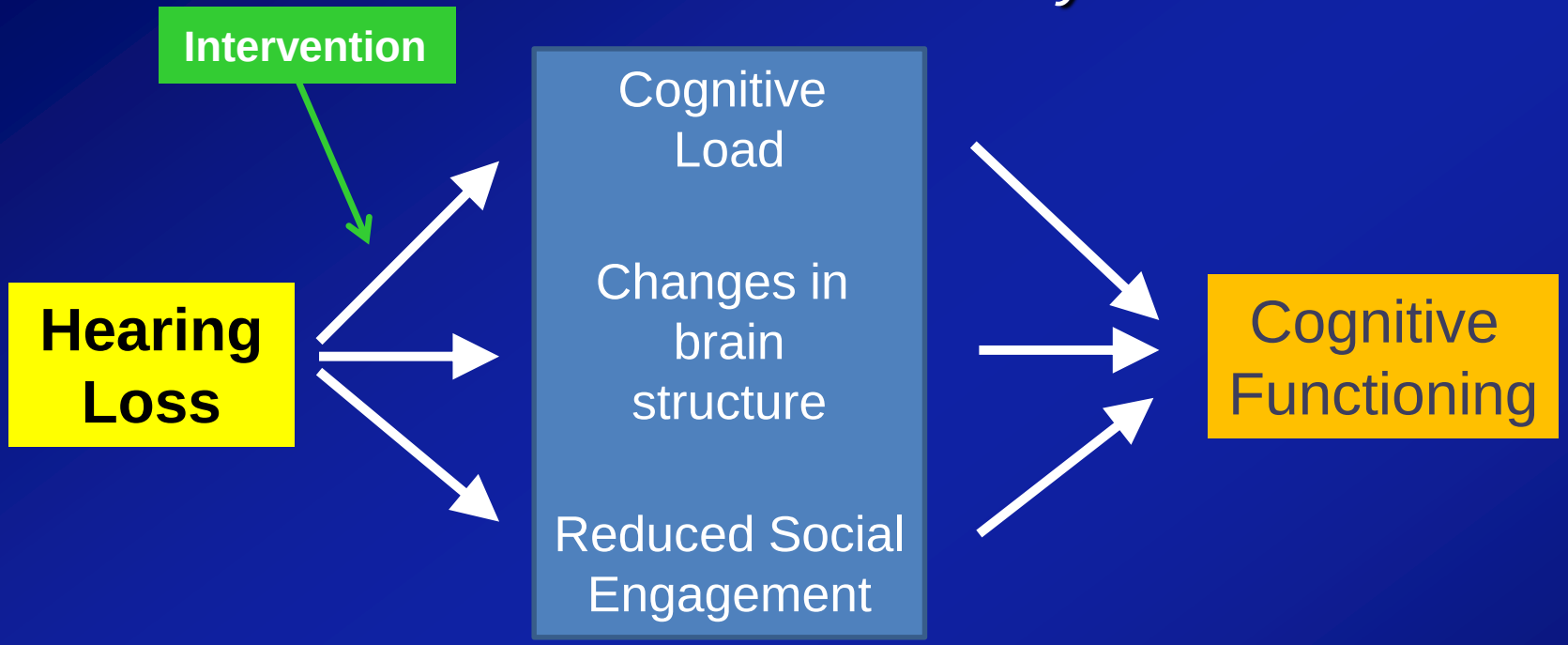
- What are the consequences of ARHL for older adults?
- **What is the impact of treating ARHL on older adults?**
- How can ARHL be effectively addressed in the community?

The question of whether treating hearing loss could delay cognitive/physical decline or dementia remains unknown

There has never been a randomized clinical trial of treating hearing loss to explore effects on reducing the risk of cognitive decline/dementia

Hearing Loss & Cognition

Mechanistic Pathways



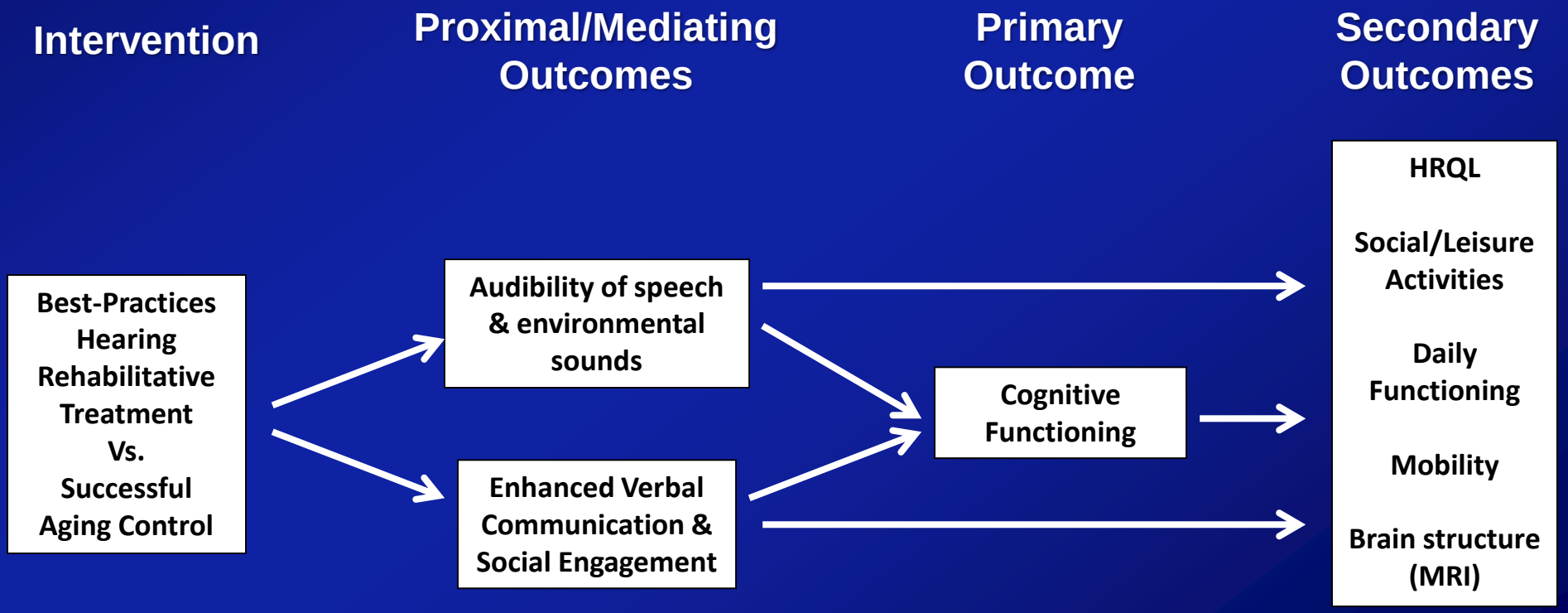
Hearing loss intervention could:

- Reduce the cognitive load of processing degraded sound
- Provide increased brain stimulation
- Improve social engagement

Role of HL as a potentially modifiable, late-life risk factor for cognitive decline & dementia

Conceptual Model for the Aging, Cognition, and Hearing Evaluation in Elders (ACHIEVE Healthy Aging) RCT

In collaboration with Marilyn Albert, Joe Coresh, Richey Sharrett, ARIC Study Team (T. Mosley, D. Knopman, C. Jack), and U. South Florida (T. Chisolm, A. Eddins)



NIA R34AG064548

Atherosclerosis Risk in Communities (ARIC)

ARIC Cohort : 1987-present; n=15,792

Supported by National Institutes of Health
NHLBI with ancillary studies by NCI, NEI, NIA, NIAAA, NIDCD, NIDDK, NIEHS, NINDS, NCRR & NIH Roadmap

ACHIEVE Trial Design

Timeline & Overview of RCT

- Timeline:
  - 2014-2016 RCT planning process (R34AG046548)
    - Pilot study, development of protocol/operations manual, etc.
  - 2016 Trial grant submission
  - 2017-18 Recruitment at ARIC field sites
  - 2018-21 Follow-up

- Participants: ~766 70-84 y.o., healthy, cognitively normal community-dwelling adults with untreated mild-moderate HL recruited

- Intervention: Randomization to best-practices hearing rehabilitative treatment vs. successful aging intervention control

- Outcome: Study powered to detect 0.25 effect-size difference in rates of cognitive decline between the two groups at 3 years post-randomization

NIA R34AG064548

Age-Related Hearing Loss (ARHL)

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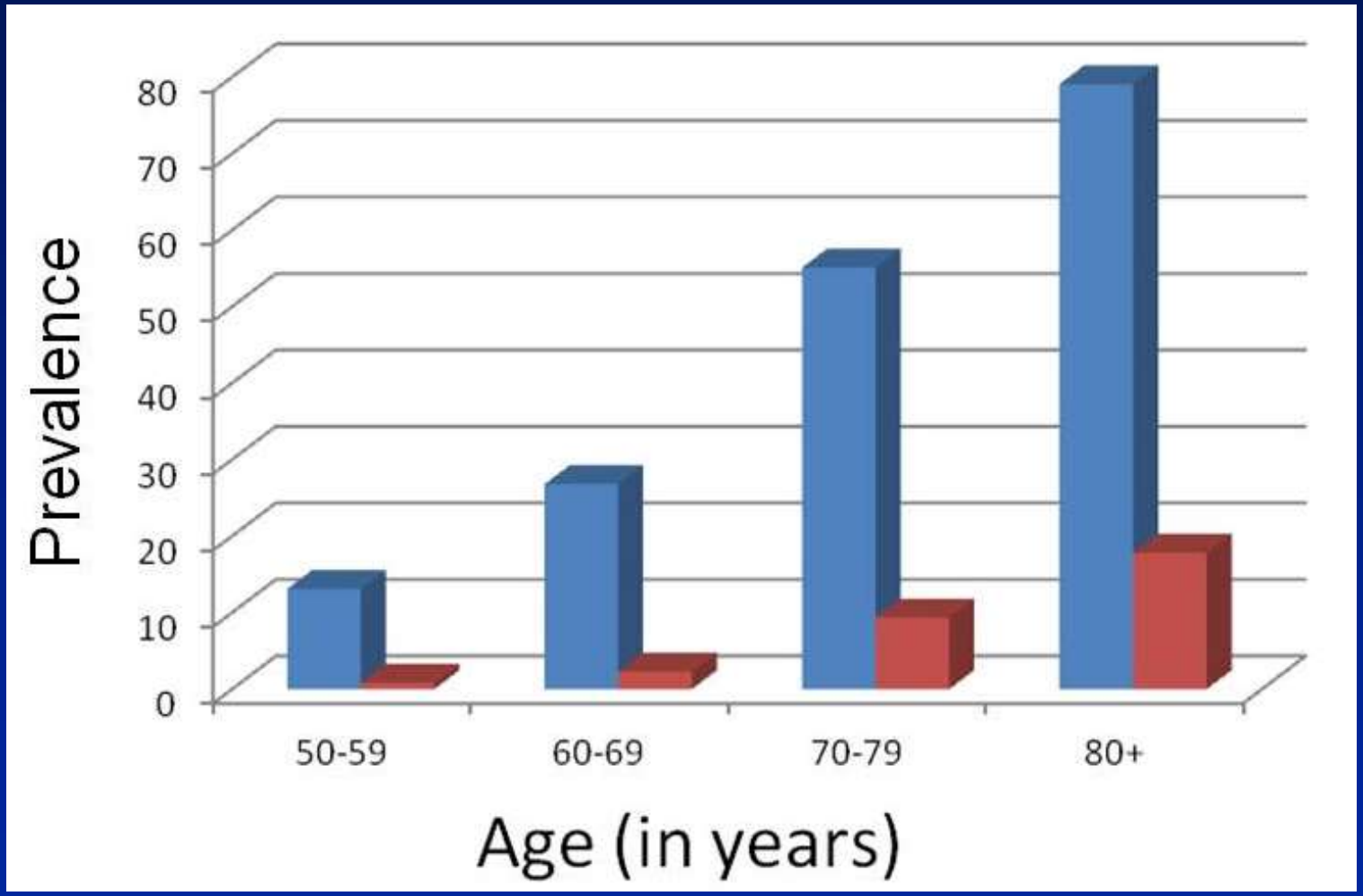
Hearing Loss & Hearing Aid Use
Prevalence in the U.S. , 1999-2006



Arch Int Med, 2012

Prevalence of Hearing Aid Use

- **United States** (Arch Int Med, 2012)
  - 26.7M adults ≥ 50 years with hearing loss
  - 3.8M use hearing aids
  - **Overall rate of HA use: 14.2%**
- **England and Wales** (NICE Report, 2000)
  - 8.1M with hearing loss
  - 1.4M use hearing aids
  - **Overall rate of HA use: 17.3%**

Barriers to Hearing Health Care (HHC)

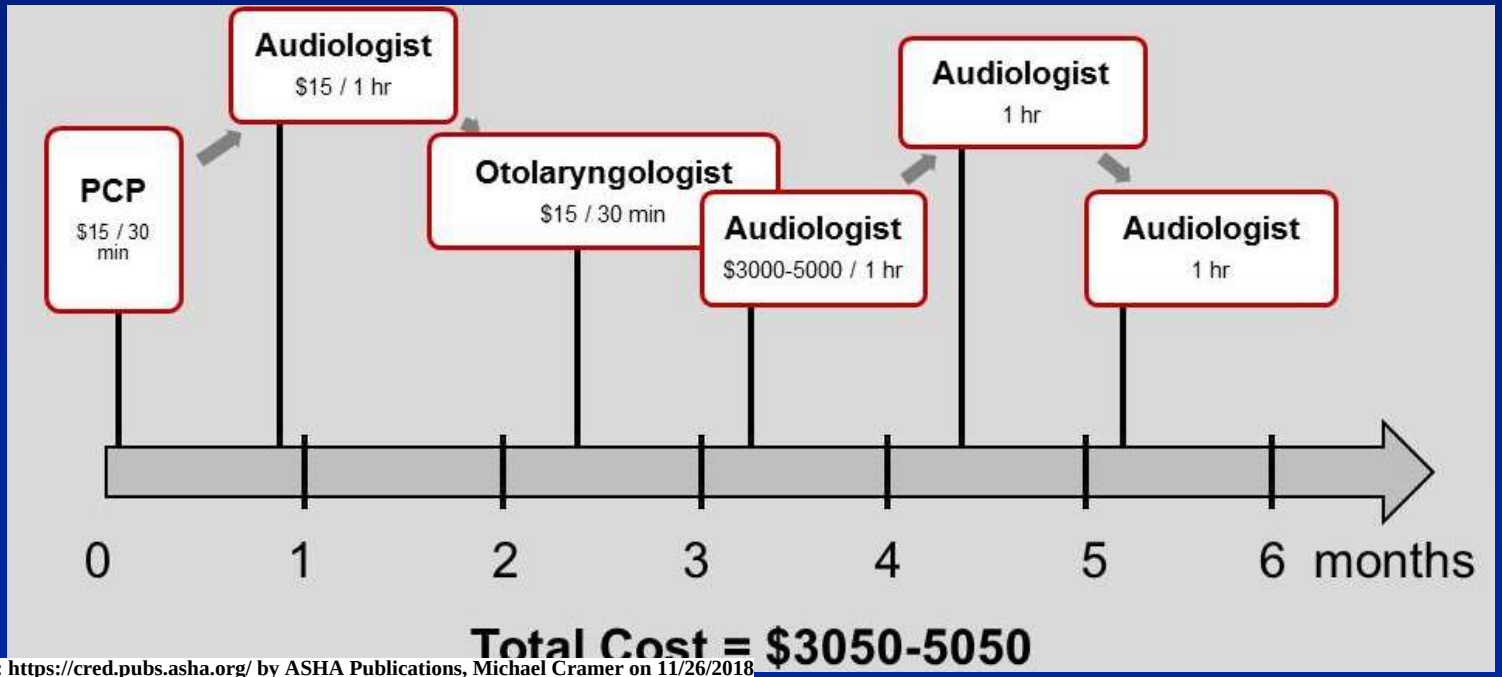
Cost/Affordability

Access to Services &Technology

Access to Services &Technology

Current (only) gold-standard model of HHC:

- Repeat clinic-based visits with audiologist/dispenser for evaluation, counseling, sensory management, fitting
- FDA/state regulations restrict direct access to hearing aids



Barriers to Hearing Health Care (HHC)

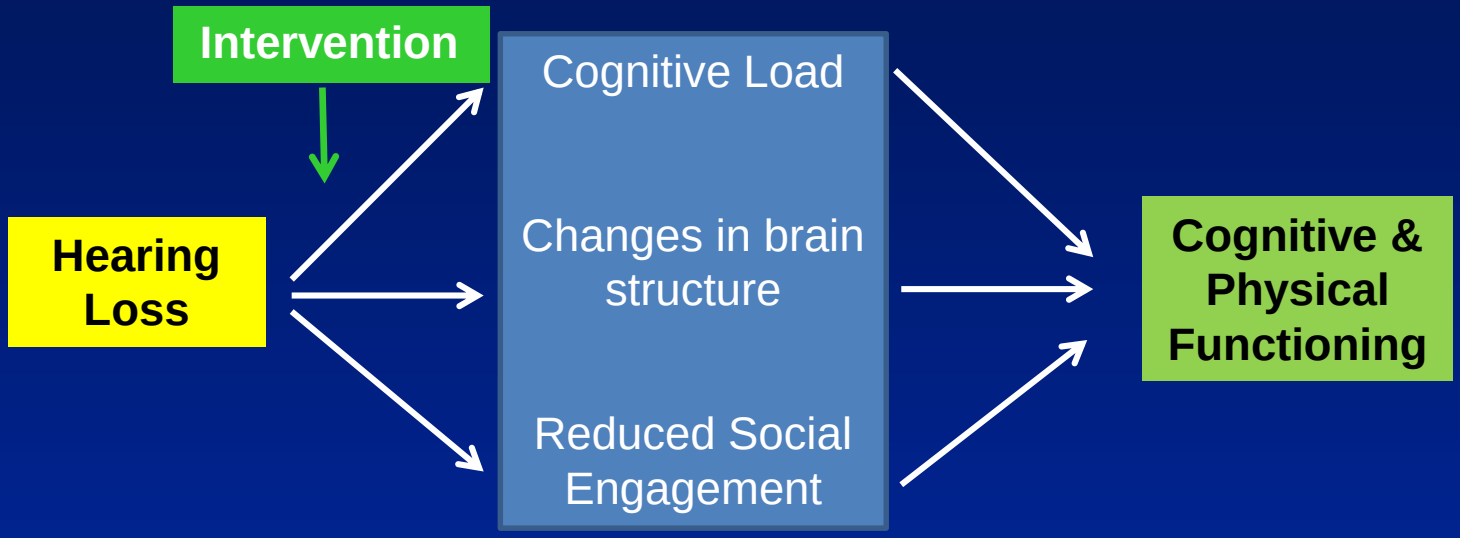
Cost/Affordability

Awareness & Understanding

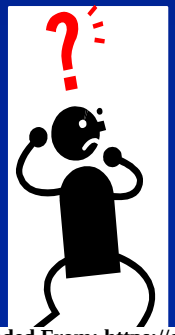
Access to Services &Technology

Awareness & Understanding

- **Awareness of impact/public health importance**

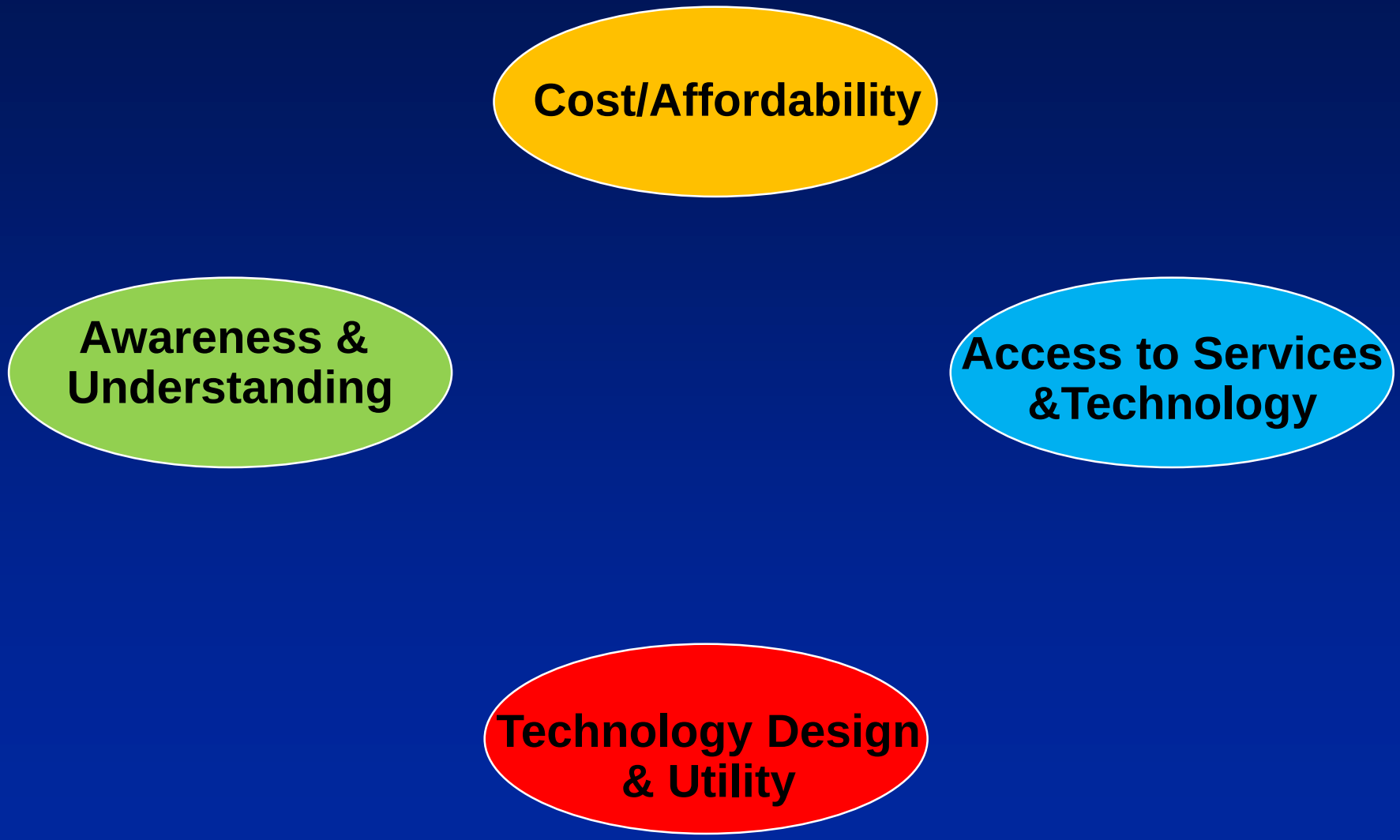


- **Understanding of treatment options**



Hearing Loss Intervention – Hearing aids? Sound amplifiers? Audiologists? ENTs? Hearing aid dispensers? Mail order hearing aids? Costco?

Barriers to Hearing Health Care (HHC)



Technology Design & Utility

Hearing when it really matters…

Proprietary 2.4GHz or 900MHz

FM Receiver with loop

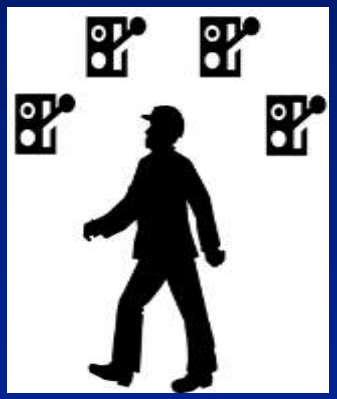
Streamer

Remote Mic

Barriers to Hearing Health Care (HHC)

Cost/Affordability

Awareness & Understanding



Access to Services &Technology

Technology Design & Utility

How can ARHL be effectively addressed in the community?

Future Trends

- Understanding & approaching hearing loss in the context of healthy aging/public health

  → White House Conference on Aging & President's Council of Advisors on Science & Technology – Report released Oct 2015

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EXECUTIVE OFFICE OF THE PRESIDENT

PRESIDENT'S COUNCIL OF ADVISORS ON SCIENCE AND TECHNOLOGY

WASHINGTON, D.C. 20502

October 2015

- #1 - FDA should designate as a distinct category ("basic" hearing aids) non-surgical, air conduction hearing aids intended to address bilateral, gradual onset, mild-to-moderate age-related hearing & approve this class of hearing aids for over-the-counter (OTC) sale, without the requirement for consultation with a credentialed dispenser.

- #2 - FDA should withdraw its draft guidance of November 7, 2013 on Personal Sound Amplification Products (PSAPs). PSAPs should be broadly defined as devices for discretionary consumer use that are intended to augment, improve, or extend the sense of hearing in individuals.

How can ARHL be effectively addressed in the community?

Future Trends

- Understanding & approaching hearing loss in the context of healthy aging/public health
  - → White House Conference on Aging & President's Council of Advisors on Science & Technology – Report released Oct 2015
  - → Institute of Medicine Consensus Study – Report due 2016

How can ARHL be effectively addressed in the community?

Future Trends

- Understanding & approaching hearing loss in the context of healthy aging
  - → White House PCAST – Oct 2015 report
  - → Institute of Medicine – Report due 2016

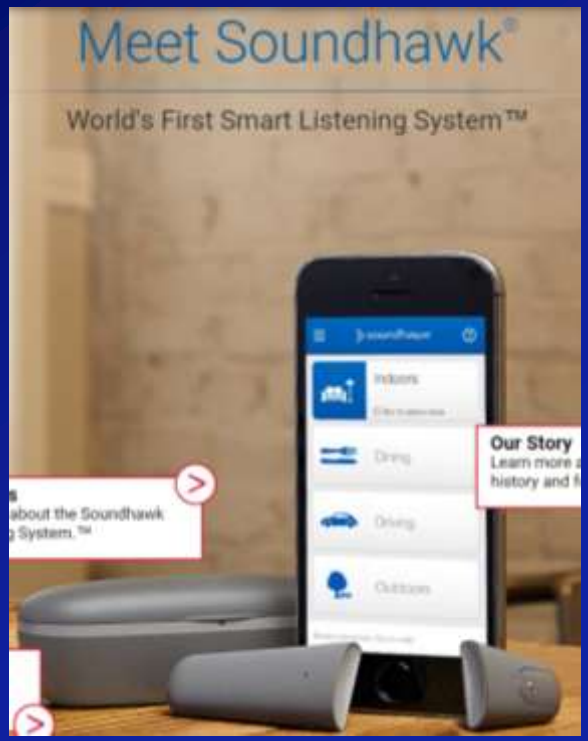
- Innovations in hearing health care/technology
  - Accessible services & affordable technology

Innovations in Hearing Health Care

Affordable & Accessible Options are Needed

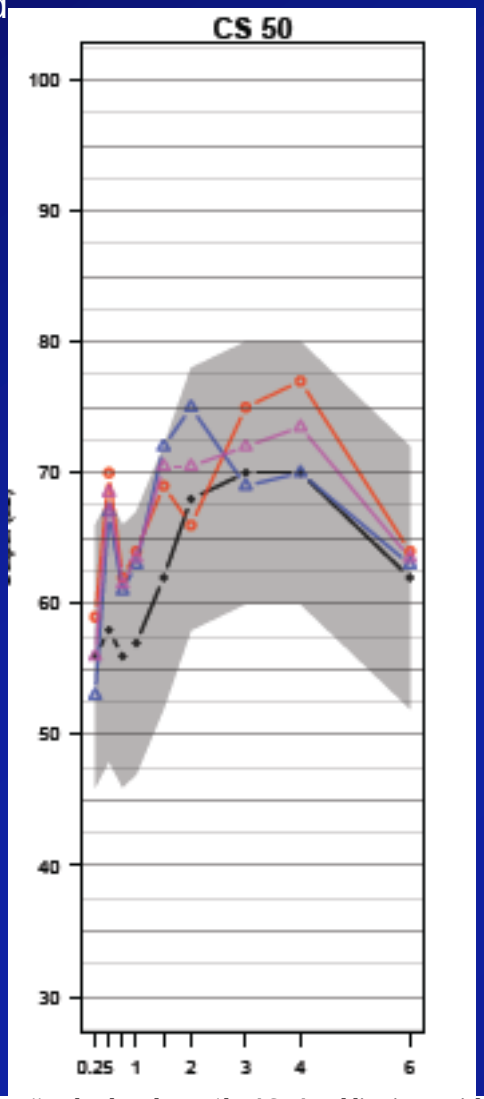
- **<u>Technology</u> – Personal sound amplifiers (PSAP)**
  - Over-the-counter “hearing aids” with in-situ testing & verification
  - Cost < $100-300

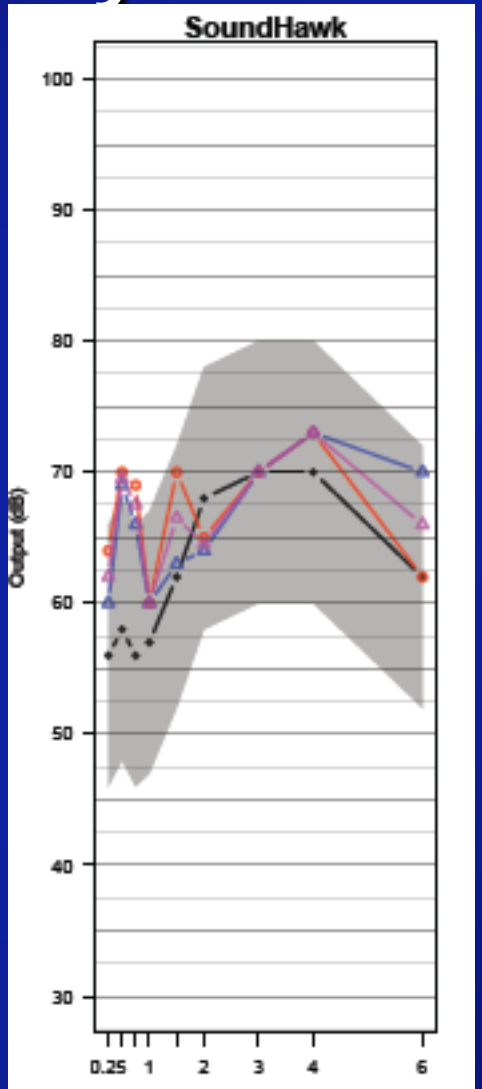
Convergence of medical devices (hearing aids) & consumer electronics ("PSAPs", "hearables")

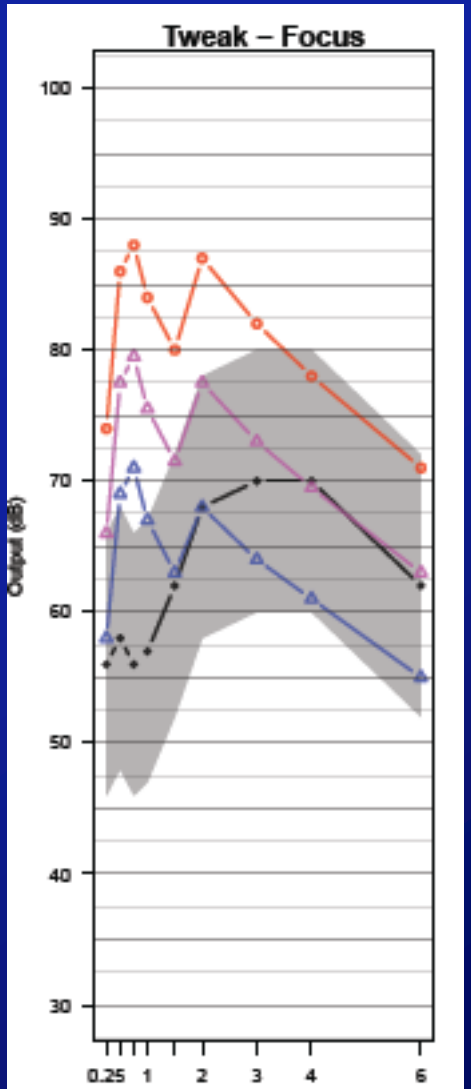


Nick Reed

Electroacoustic/Real Ear Analysis of PSAPs







Innovations in Hearing Health Care

Affordable & Accessible "Stepping Stones" are Needed for Hearing Health Care

- **Technology – Personal sound amplifiers (PSAP)**
  - Over-the-counter "hearing aids" with in-situ testing & verification
  - Cost < $100-300

- **Services - Community health care workers**
  - Community-based hearing screening
  - Counseling, education, & provision of sound amplifiers & other assistive technologies
  - Referral as needed

Access HEARS: Hearing care Equality through Accessible Research & Solutions

HEARS Intervention

1) Hearing Loss Screening
2) Device Orientation:
   - Self-fit amplification device
   - Individual programming
3) Counseling:
   - Expectation management
   - Communication Strategies

Carrie Nieman

Pilot Studies in Multiple Populations

Carrie Nieman

Sara Mamo

Janet Choi

Older Adults in Assisted Living Facilities or with Cognitive Impairment

Korean-American Older Adults – Korean Martyrs Catholic Church

Licensing & Dissemination

Non-profits
Local government

2016-2019

Pilot Studies

Multiple Communities

2014-2016

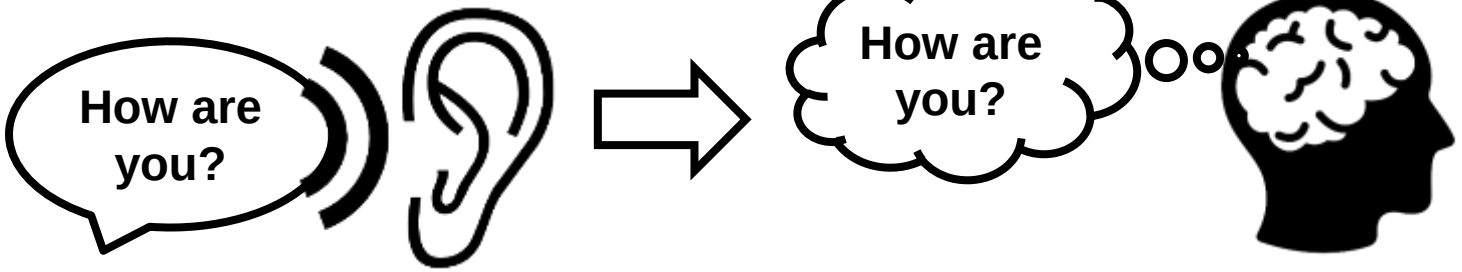
Intervention Development

2013

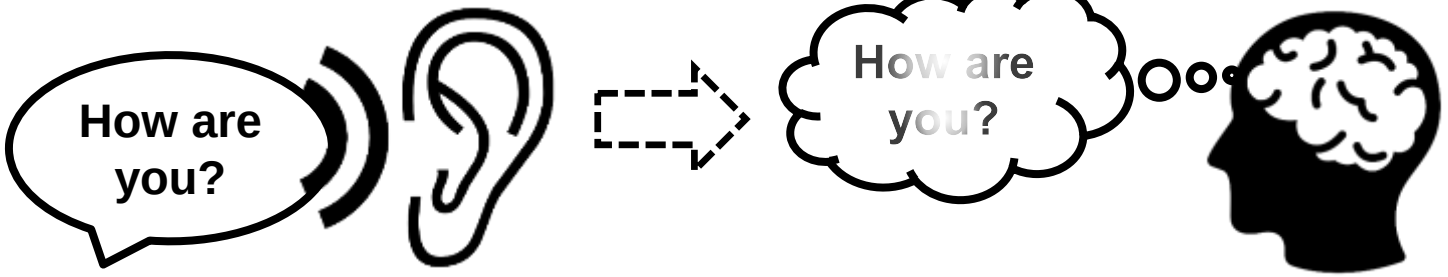
Outcomes in participant & communication partner

Social Engagement
Communication
Activities
HRQL

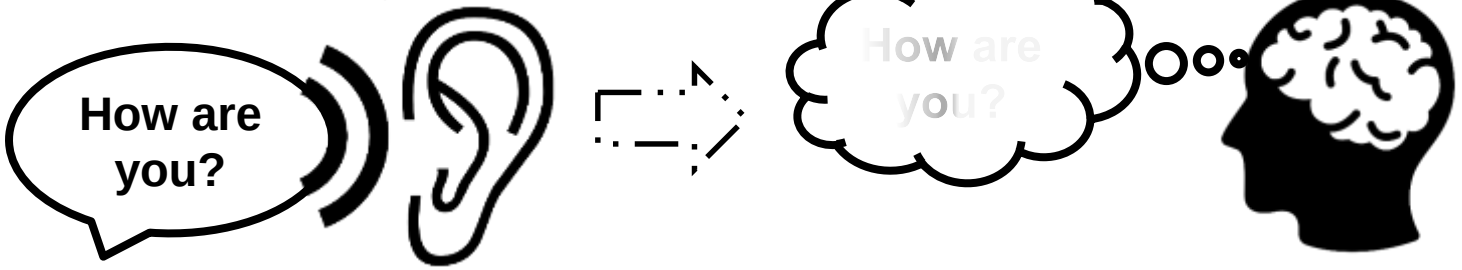
Normal Hearing



Some Hearing Loss



A lot of Hearing Loss



Listen by Mister Pixel from The Noun Project
Brain by Marek Polakovic from The Noun Project

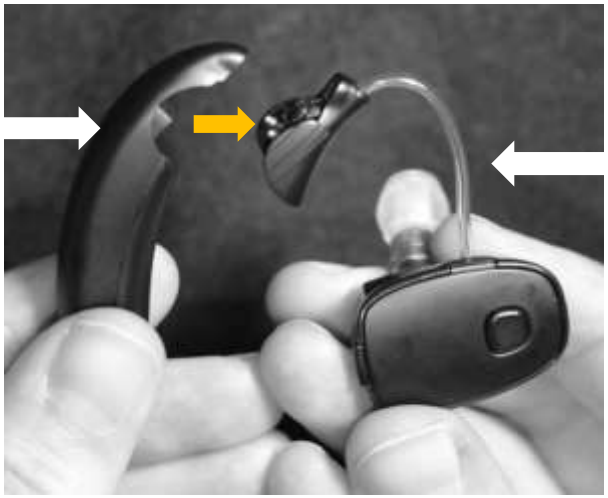
Communication Tip #2: Repeat then Reword

If someone did not understand you, repeat it once.
If that does not work, reword it.

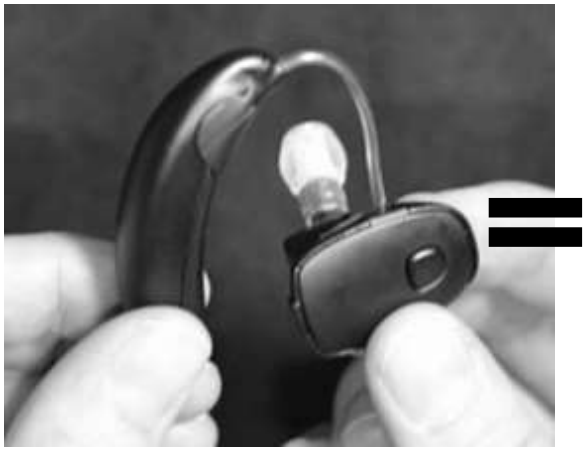
Repetition only works once.

Place the Battery, Turn on CS-50

Battery



Earpiece



ON
Ready to use

Checklist

- ☐ Connect battery to earpiece
- ☐ Indicate when CS-50 is ON

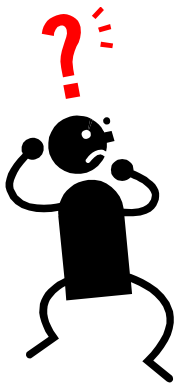
Memory Clinic HEARS Project

Feedback – Son-in-law of a 91 yo woman with MMSE of 17

Week 1	**Notes, questions, concerns:** This week there was trouble adjusting the volume. Different T.V. stations had different levels of volumes. People came into her room with different ways of expressing themselves. She would holler that the device was too loud.
Week 2	**Notes, questions, concerns:** The "huh" stopped right away. Her asking to repeat a statement has almost disappeared. The speed of conversation has quickly picked up. She helped me to adjust the hearing device to make things more comfortable.
Week 3	**Notes, questions, concerns:** She began telling her historical stories more accurately. She asked me questions in smoother sentences. Her patience was extended. There were less "hurry-up"s.
Week 4	**Notes, questions, concerns:** She seemed to be less interested in having her way and imparting restrictions on the second party when she did not get her way.
Week 5	**Notes, questions, concerns:** Her willingness to make decisions is stronger. Such decisions have made more sense. Note: The dementia is still there, but it seems to take more of a back seat in her life.

Additional Models of Hearing Health Care are Needed

Audiologist as the Leader of a Team



PSAP or OTC Hearing Aid
$
1-2 hours

Community Health Worker
$$
1/2 day

Hearing Aid Dispenser
$$$
1-2 months

Gold Standard Audiology Care
$$$$
3-6 months

Sara Mamo

Nick Reed

Time/
Expense/
Expertise

How can ARHL be effectively addressed in the community?

Future Trends

- Understanding & approaching hearing loss in the context of healthy aging
  - → Jan 2014 Institute of Medicine Workshop in the U.S.

- Innovations in hearing health care/technology
  - Accessible services & affordable technology
  - Open wireless standards

Open Wireless Standards

- Fundamental limitation of all hearing aids?
- How to increase signal-to-noise ratio?
- Options:
  - Post-microphone
    - Algorithmic processing of sound
  - Pre-microphone
    - Hearing loop systems
    - Proprietary wireless systems (2.4Ghz, 900Mhz)

Hearing when it really matters…

Proprietary
2.4GHz or
900MHz

FM
Receiver
with loop

Streamer

Remote Mic

Convergence of medical devices with consumer electronics

Wi Fi DIRECT

Bluetooth® SMART READY

How can ARHL be effectively addressed in the community?

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  - → Institute of Medicine Workshop – Report due 2016
  - → White House PCAST– Report due Fall 2015

- Innovations in hearing health care/technology
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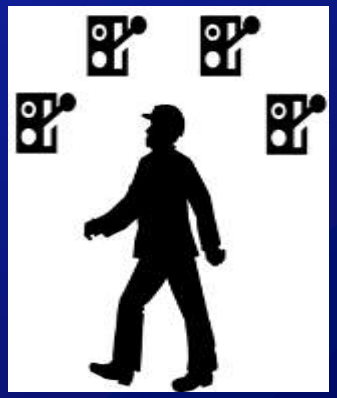

- Third-party reimbursement of hearing health care
  - Unbundling of hearing health care
  - Coverage for audiologic rehabilitative services (not devices)

“Are you telling me that I’m going to develop dementia?”

equences of hearing

mpact of treating hearing loss on older adults?

- How can hearing loss be effectively addressed in the community?

- Hypertension → Heart attack & stroke
  - Intervention: Medication, Lifestyle modification

- Hearing loss → Cognitive decline, dementia, poorer physical functioning
  - Intervention: Comprehensive hearing tx?

Acknowledgments

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