



A/Prof Frank Lin

Otolaryngology

Johns Hopkins University

Hearing loss in older adults: implications for healthy aging - Concurrent Workshop Repeated

Saturday, 17 August 2013

Start 11:00am

Duration: 55mins

Kremlin

Start 12:05pm

Duration: 55mins

Kremlin



South GP CME 2013

General Practice Conference & Medical Exhibition

15-18 August | Edgar Centre | Dunedin

Hearing Loss in Older Adults: Implications for Healthy Aging

Frank R. Lin, M.D. Ph.D.

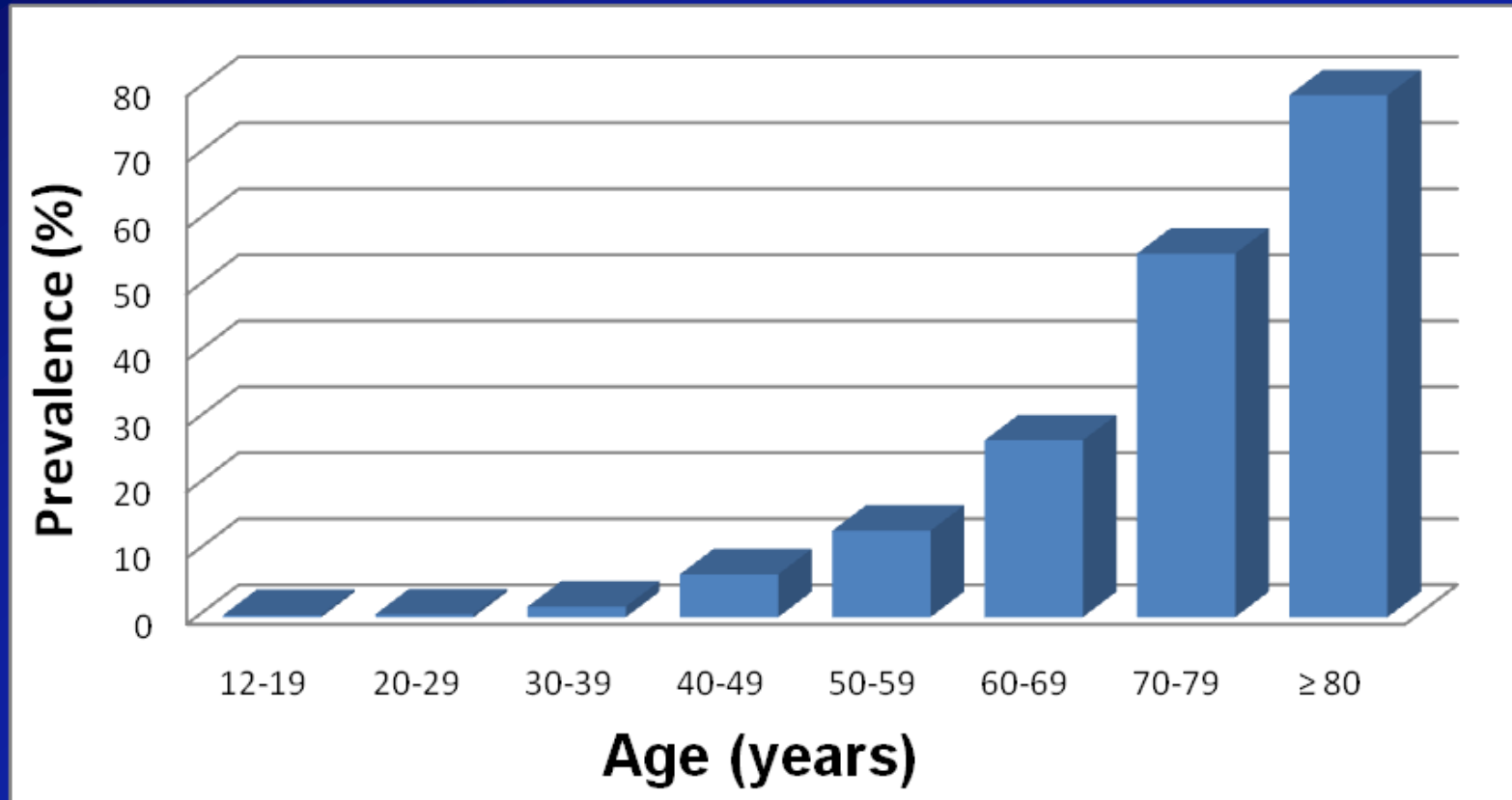
Assistant Professor of Otolaryngology, Geriatric Medicine,
Mental Health, and Epidemiology
Johns Hopkins University
Baltimore, Maryland



Disclosures

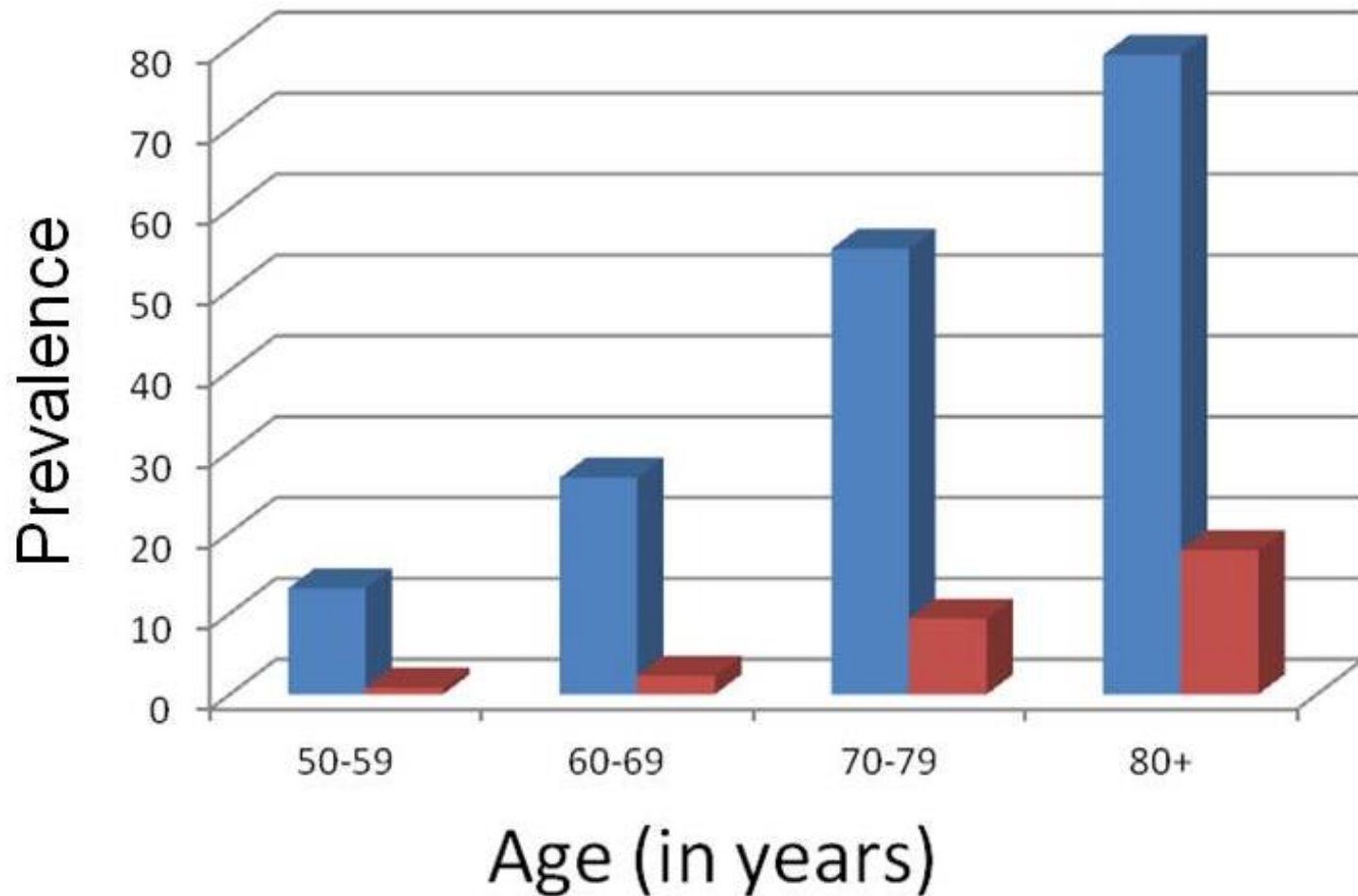
- Consultant for Cochlear Limited
- Scientific Advisory Board for Pfizer and Autifony Therapeutics
- Speaker honoraria from Amplifon & Med El

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

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



Prevalence of Hearing Aid Use

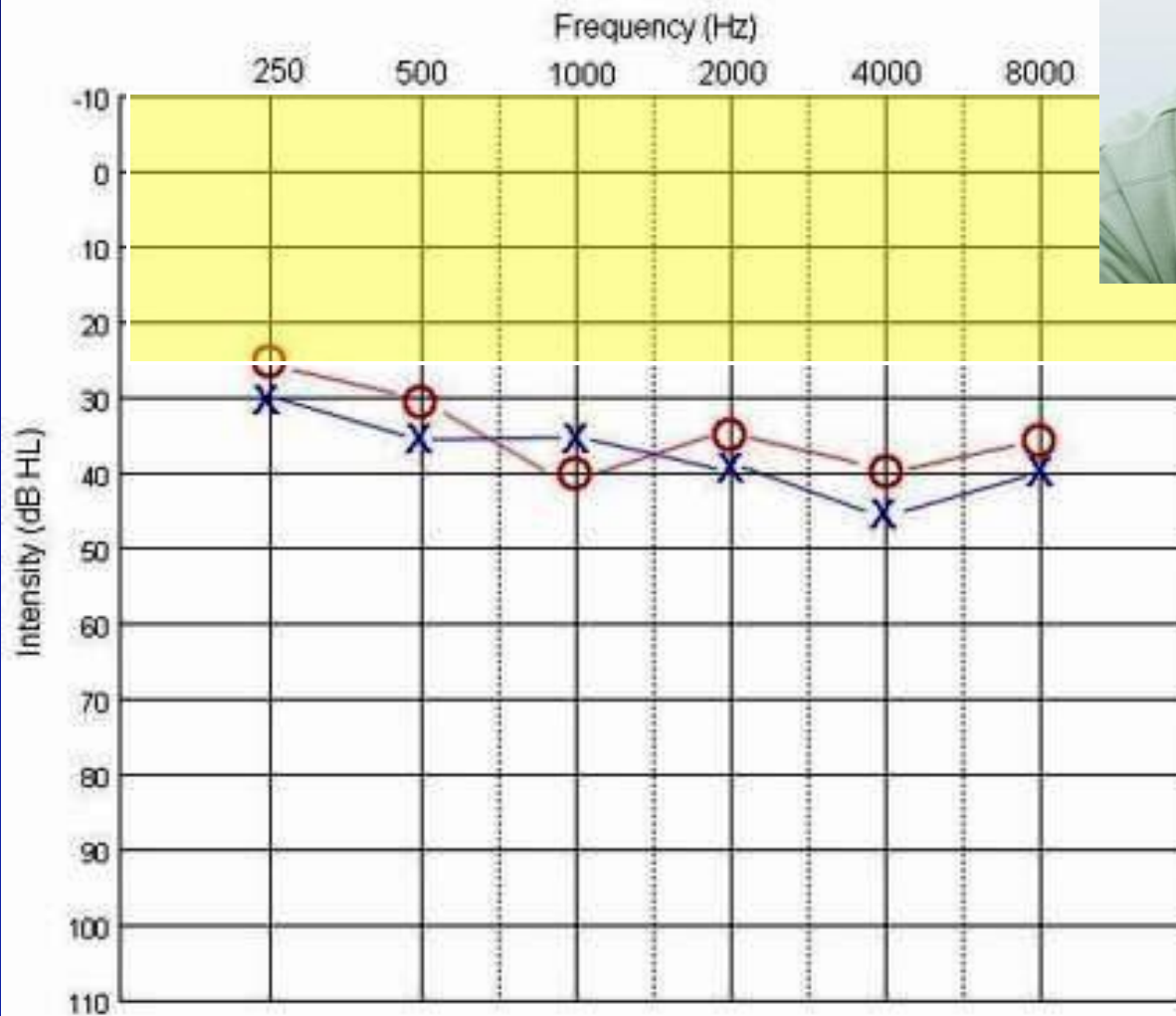
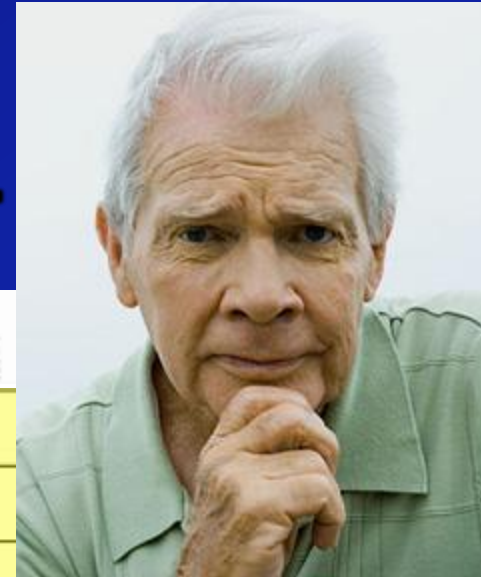
- **United States** (Chien & Lin, Arch Int Med, 2012)
 - 26.7M adults $\geq$ 50 years with hearing loss
 - 3.8M use hearing aids
 - **Overall rate of HA use: 14.2%**
- **England and Wales** (Taylor & Paisley, NICE Report, 2000)
 - 8.1M with hearing loss
 - 1.4M use hearing aids
 - **Overall rate of HA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

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)

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?



Healthy Aging



Cognitive Vitality
& Avoiding Dementia

Avoiding Injury

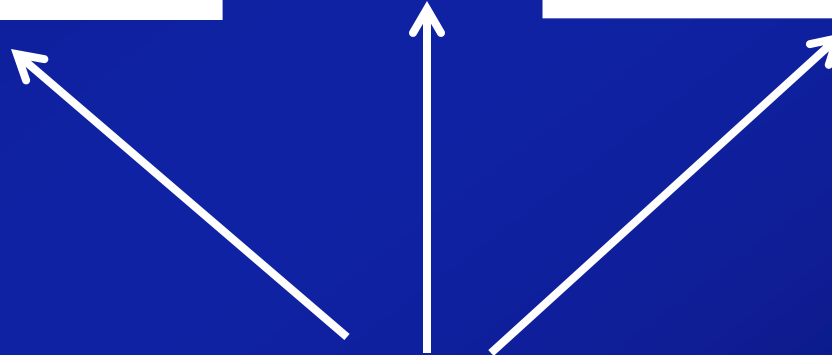
Maintaining Physical
Mobility & Activity

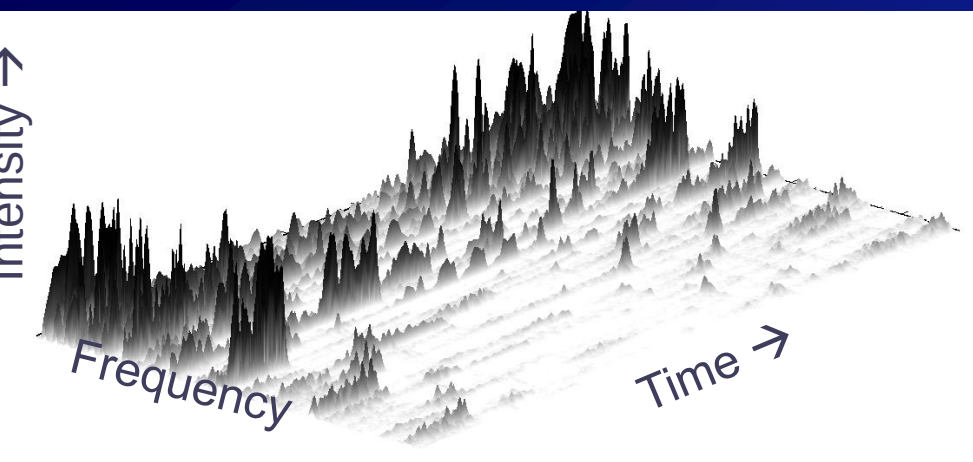
Healthy Aging

Keeping Socially
Engaged & Active

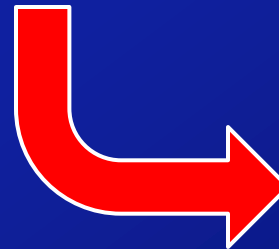
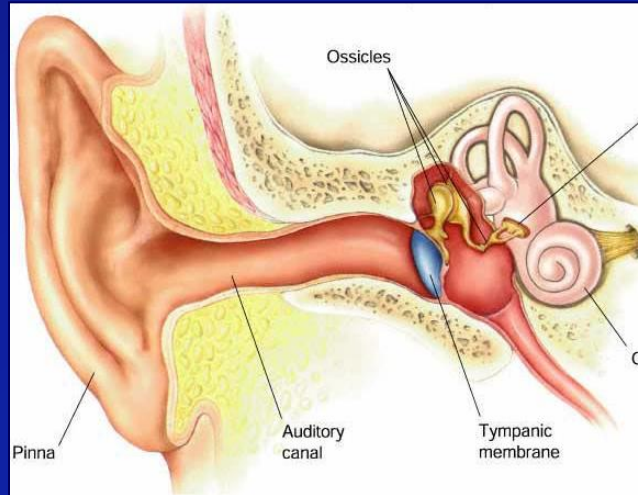
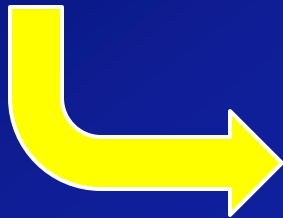
Health Economic
Outcomes/Mortality

Hearing Loss





“Sunday”



Principles of Auditory Physiology

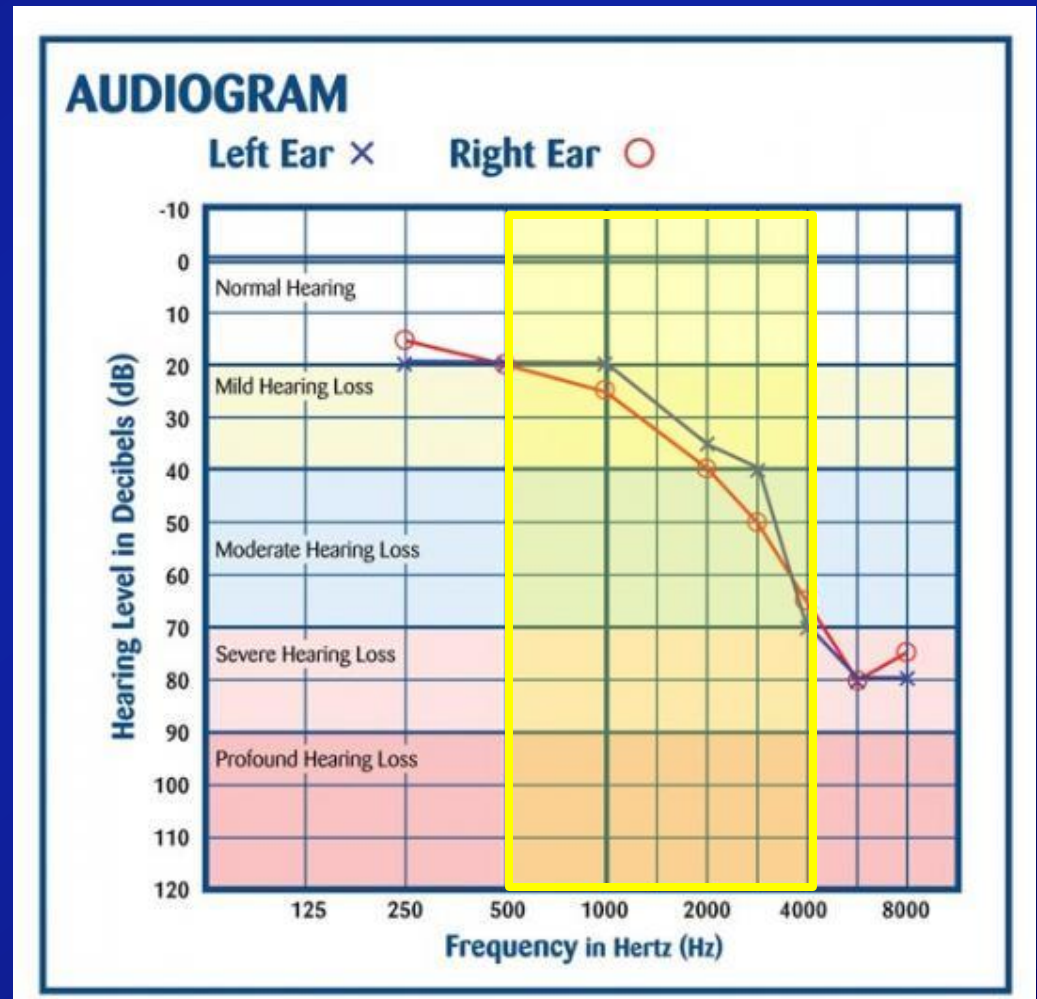
#1 Hearing depends on peripheral transduction & central processing of sound



Principles of Auditory Physiology

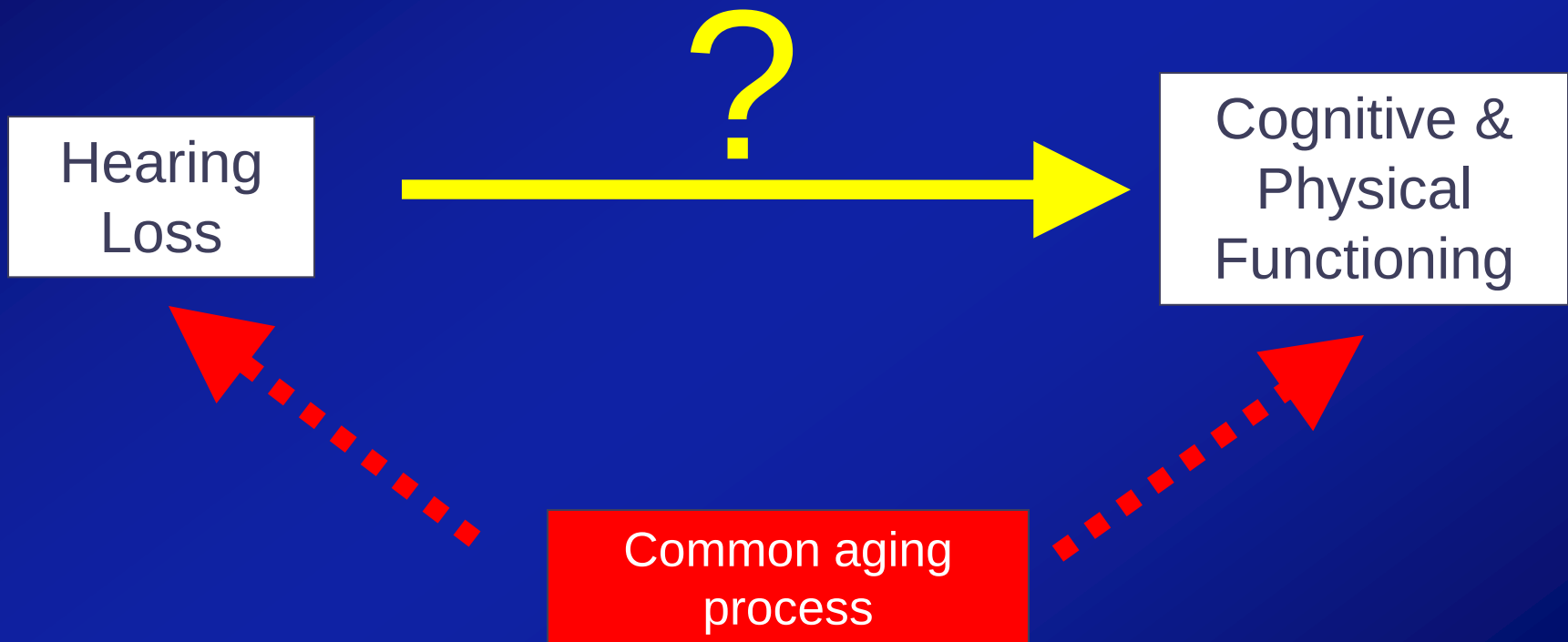
#2 *Audiometry measures the cochlea's ability to detect & encode sound*

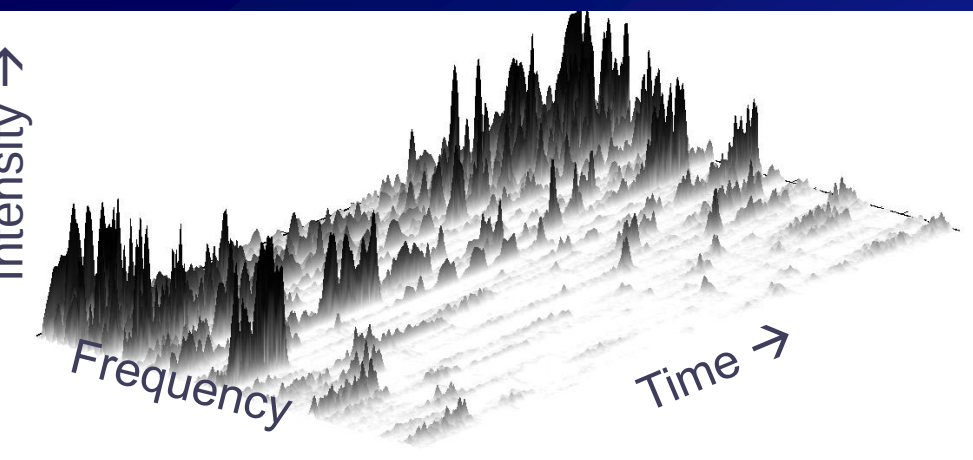
PTA = Pure tone average of 0.5, 1, 2, & 4 KHz tones in the better-hearing ear



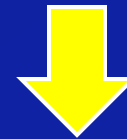
Hearing Loss & Healthy Aging

Common Cause or Modifiable Risk Factor

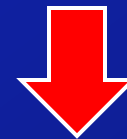




**Hearing Loss &
Cochlear impairment**

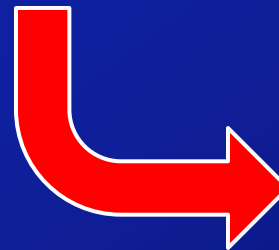
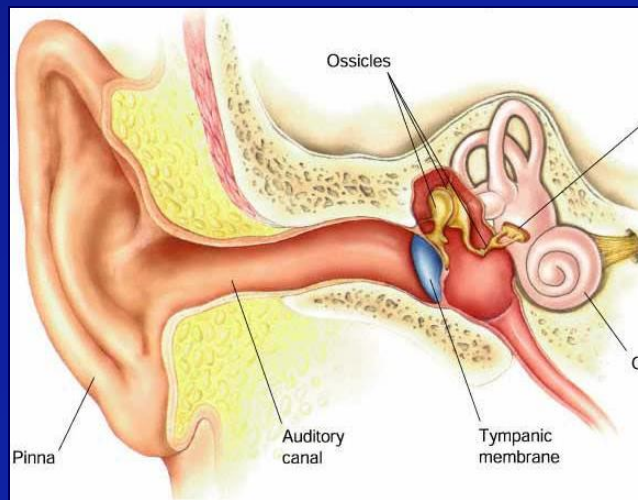
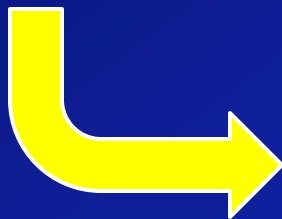


**Increased hearing
thresholds & poor
frequency resolution**



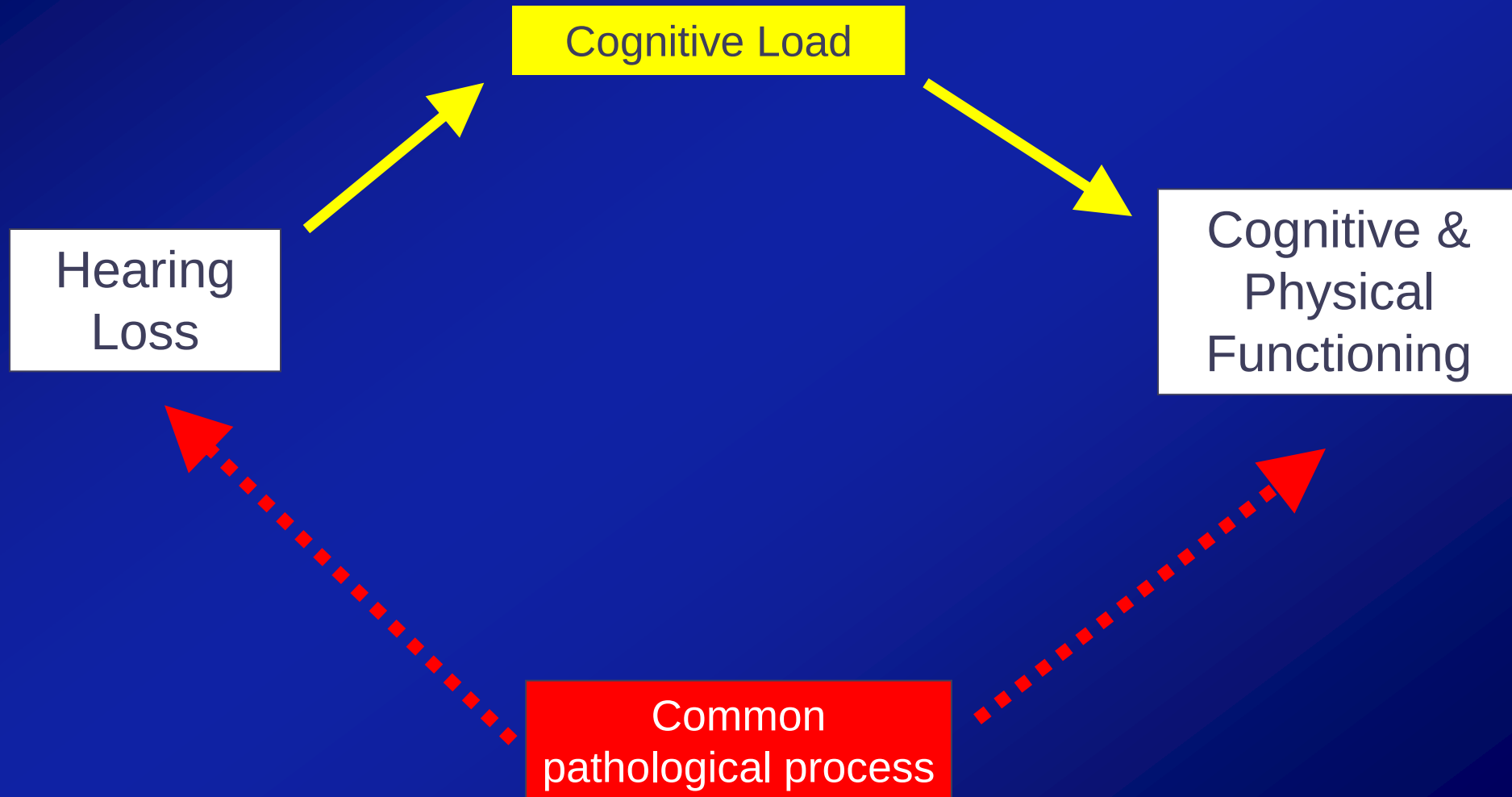
“Effortful listening”

“Sunday”



Hearing Loss & Healthy Aging

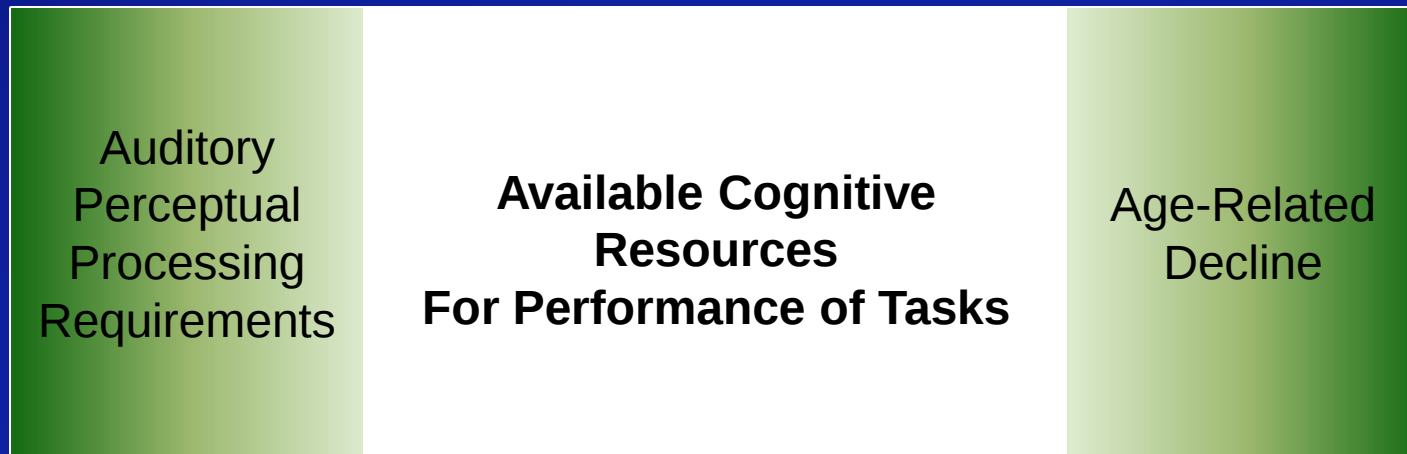
Common Cause or *Modifiable Risk Factor*



Hearing Loss & Cognitive Load

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

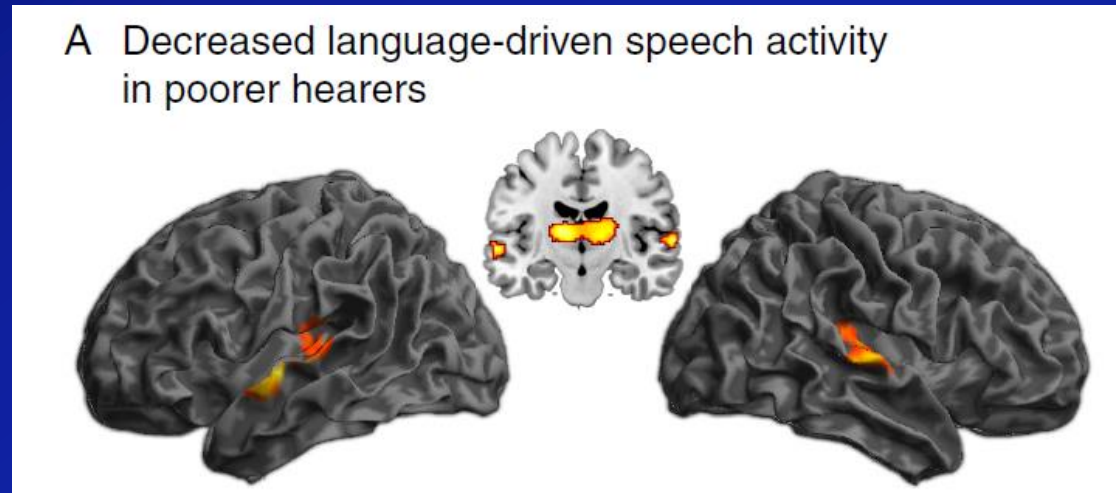
Cognitive Resource Capacity



Hearing Loss & Cognitive Load

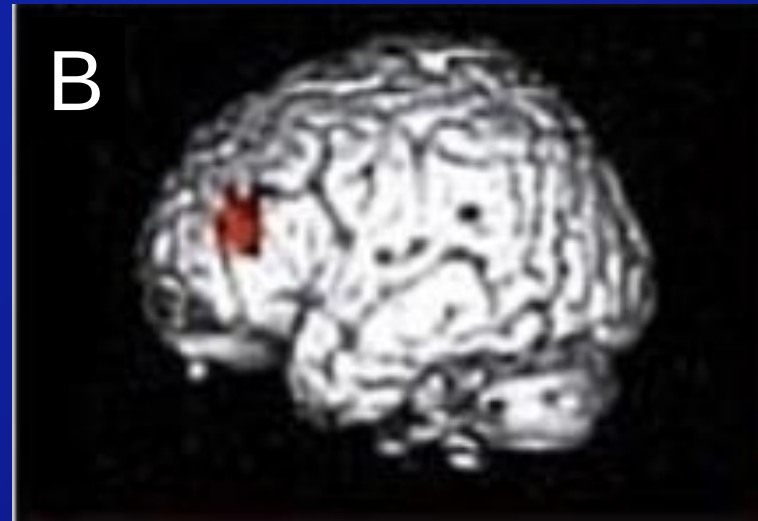
Poorer hearing is associated with:

A. Reduced language-driven activity in primary auditory pathways



Peele et al, J. Neurosci, 2011

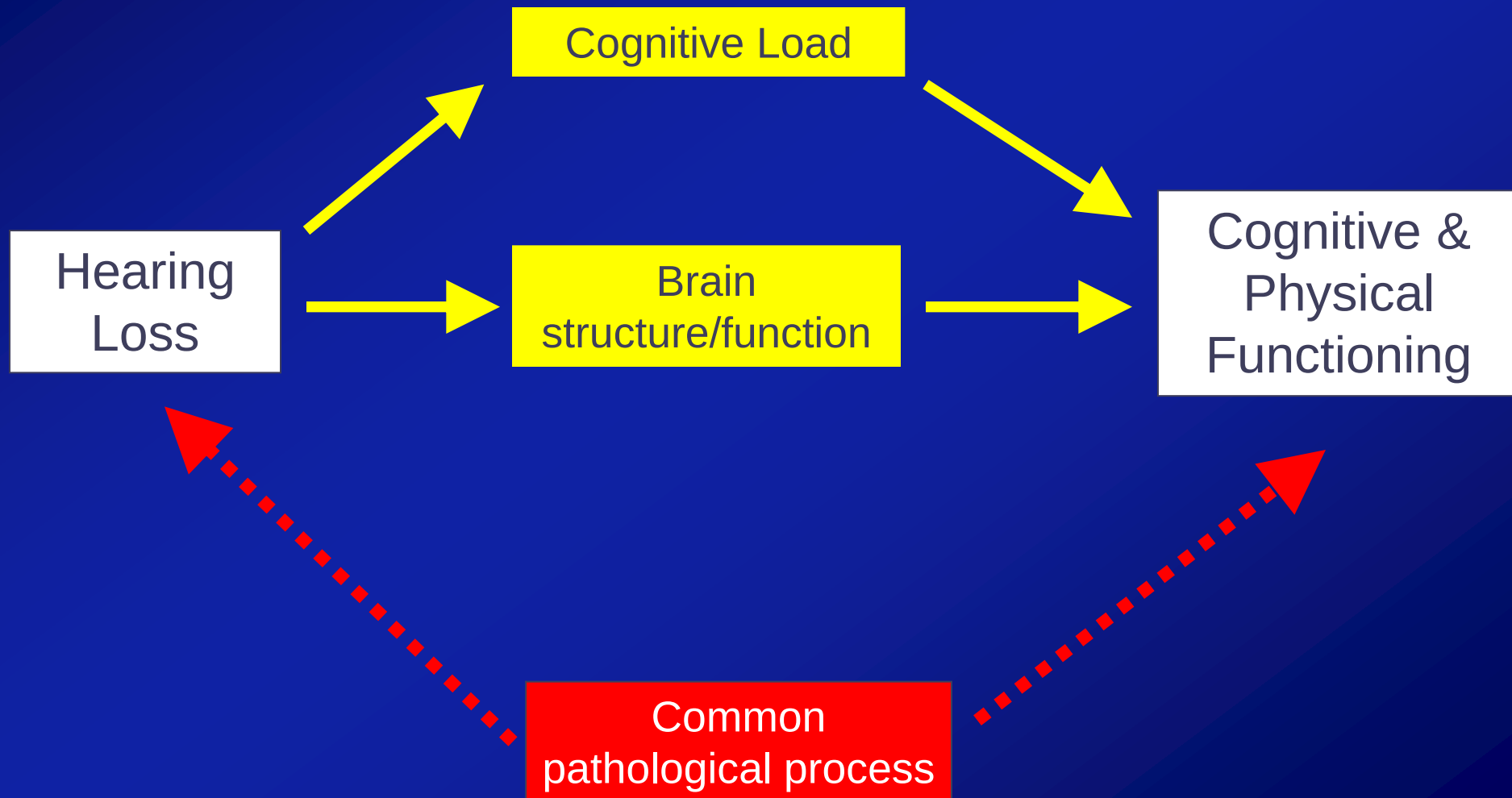
B. Increased compensatory language-driven activity in pre-frontal cortical areas



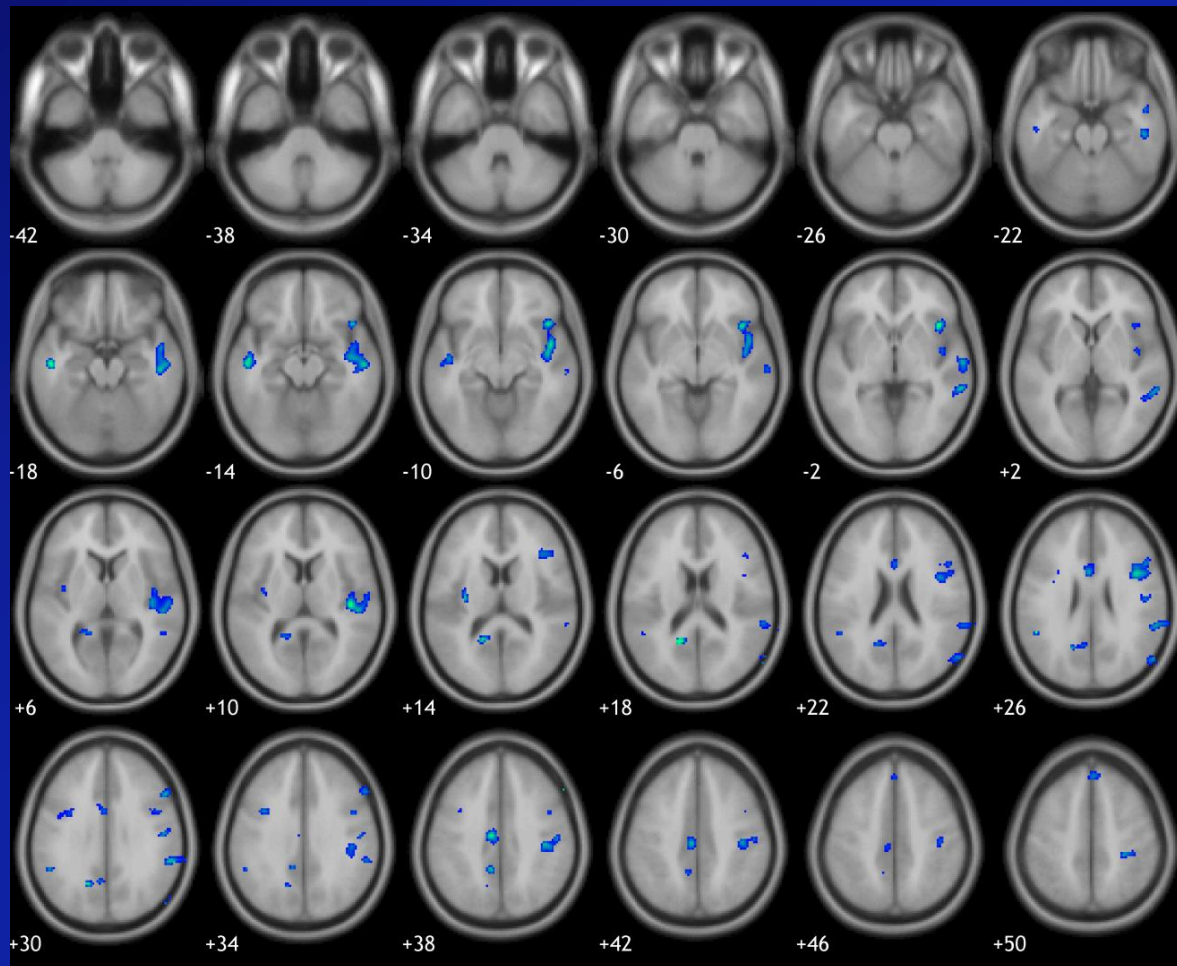
Grossman et al, Brain Lang, 2002

Hearing Loss & Healthy Aging

Common Cause or *Modifiable Risk Factor*



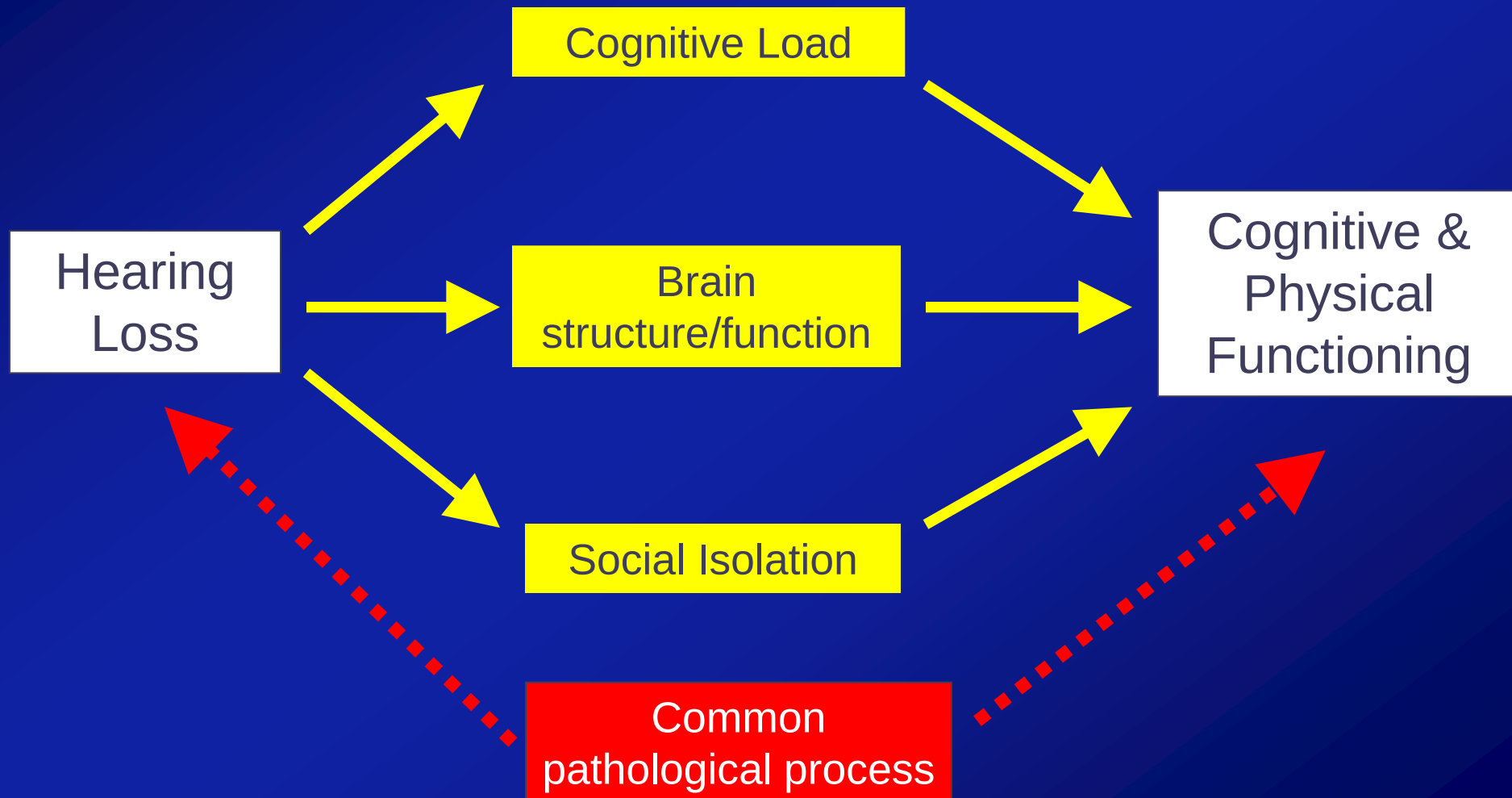
Individuals with hearing loss have accelerated rates of atrophy in the temporal lobe

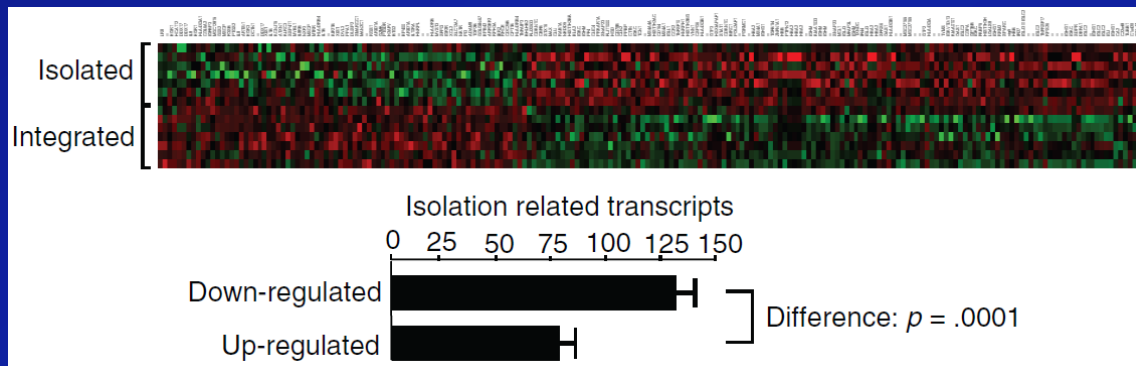
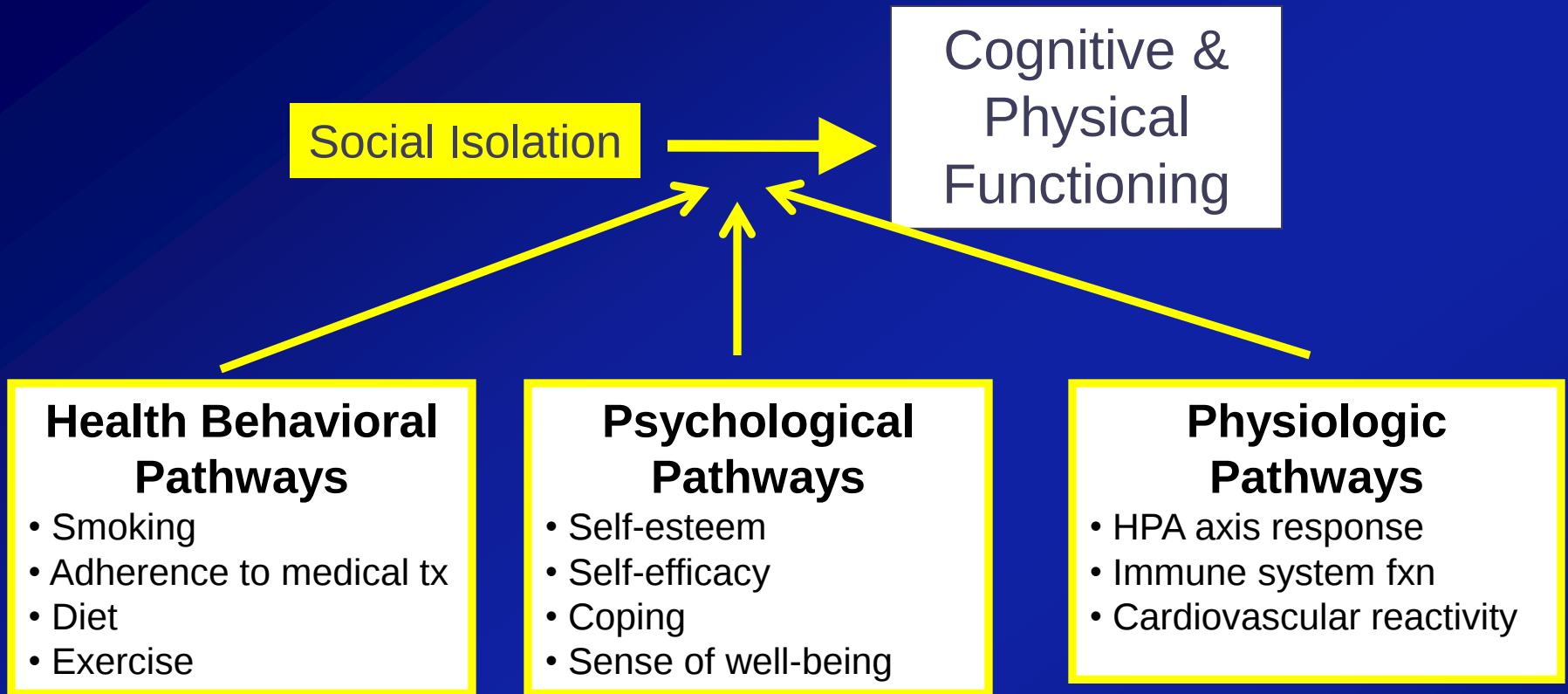


Faster decline in
brain volume in
HL vs. NH

Hearing Loss & Healthy Aging

Common Cause or Modifiable Risk Factor

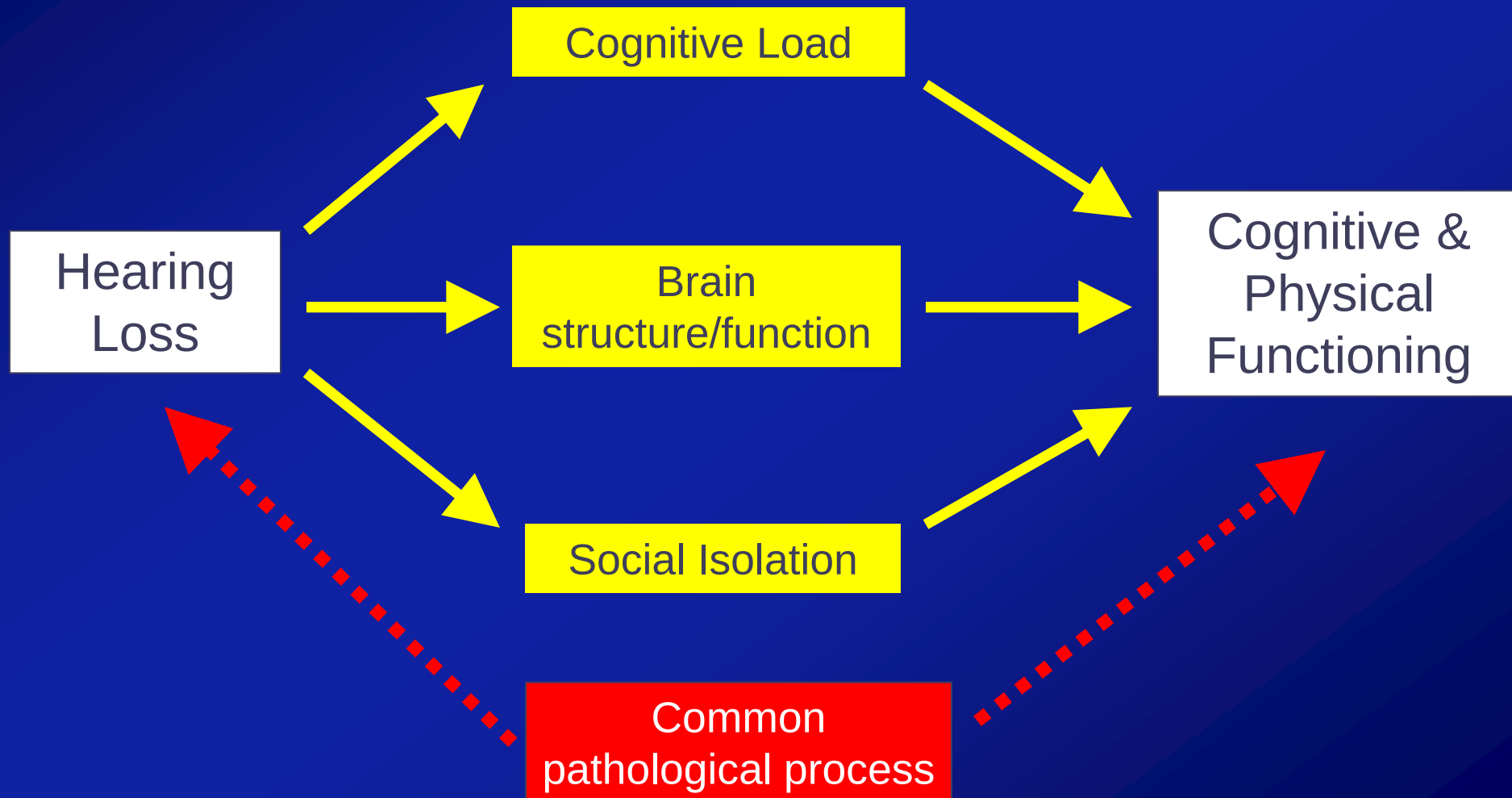




Social isolation is associated with upregulation of pro-inflammatory genes & increased inflammation

Hearing Loss & Healthy Aging

Common Cause or Modifiable Risk Factor



Cognitive Vitality
& Avoiding Dementia

Avoiding Injury

Maintaining Physical
Mobility & Activity

Healthy Aging

Keeping Socially
Engaged & Active

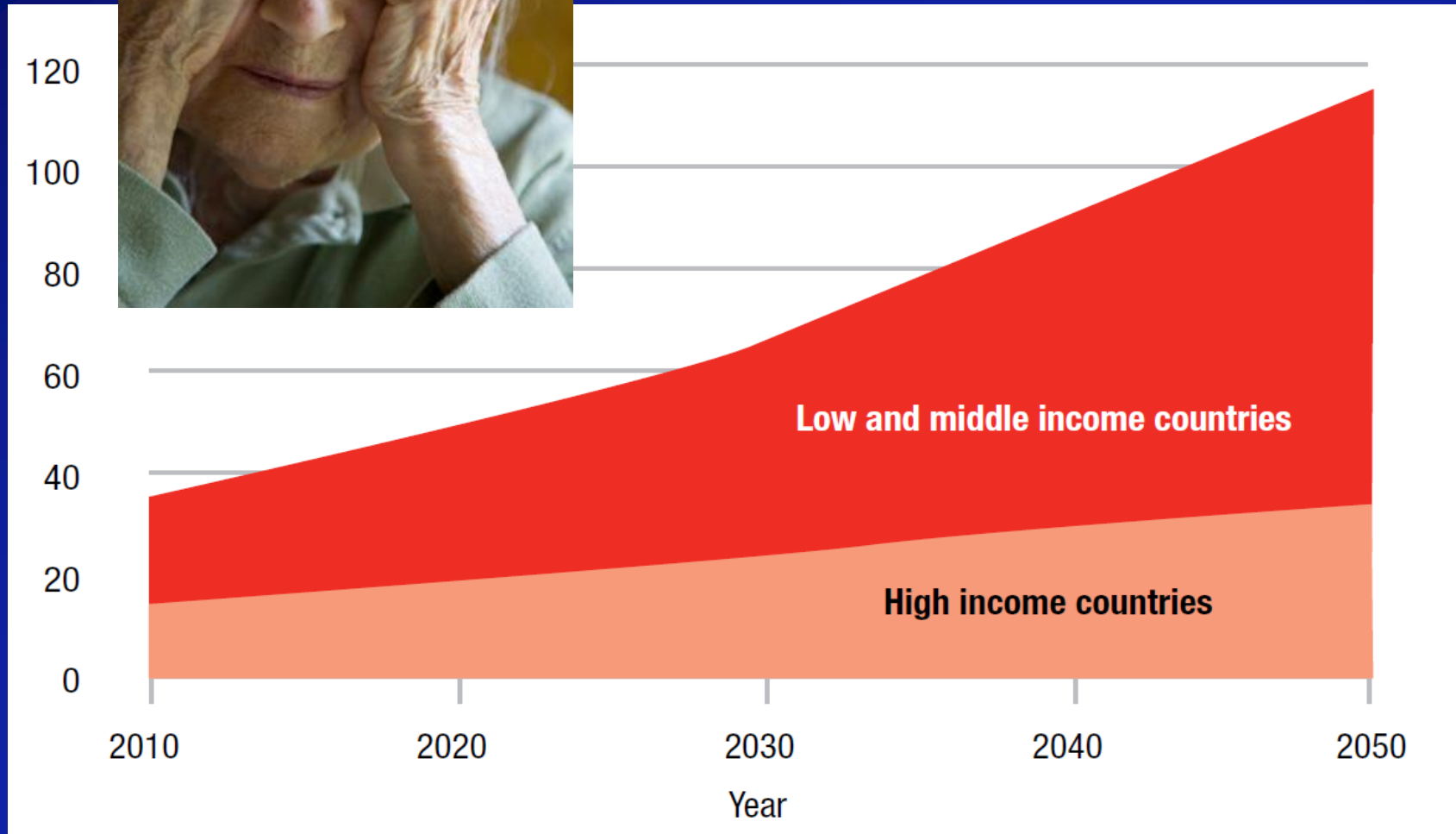
Health Economic
Outcomes/Mortality

Hearing Loss





Projected Worldwide Prevalence of Dementia 2010-2050



Hearing Loss & Cognition

Background

– Memory

- Free and cued selective reminding test (FCSRT)

– Executive Function

- Trail Making B
- Stroop Mixed
- Digit symbol substitution

These tests are
not dependent
on hearing.

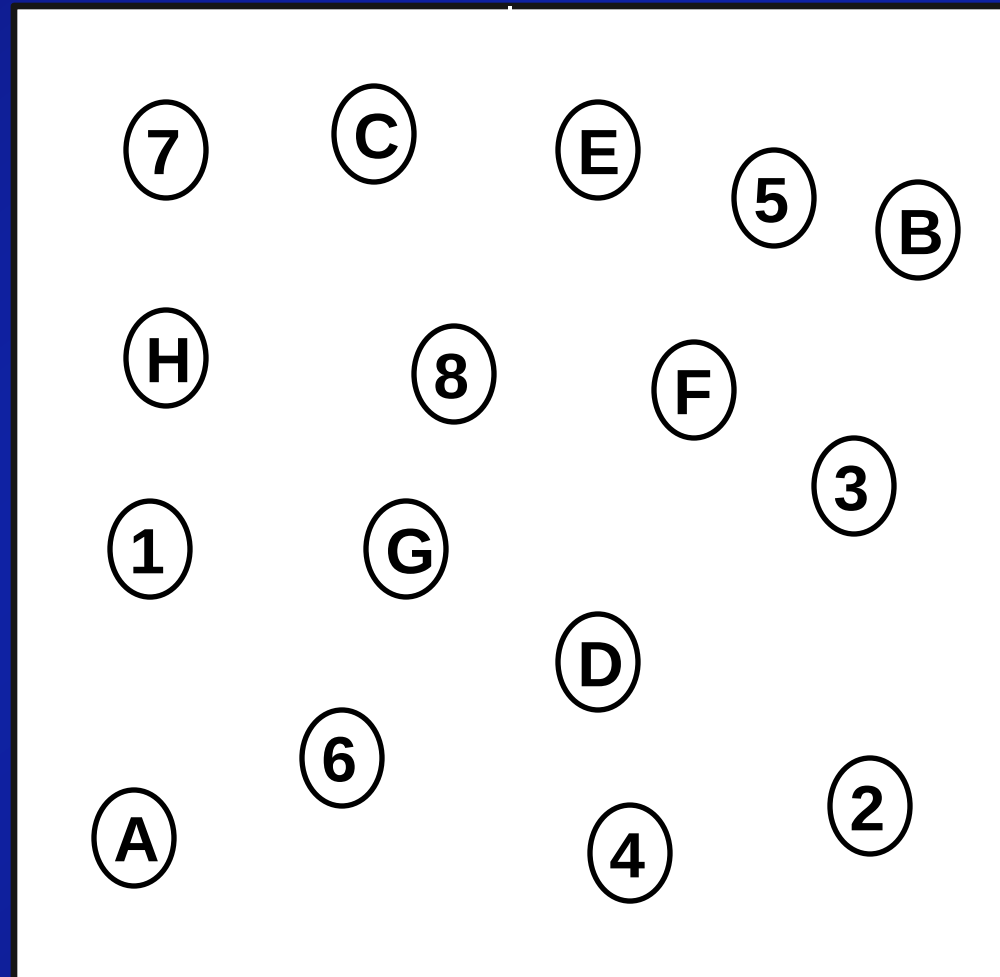
– Psychomotor/processing speed

– Verbal function & language

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

1	2	3	4	5	6	7	8	9
V	⊂	÷	∧	X	⊥	⊆	⊄	⊂

[illegible][illegible][illegible][illegible]

Hearing Loss & Cognition/Dementia

Datasets for Epidemiologic Analyses

- **NHANES**: National Health and Nutritional Examination Surveys
 - Cross-sectional, representative sample of U.S. population
- **BLSA**: Baltimore Longitudinal Study of Aging
 - Ongoing prospective study of older adults since 1958
- **HealthABC**: Health, Aging, & Body Composition Study
 - Prospective, population-based study of ~3000 adults 70 years and older

Hearing Loss and Cognition

Cross-Sectional Studies

NHANES N = 605 adults 60-69 years

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

	β^a (95% CI)	Age (per year) <i>P</i>	Hearing loss (per 25 dB) β^b (95% CI)	<i>P</i>	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

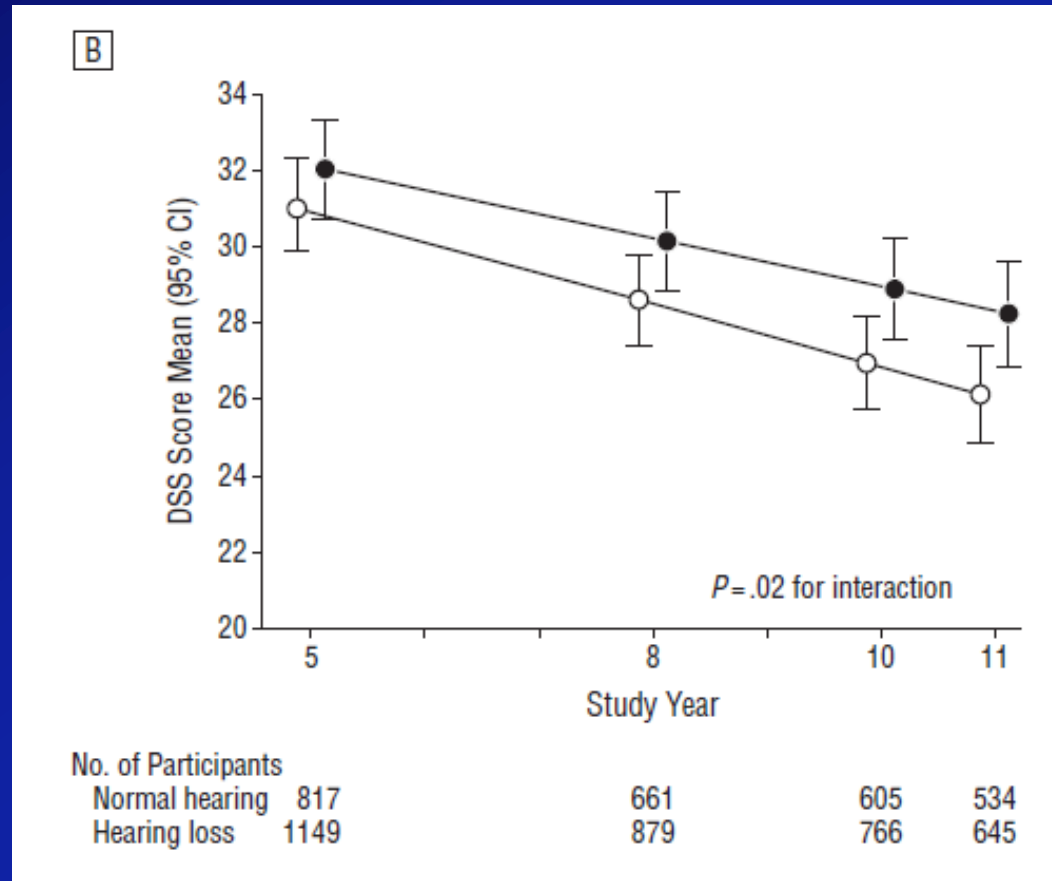
Lin et al., Neuropsych., 2011

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	-0.00074 (-0.0015 – 2.74x10 ⁻⁶)	.05	6.7

Models adjusted for age, sex, race, education, diabetes, smoking, hypertension

HealthABC

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



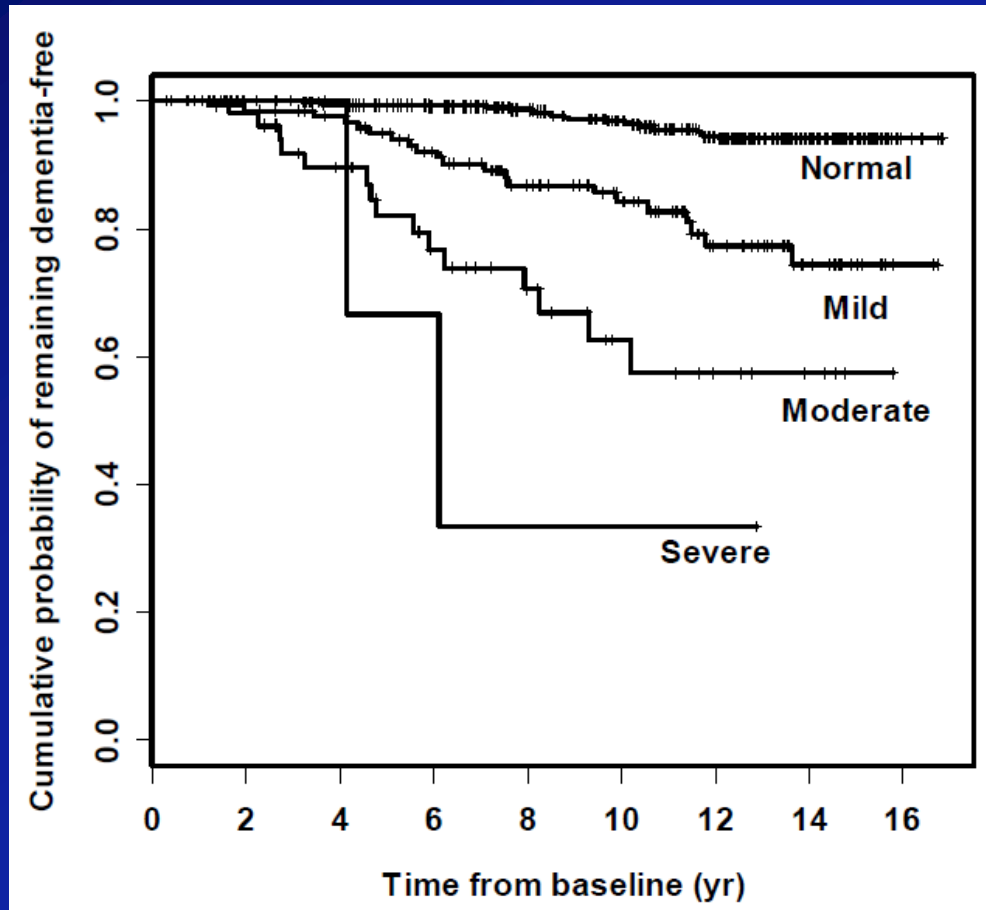
**42% faster rate
of cognitive
decline in **DSS**
scores in HL
vs. NH**

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

	<u>HR</u>	<u>95% CI</u>	<u>p</u>
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

Cognitive Vitality
& Avoiding Dementia

Avoiding Injury

Maintaining Physical
Mobility & Activity

Healthy Aging

Keeping Socially
Engaged & Active

Health Economic
Outcomes/Mortality

Avoiding injury

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

Physical mobility

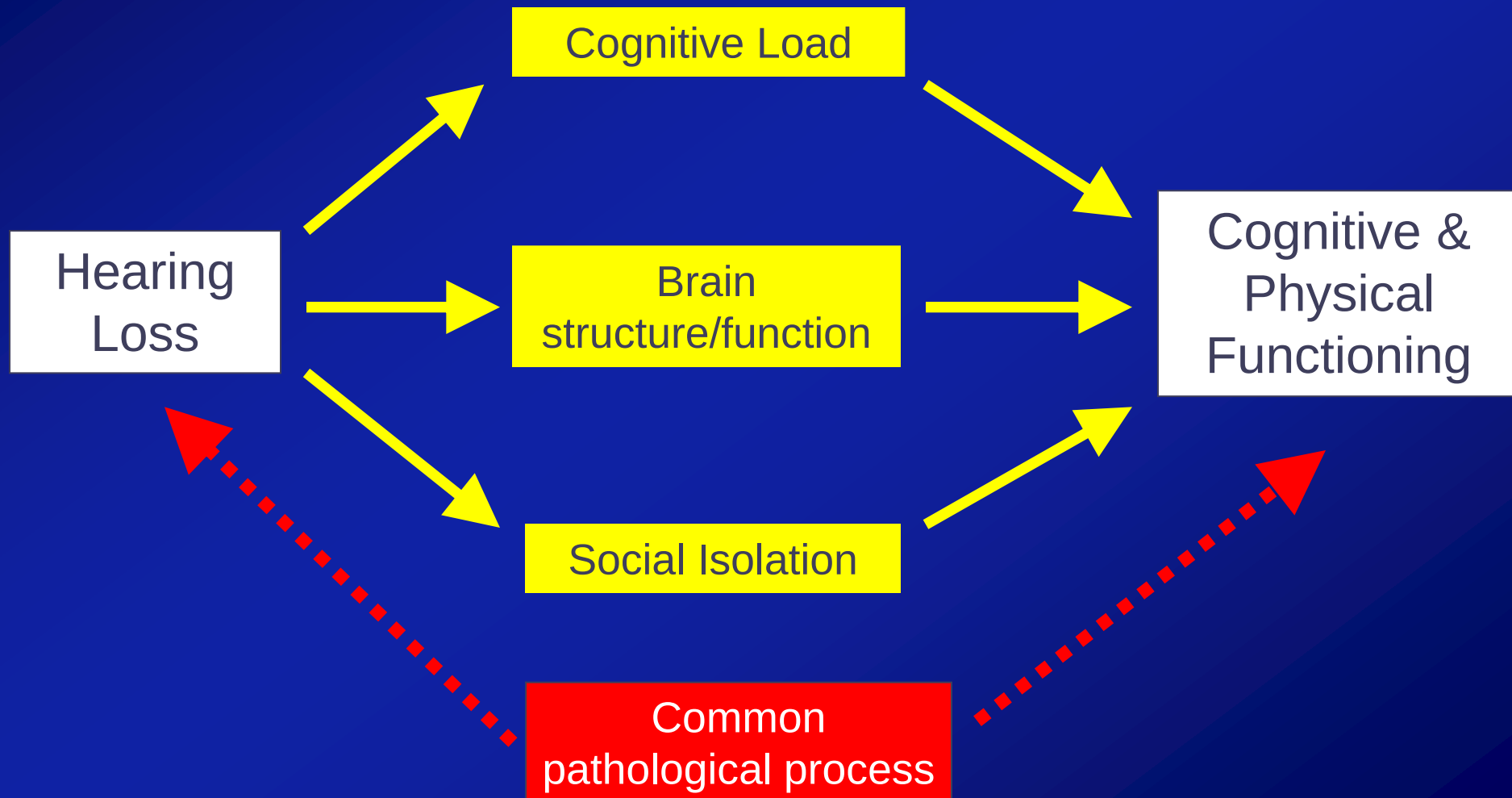
- Reduced walking speed (Viljanen et al. JAGS 2009; Li et al., Gait & Posture 2012)
- Accelerated decline in physical functioning (Wallhagen et al JAGS 2001; Bess et al. JAGS 1989; Chen et. al. In prep)
- Driving ability (Hickson et al. JAGS 2009)

Health economic outcomes/mortality

- Increased odds of hospitalization (Genther et al, JAMA, 2013)
- Increased mortality (Karpa et al Ann Epi 2010; Genther et al, Under review)

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



Studying Multiple
Outcomes after
Aural Rehabilitative
Treatment Study I



Current/Future Studies on Impact of Treating Hearing Loss

- SMART: Ongoing observational pre/post study studying effects of HA/CI on:
 - Neurocognitive function
 - Social engagement
 - Salivary/hair cortisol
 - Physical performance battery (balance, gait)

Conceptual Model for HL-Cognition RCT

In collaboration with Marilyn Albert, Joe Coresh, Richey Sharrett, ARIC Study Team, and U. South Florida

Intervention

**Proximal/Mediating
Outcomes**

**Primary
Outcome**

**Secondary
Outcomes**

**Best-Practices
Hearing
Rehabilitative
Treatment**

**Audibility of speech
& environmental
sounds**

**Enhanced Verbal
Communication &
Social Engagement**

**Cognitive
Functioning**

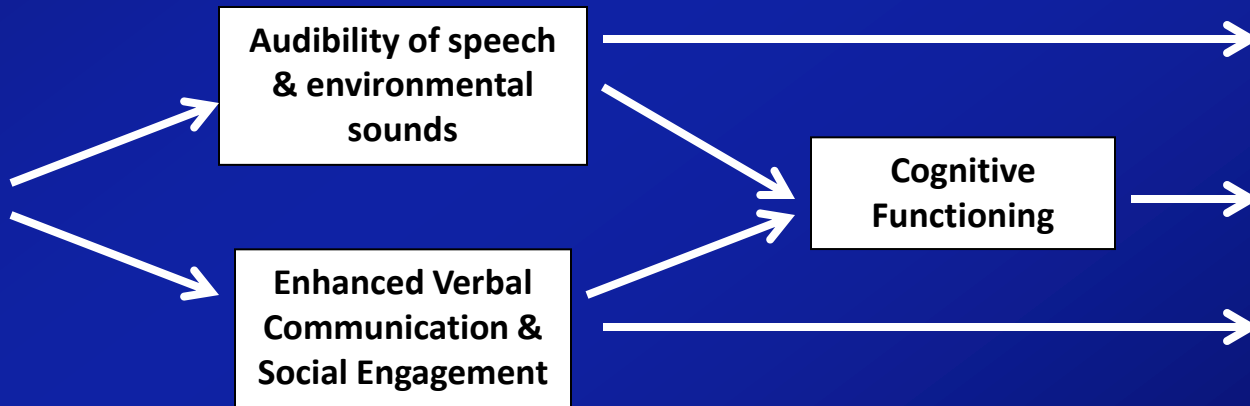
HRQL

**Social/Leisure
Activities**

**Daily
Functioning**

Mobility

**Brain structure
(MRI)**



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?**

How can ARHL be effectively addressed in the community?

Future Trends

- Understand & approach hearing loss in the context of healthy aging
 - Jan 2014 Institute of Medicine Workshop in the U.S.
- Hearing industry development
 - More accessible & affordable HA's
 - Open wireless standards

Accessible & Affordable Hearing Aids

Current (and only) model of hearing healthcare:

- Repeat visits with audiologist for evaluation, counseling & fitting
- Real-ear verification of audibility of HA output
- Cost: \$2000-\$6000

→ Not readily accessible/convenient for many adults

In-situ approach with self-fit HA

- Measurement of hearing thresholds with open fit hearing aids
- Output calibrated on the same coupler & accounts for all individual ear characteristics
- Cost \$100-300

→ Audiologically-sound “middle of the road” approach



BLUETOOTH SERIES

CS10

PERSONAL SOUND AMPLIFIER



GET BACK IN THE CONVERSATION™

CS10 Features

Each CS10 Personal Sound Amplifier features Bluetooth connectivity, Customizer App for use with Android® smartphones, our Clarity Control proprietary sound quality algorithm, and a comfortable customizable fit. Learn more:

Bluetooth



Customizer App



Clarity Control



Personal Fit



Buy Now

The CS10 is now available for purchase in our online store. [Shop >](#)



CS10
Personal Sound
Amplifier **\$299.99**

Resources

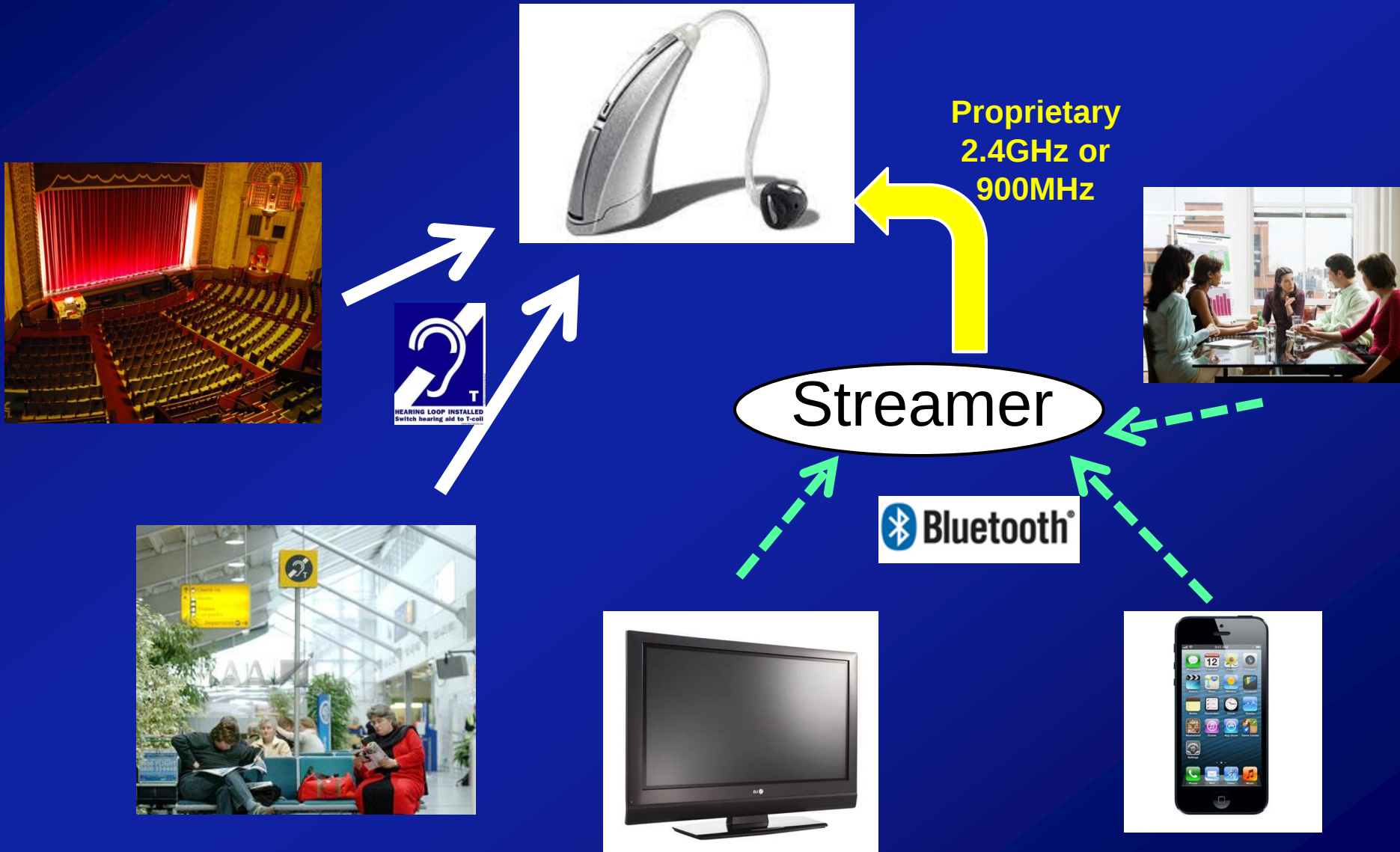
- > [Quick Start Guide](#)
- > [User Guide](#)
- > [Included Accessories](#)



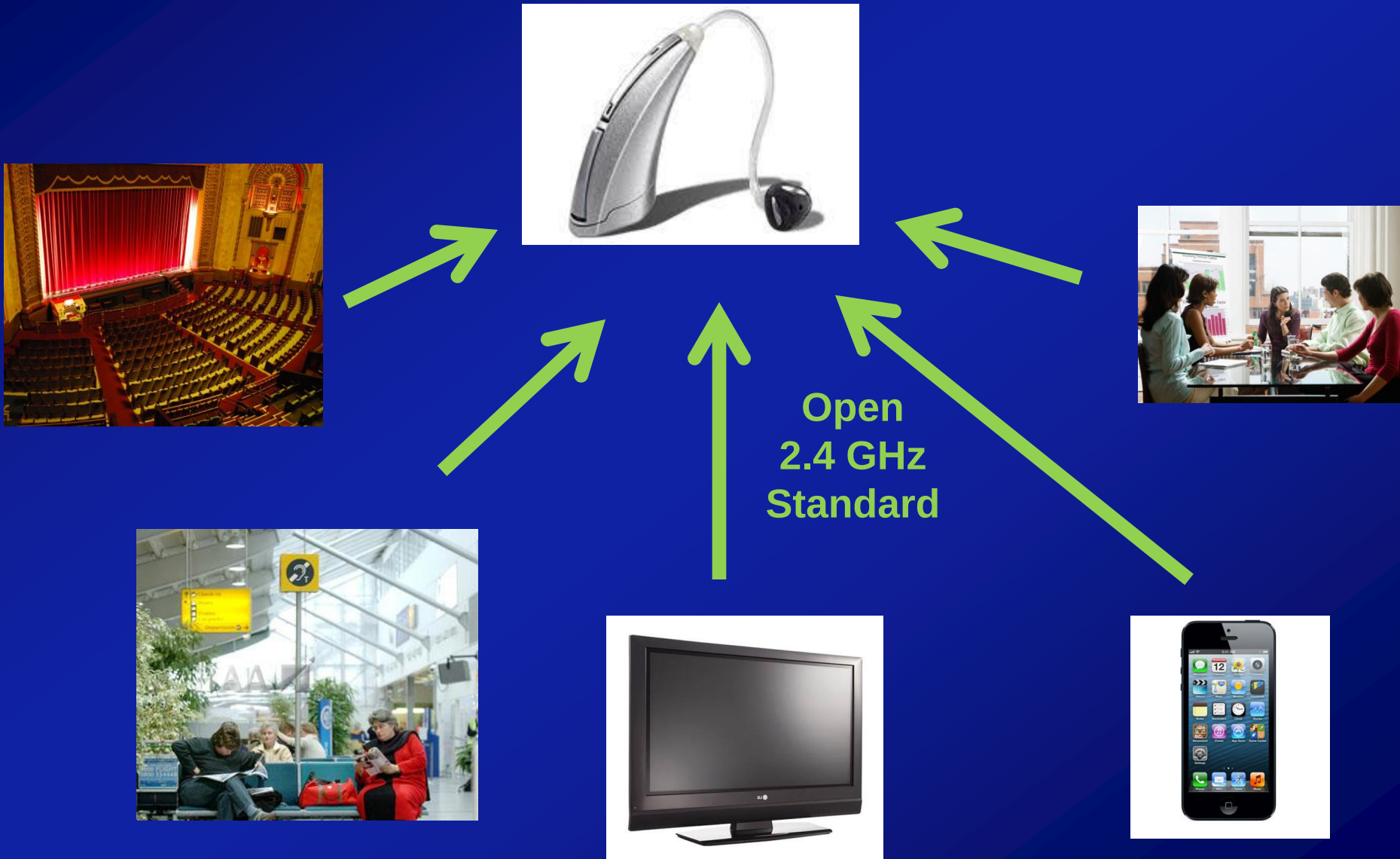
Open Wireless Standards

- 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, *not* Bluetooth)

Wireless – Current State



Wireless– Open Standards Are Needed



How can ARHL be effectively addressed in the community?

Future Trends

- Understand & approach hearing loss in the context of healthy aging
- Hearing industry development
 - More accessible & affordable HA's
 - Open wireless standards
- Pharmacologic approaches

Pharmacologic Approaches to ARHL

General strategies:

- Neuropreventative
- Neurorestorative
- Symptomatic treatment

Completed Pfizer Phase 1b study:

- “A Study Of The Effects Of PF-04958242 In Subjects With Age-Related Hearing Loss” (ClinicalTrials.gov identifier: NCT01518920)

Pharmaceutical Companies Actively Pursuing Programs in ARHL Treatment



How can ARHL be effectively addressed in the community?

Future Trends

- Understand & approach hearing loss in the context of healthy aging
- Hearing industry development
 - More accessible & affordable HA's
 - Open wireless standards
- Pharmacologic approaches
- Earlier intervention for older adults



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

sequences of hearing

Impact 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?

Additional Reading Including Patient Handouts

www.linresearch.org

flin1@jhmi.edu

Acknowledgments

- Johns Hopkins
 - Dane Genther
 - David Chen
 - Caitlin Blake
 - George Rebok
 - John Niparko
 - Marilyn Albert
 - Josh Betz
 - Qian-Li Xue
- BLSA
 - Luigi Ferrucci
 - Susan Resnick
 - Jeff Metter
 - Yang An
 - Josh Goh
- HealthABC
 - Tamara Harris
 - Eleanor Simonsick
 - Kristine Yaffe
- NIDCD K23DC011279
- Triological Society & American College of Surgeons Clinician Scientist Award
- Eleanor Schwartz Charitable Foundation
- NIA Pepper OAIC Career Development Award
- NIA Intramural Research Program