Hearing Loss & Aging – A Public Health Perspective

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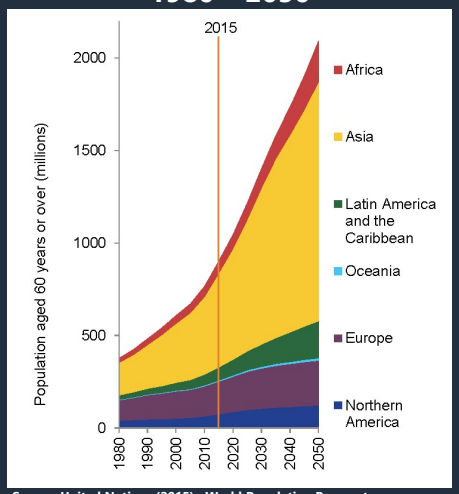
Hearing Loss & Public Health

Rationale

Population Ages 60+ by Region
1980 – 2050



Source: United Nations (2015). World Population Prospects

Eras of Public Health

1st – Infectious diseases (early 20th cent.)

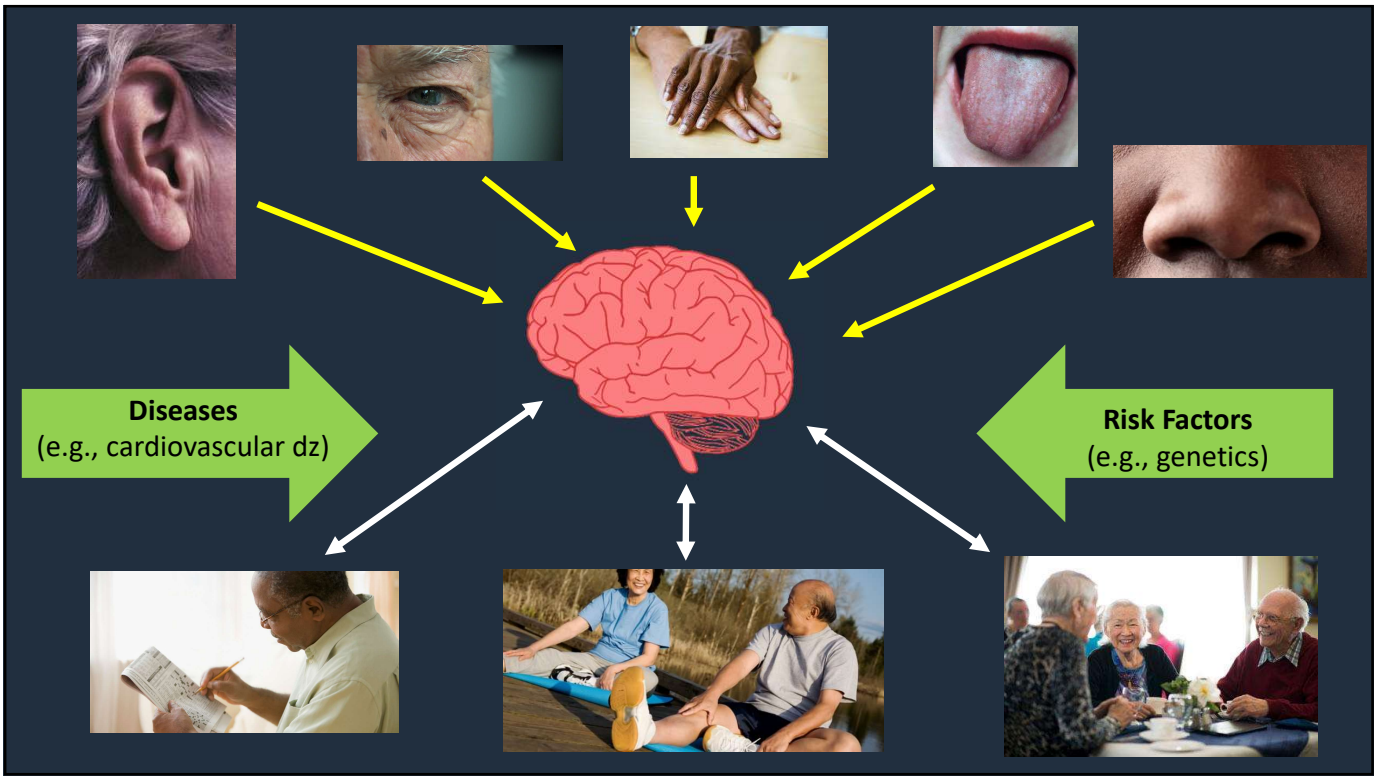
2nd – Chronic diseases (mid 20th cent. – now)

3rd – Aging processes (21st cent. & on)

Fries JF, 1982; Deaton A, 2013

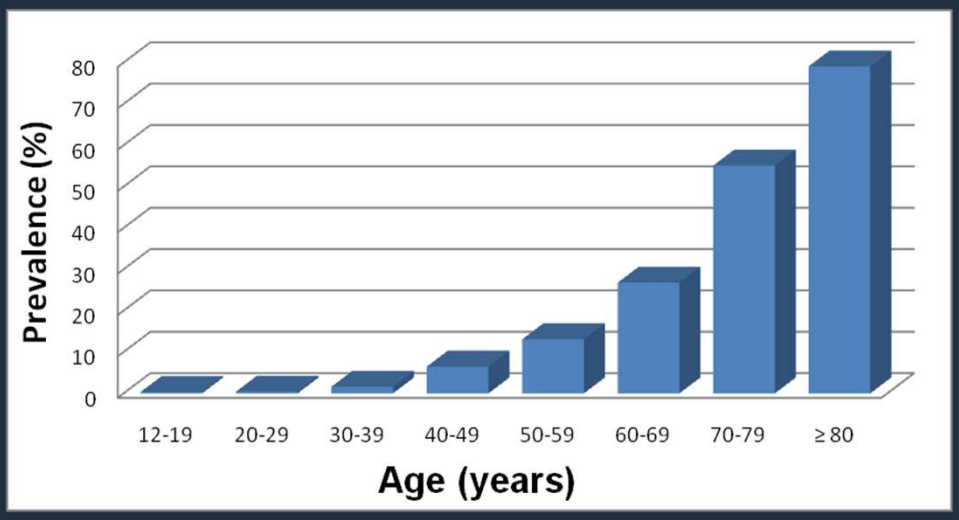
What health & policy strategies are needed for optimal/healthy aging?

- Prevention/delay of disease → Compression of morbidity
- Effective treatment of disease→ Managing multimorbidity
- Lifestyle factors → Diet, physical activity, social engagement, etc.
- Biological processes underlying aging → future drugs?
- **Optimizing sensory function?**



Prevalence of Hearing Loss by Age Decade

Our ability to hear & engage with the people & environment around us is fundamental to our health & well-being



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

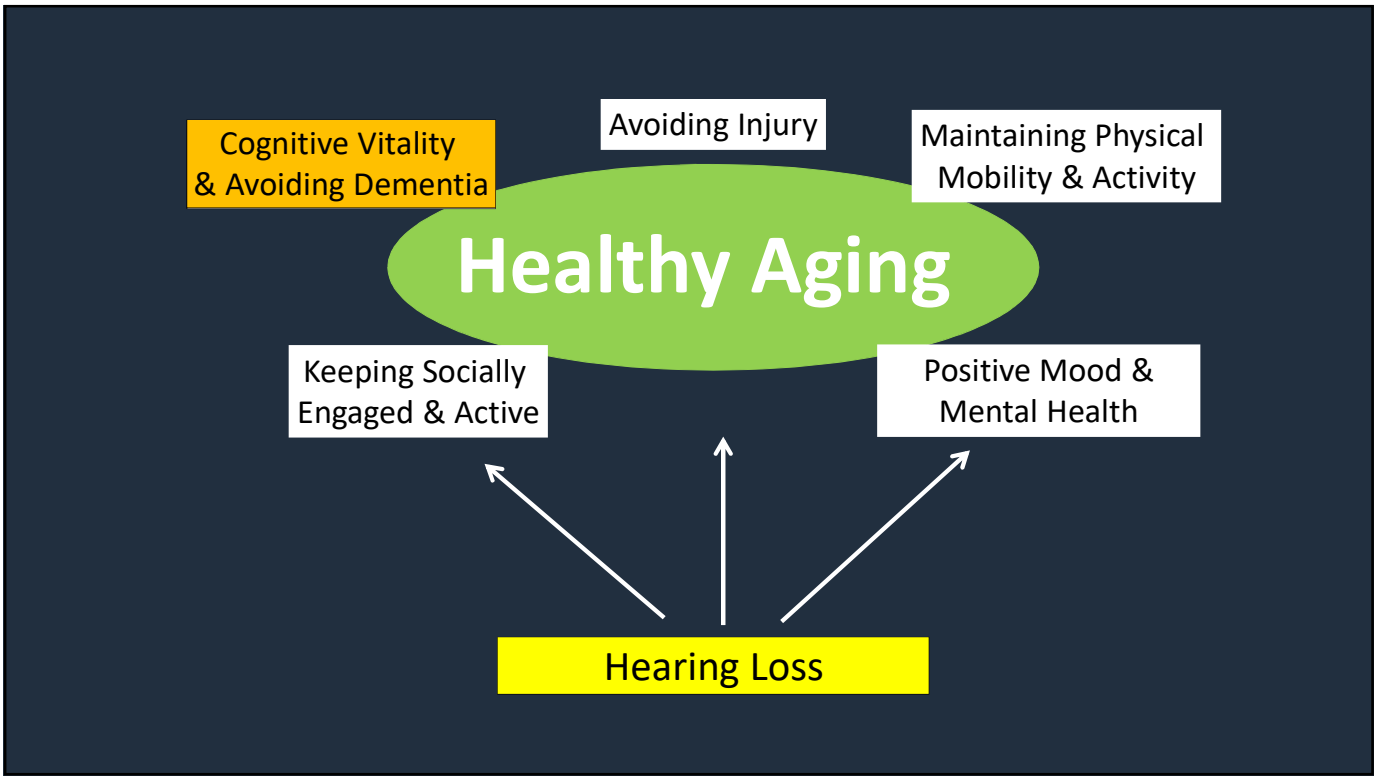
Lin et al., Arch Int Med. 2011

Hearing Loss & Aging

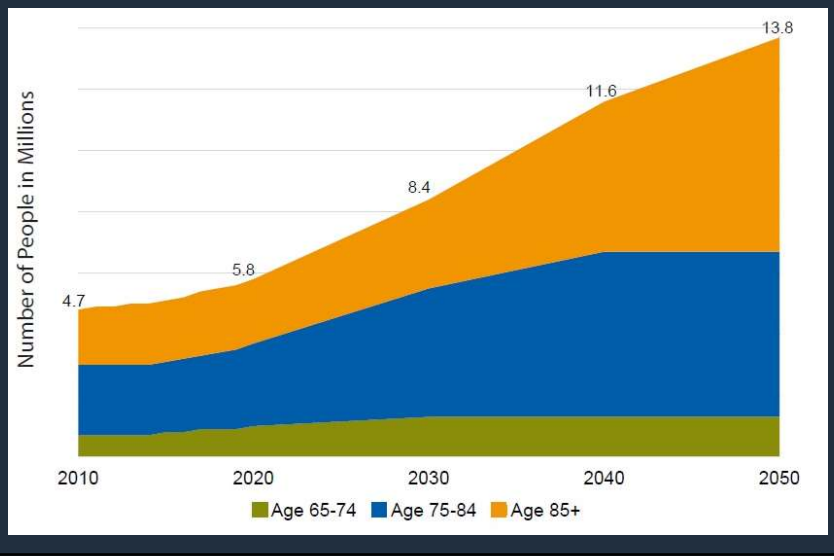
Basic Questions from the Perspective of Public Health

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


Healthy Aging


Cognitive Vitality & Avoiding Dementia
Avoiding Injury
Maintaining Physical Mobility & Activity
Healthy Aging
Keeping Socially Engaged & Active
Positive Mood & Mental Health
Hearing Loss

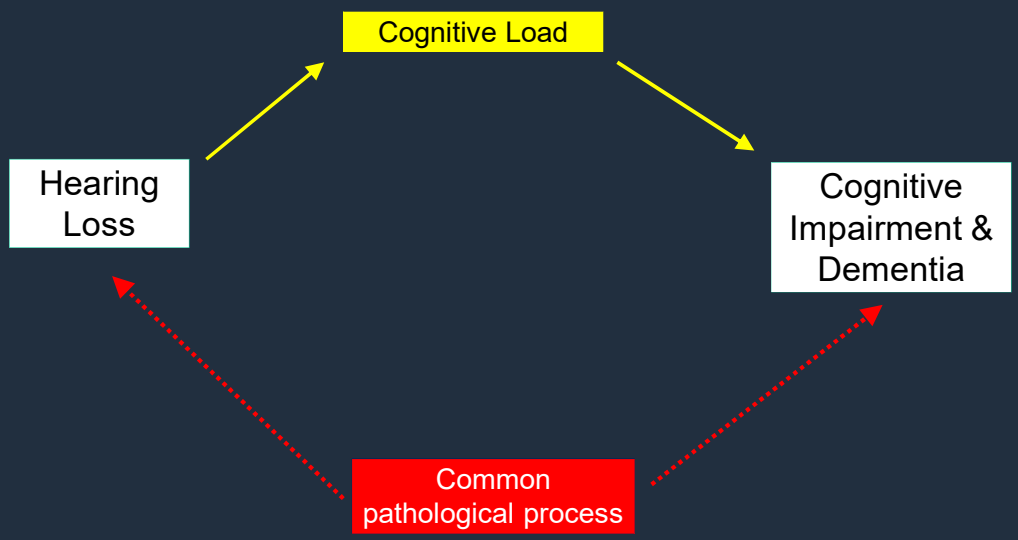
Projected Number of People 65+ with Alzheimer's Disease by Age Group, U.S. 2010-2050



Neurology 2013;80(19):1778-83

Hearing Loss & Cognition

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

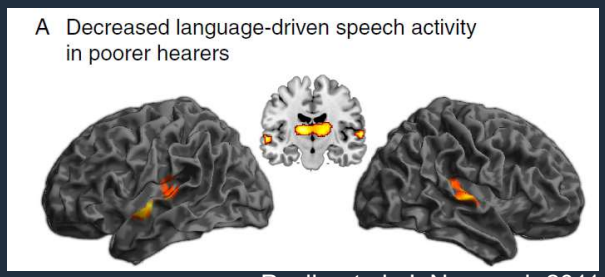
Auditory Perceptual Processing Requirements	**Available Cognitive Resources For Performance of Tasks**	Age-Related Decline

Hearing Loss & Cognitive Load

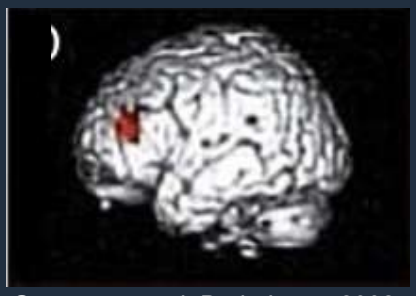
Poorer hearing is associated with:

A. Reduced language-driven activity in primary auditory pathways

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



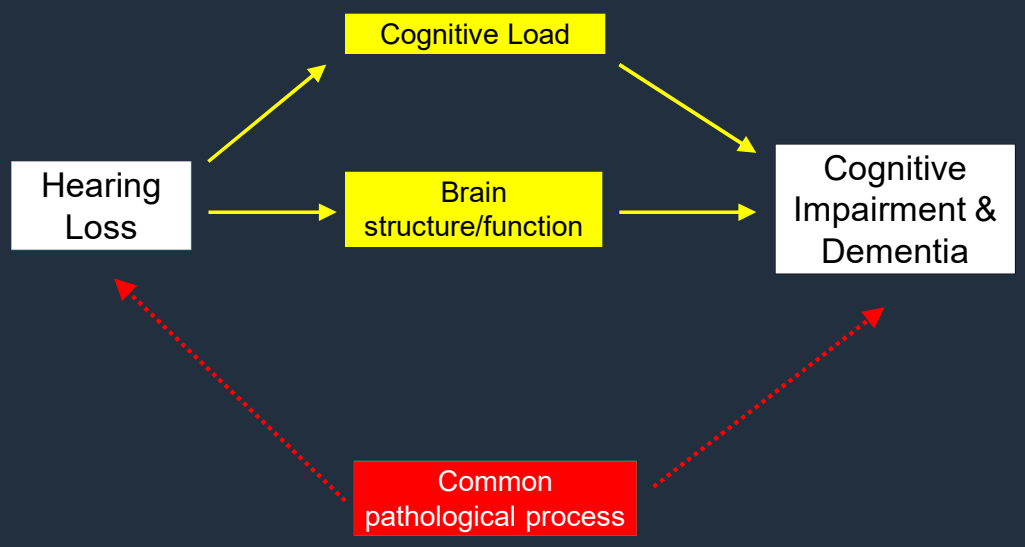
Peelle et al, J. Neurosci, 2011



Grossman et al, Brain Lang, 2002

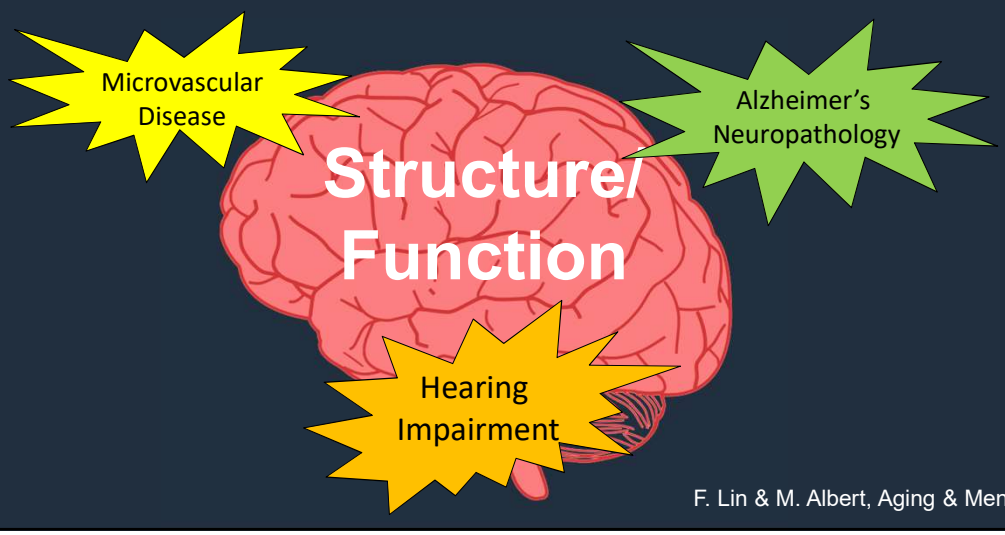
Hearing Loss & Cognition

Common Cause or Modifiable Risk Factor



Multiple Hit Theoretical Model of Risk Factors for Brain Aging/Injury

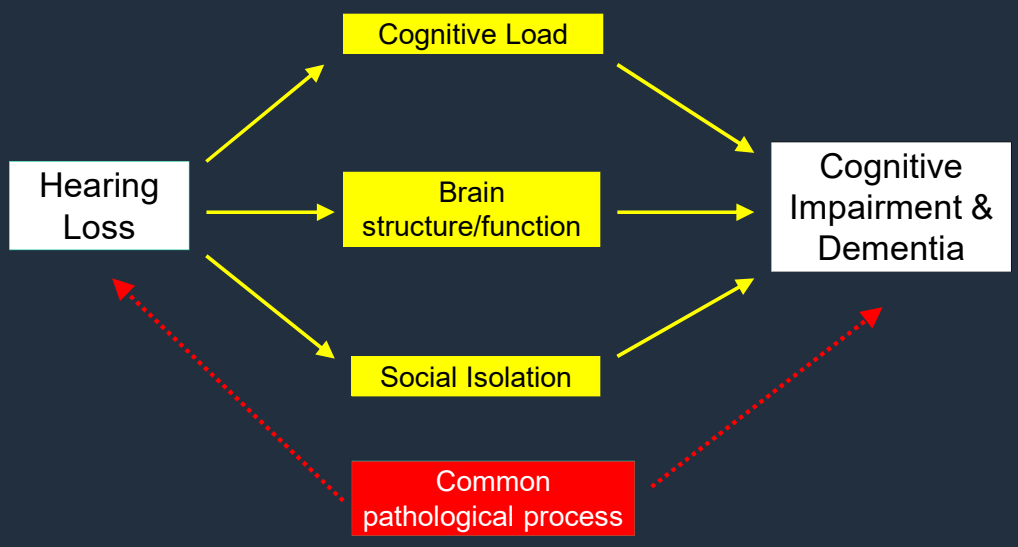
Hearing Loss & Brain Structure/Function

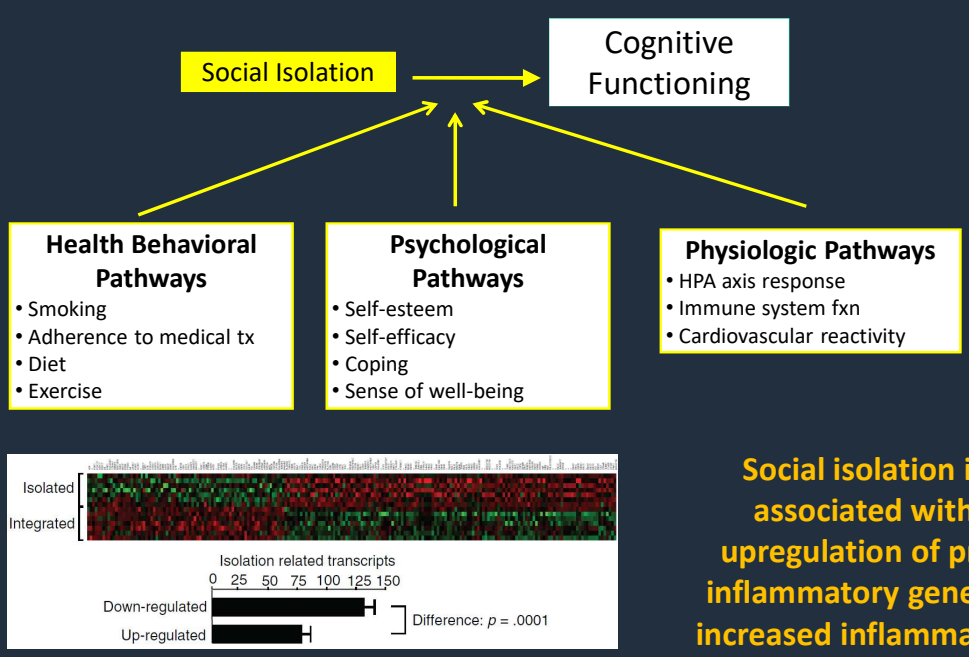


F. Lin & M. Albert, Aging & Mental Health, 2014

Hearing Loss & Cognition

Common Cause or Modifiable Risk Factor



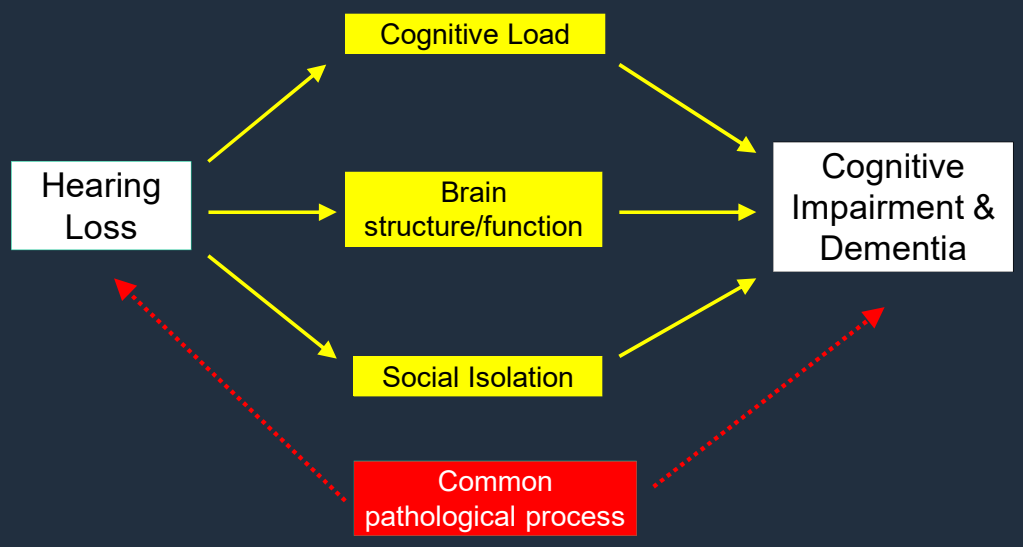


Social isolation is associated with upregulation of pro-inflammatory genes & increased inflammation

Cole & Cacioppo, Genome Biology, 2007
Cole & Cacioppo, PNAS, 2011

Hearing Loss & Cognition

Common Cause or Modifiable Risk Factor



Studying Hearing Loss & Cognition

Role of Epidemiology (rather than clinical research)

- **NHANES**: National Health and Nutritional Examination Surveys
  - Cross-sectional, representative sample of U.S. population (~3000-4000)
- **BLSA**: Baltimore Longitudinal Study of Aging at the NIH
  - Ongoing prospective study of >1000 older adults since 1958
- **HealthABC**: Health, Aging, & Body Composition Study
  - Prospective, population-based study of ~3000 adults 70 years and older
- **ARIC**: Atherosclerosis Risk in Communities Study
  - Prospective, population-based study of ~16,000 adults followed since 1977

Hearing Loss & Cognition

Background

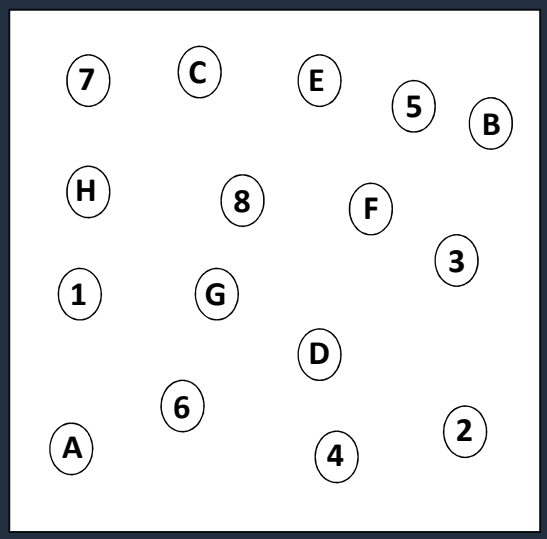
- **Memory**
  - Free and cued selective reminding test (FCSRT)
- **Executive Function**
  - Trail Making B
  - Stroop Mixed
  - Digit symbol substitution
- **Psychomotor/processing speed**
- **Verbal function & language**

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

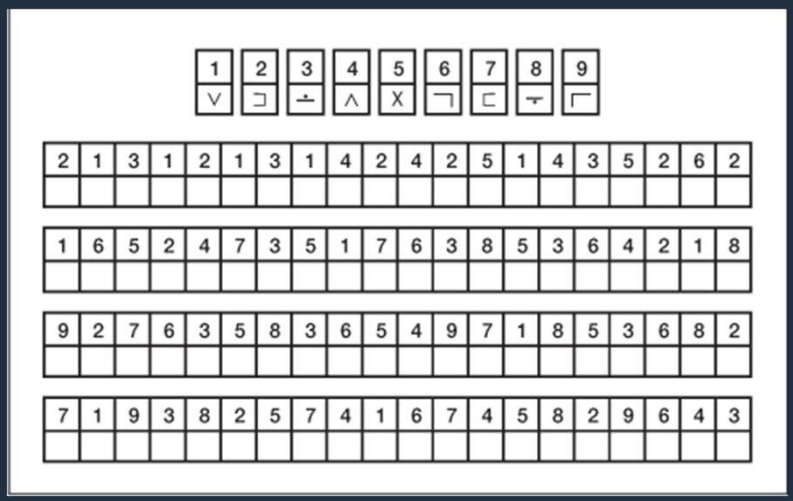
Stroop Mixed

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

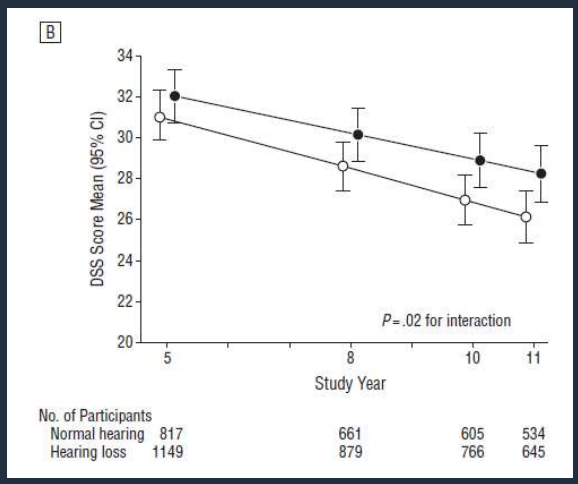
Stroop Mixed	-0.33 (-0.48 – -0.18)	<.001	-2.27 (-4.14 – -0.40)	.02	6.8
Trail Making B	-0.00011 (-0.00018 – -0.000044)	.001	-.00074 (-0.0015 – 2.74×10^{-6})	.05	6.7

Models adjusted for age, sex, race, education, 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



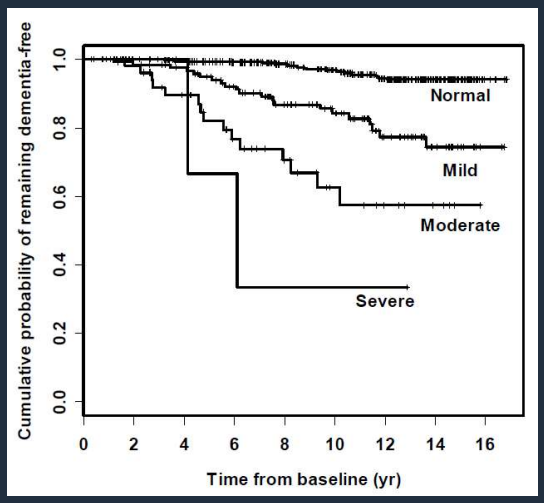
42% faster rate of cognitive decline in 3MS scores in HL vs. NH

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 Baltimore Longitudinal Study of Aging



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 & Incident Dementia

Dementia Incidence in 1057 Men Followed for 17 years in the Caerphilly Prospective Study (U.K.)

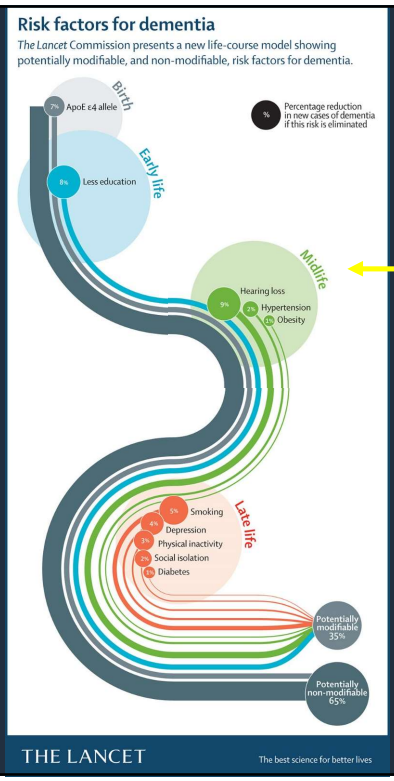
Cognitive impairment	Model 1: adjusted for age, OR[a] (95% CI), *p* value	Model 2: adjusted for age, social class, anxiety, OR[a] (95% CI), *p* value	Model 3: adjusted for age, social class, anxiety, premorbid intelligence, OR[a] (95% CI), *p* value
All dementia (n = 79)	4.07 (2.21-7.50), <0.001	3.26 (1.71-6.21), <0.001	2.67 (1.38-5.18), 0.004
Vascular dementia (n = 38)	3.83 (1.69-8.65), 0.001	2.93 (1.24-6.94), 0.015	2.40 (0.99-5.83), 0.05
Nonvascular dementia (n = 41)	4.20 (1.84-9.55), 0.001	3.58 (1.50-8.51), 0.004	2.96 (1.21-7.22), 0.017
CIND (n = 146)	2.32 (1.50-3.59), <0.001	1.72 (1.09-2.74), 0.021	1.24 (0.77-2.01), 0.38
All dementia (n = 46), omitting men with evidence of early cognitive decline	2.23 (1.04-4.77), 0.039	1.64 (0.72-3.73), 0.24	1.32 (0.57-3.12), 0.52

Abbreviations: CI = confidence interval; CIND = cognitive impairment no dementia; OR = odds ratio; PTA = pure-tone average (threshold).
[a] Odds ratio is the effect per 10-dB_A rise in usual PTA.

Neurology 79 October 9, 2012

J. Gallacher et al., Neurology, 2012

Lancet Commission on Dementia Prevention, Intervention & Care



Hearing loss in mid & late life identified as the single modifiable risk factor for dementia with the greatest population attributable fraction of risk

G. Livingston et al., Lancet, 2017

Healthy Aging

Avoiding Injury

Cognitive Vitality & Avoiding Dementia

Maintaining Physical Mobility & Activity

Keeping Socially Engaged & Active

Health Resource Utilization/Mortality

Epidemiological Studies of Hearing & Aging Outcomes

Cognition/Dementia/Brain Aging

J Gerontol A Biol Sci Med Sci. 2016 Apr 12.
Am J Epidemiol. 2015 May 1;181(9):680-90.
Aging Ment Health. 2014;18(6):671-3.
Neuroimage. 2014 Apr 15;90:84-92.
JAMA Intern Med. 2013 Feb 25;173(4):293-9.
Neuropsychology. 2011 Nov;25(6):763-70.
Gerontol A Biol Sci Med Sci. 2011 Oct;66(10):1131-6.
Arch Neurol. 2011 Feb;68(2):214-20.

Injury/Physical Functioning

J Aging Health. 2016 Aug;28(5):890-910.
J Aging Health. 2016 Jun;28(4):644-60.
J Am Geriatr Soc. 2016 Apr;64(4):906-8.
J Gerontol A Biol Sci Med Sci. 2015 May;70(5):654-61.
J Am Geriatr Soc. 2014 Aug;62(8):1427-33.
J Am Geriatr Soc. 2014 Jun;62(6):1186-8.
Am Geriatr Soc. 2014 May;62(5):850-6.
Gait Posture. 2013 May;38(1):25-9.

Health Economics/Mortality

J Aging Health. 2016 Feb;28(1):68-94.
JAMA Otolaryn Head Neck Surg. 2015 Oct;141(10):944-6.
J Am Geriatr Soc. 2015 Jun;63(6):1146-52.
J Gerontol A Biol Sci Med Sci. 2015 Jan;70(1):85-90.
J Am Geriatr Soc. 2014 Nov;62(11):2207-9.
J Am Geriatr Soc. 2014 Jun;62(6):1188-9.
JAMA. 2013 Jun 12;309(22):2322-4.

Social Engagement/Mental Health

J Aging Health. 2016 Sep;28(6):979-94.
J Gerontol B Psychol Sci Soc Sci. 2016 May;71(3):400-4.
J Aging Health. 2016 Feb 24.
Otolaryngol Head Neck Surg. 2014 Mar;150(3):378-84.
J Am Geriatr Soc. 2013 Sep;61(9):1627-9.

Hearing Loss & Aging

Basic Questions from the Perspective of Public Health

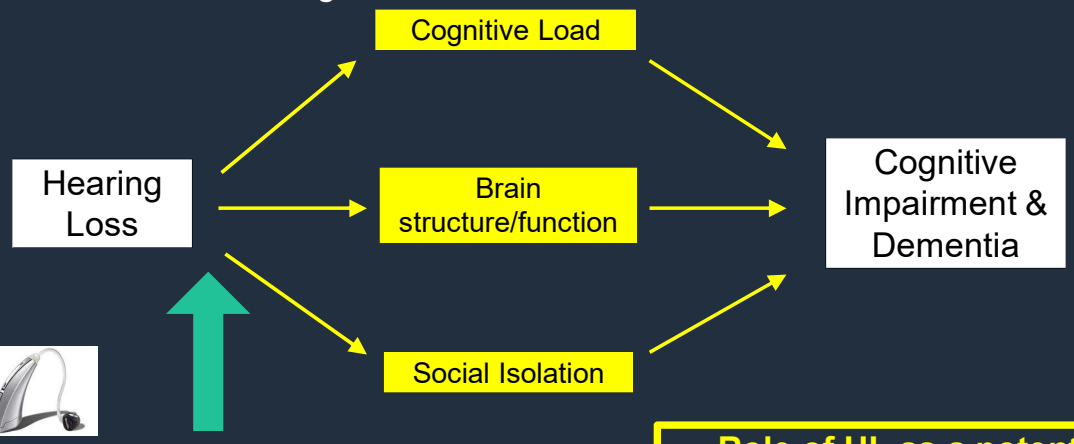
- What are the consequences of HL for older adults?
- What is the impact of treating HL on older adults?
- How can HL be effectively addressed in society?

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

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

Hearing Loss & Dementia

Hearing Loss as a Modifiable Risk Factor



Hearing loss intervention could:

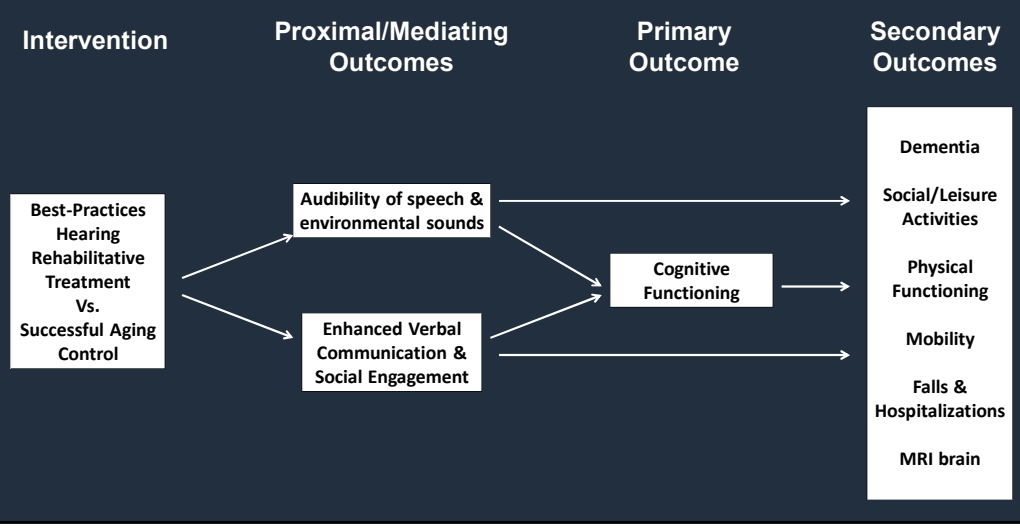
- Reduce the cognitive load of processing degraded sound
- Provide increased brain stimulation
- Improve social engagement

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

ACHIEVE
HEALTHY AGING

Aging & Cognitive Health Evaluation in Elders Randomized Trial (N = 850)

In Partnership with Joe Coresh & ARIC-NCS



ACHIEVE Trial Design

Study Sites & Inclusion Criteria

Supported by National Institutes of Health

Main study inclusion criteria:

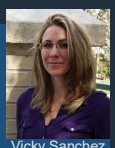
- 70-84 y.o. community-dwelling adults
- Mild-moderate hearing loss
- No cognitive impairment
- No self-reported disability in >1 ADL
- No self-reported hearing aid use in the past year

ACHIEVE Trial Design

Interventions


Terry Chisolm

Hearing Loss Intervention – Univ S. Florida


Vicky Sanchez

- Could help promote better social engagement & reduce load of hearing loss on the brain
- 4 sessions with a study audiologist to receive hearing loss education & hearing devices
- Semiannual visits thereafter for 3 years to receive booster sessions & track cognitive/physical health


Michelle Arnold

Successful Aging Education Interve – U. Pitt


Nancy Glynn

- Established program that helps promote better understanding of key health topics (nutrition, high blood pressure) important for healthy aging
- 4 sessions with a health educator to cover the 10 Keys™ program
- Semiannual visits thereafter for 3 years to receive booster sessions & track cognitive/physical health

ACHIEVE Trial Design

Outcomes & Analysis

- Baseline & semiannual visits for intervention delivery & outcome assessments
- Primary outcome – Global & domain-specific cognitive function
  - Comprehensive neurocog battery including tests of memory, executive function, etc.
  - Verification of speech understanding/audibility is confirmed before cognitive testing at all time points (with additional steps taken as needed) to ensure testing is not confounded by poor speech understanding
- Secondary outcomes
  - Adjudicated dementia/MCI diagnoses, depression, communicative & social function, physical functioning, accelerometry, falls, hospitalizations, HRQL, hearing aid data logging, brain MRI
- Analysis
  - Multiple imputation ANCOVA model of change from baseline to year 3 with adjustment for baseline cognitive factor score, baseline hearing loss, race*center, ARIC status, age, & education

ACHIEVE Trial

Timeline

- **2011- 2013**
  - Epidemiological studies establishing association of hearing loss & dementia
- **2014 - 2016**
  - Trial planning grant (NIH R34AG046548)
  - Pilot study, development of protocol/operations manual, submission of grant for full-scale trial
- **2017**
  - ACHIEVE grant funded by the NIA (R01AG055426)
- **2018 - 19** Recruitment at field sites
- **2019 - 22** Follow-up

Hearing Loss & Aging

Basic Questions from the Perspective of Public Health

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

What's the goal when seeing a patient with hearing loss?

Making sure the patient understands how a hearing aid can help them?

Ensuring hearing aid is properly programmed and fit?

Ensuring that the individual can communicate effectively in all settings

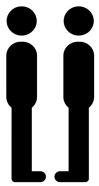
Ensuring Effective Communication

- Teaching communication strategies
- Helping the patient choose the right technologies

Communication Strategies

Communication Tip #1: Get Face to Face

Facial expressions and gestures help fill in the gaps. Turn off background noise.



Communication Tip #2: Repeat then Reword

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

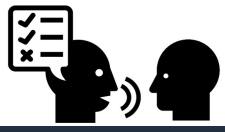
Repetition only works once.

Communication Tip #3: Summarize

Be specific about what you do and do not hear.
Summarize what you heard.

Do not say 'huh?' or 'what?'.

Say 'I heard you say something about __ but I missed ___.'



Choosing the Right Technologies

- Hearing aids – importance of remote mics/streamers
- Cochlear implants – speech discrimination <60% deserves referral
- Assistive listening devices
  - Telephone use – Skype/Facetime; Captioned phones
  - Portable body-worn amplifier

Internet-Protocol Captioned Telephone Service Telephone Use

- Captioned telephones help people with hearing loss to hear & read what their callers say
- A captioning phone sends the caller's voice to a captioning service center via the internet where words are quickly converted to text by a captioning agent using voice recognition technology
- The cost of the captioning service is covered fully for qualified individuals by a fund established under the Americans with Disabilities Act – some providers also make their equipment available at no cost to qualified individuals
- To qualify, a hearing care or healthcare professional must certify the individual has a hearing loss that requires captions to use the phone effectively

Portable Amplifiers

Super Ear SE9000

Comfort Duett

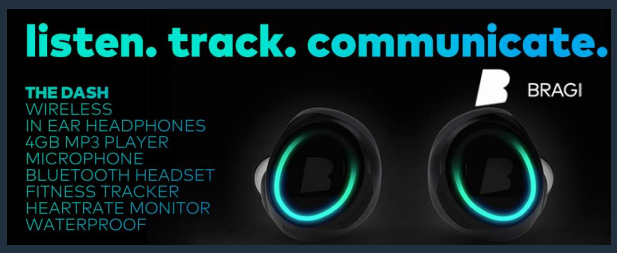
Choosing the Right Technologies

- Hearing aids – importance of remote mics/streamers
- Cochlear implants – speech discrimination <60% deserves referral
- Assistive listening devices
  - Telephone use – captioned phones
  - Portable body-worn amplifier
- Over-the-Counter Hearing Aids

Over-the-Counter Hearing Aids

- Current FDA/State regulations limit hearing aid sales only through a licensed professional
- Based on recommendations from the White House President's Council of Advisors on Science and Technology (2015) and the National Academies (2016), OTC Hearing Aid Bill passed into law in August 2017
- By August 2020, the FDA will issue regulations and performance standards for OTC hearing aids to ensure safety/effectiveness
- Regulations will allow any manufacturer meeting regulations/standard to direct sell HAs OTC to consumers

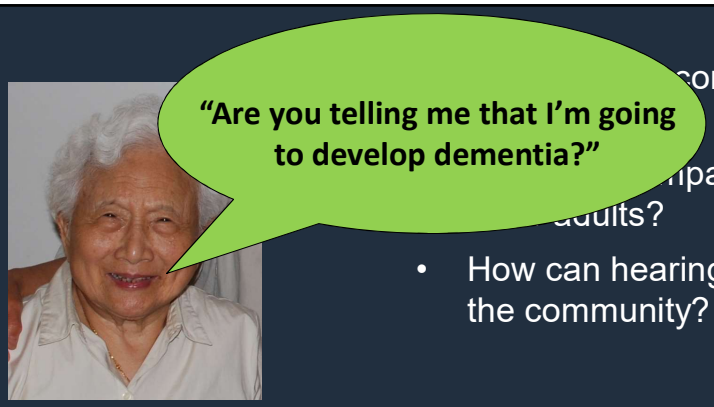
Convergence of medical devices (hearing aids) & consumer electronics ("hearables")



Ensuring our Patients Can Communicate Effectively

Summary

- Communication strategies
- Helping patients choose the right technologies
  - Hearing aids
  - Cochlear implants
  - Assistive listening devices (captioned phones, portable amplifiers)
  - Over-the-Counter Hearing Aids (2020 or sooner)



consequences of hearing loss for

npact of treating hearing loss on
adults?

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

Hypertension → Heart attack & stroke

Intervention: Medication, Lifestyle modification

Hearing loss → Cognitive decline, dementia

Intervention: Hearing loss interventions/treatments??

Thank You

flin1@jhmi.edu

www.jhsph.edu/cochlear-center