

## THE CONNECTION BETWEEN HEARING AND OVERALL HEALTH



Jack M. Scott, Ph.D.  
Senior Audiologist  
GN Hearing  
Adjunct Lecturer  
Northwestern University

GN Making Life Sound Better FOR 150 YEARS

1

GN

1

### Learning Outcomes

After this course, participants will...

- Identify the impact of health conditions on hearing loss.
- Describe the relationship between hearing loss and cognition.
- Describe how improving audibility with modern technology can impact overall wellbeing and satisfaction.

GN Making Life Sound Better FOR 150 YEARS

2

GN

2

## Outline

- Introduction of hearing loss
- Possible causes of hearing loss and their epidemiology
- Health impact on hearing thresholds
- Hearing loss impact on health
- Relationship between cognition and hearing
- Research and evidence of treating hearing loss on outcomes of health and well-being
- Summary

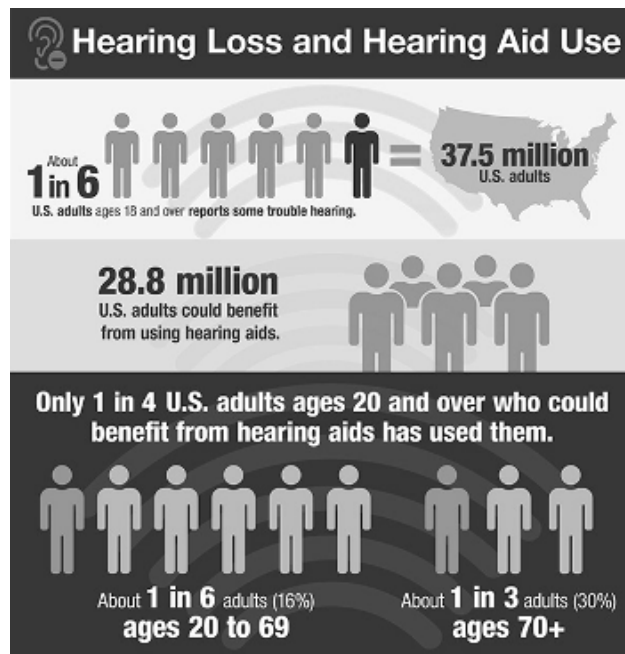
GN Making Life Sound Better FOR 150 YEARS

3

GN

3

## By The Numbers

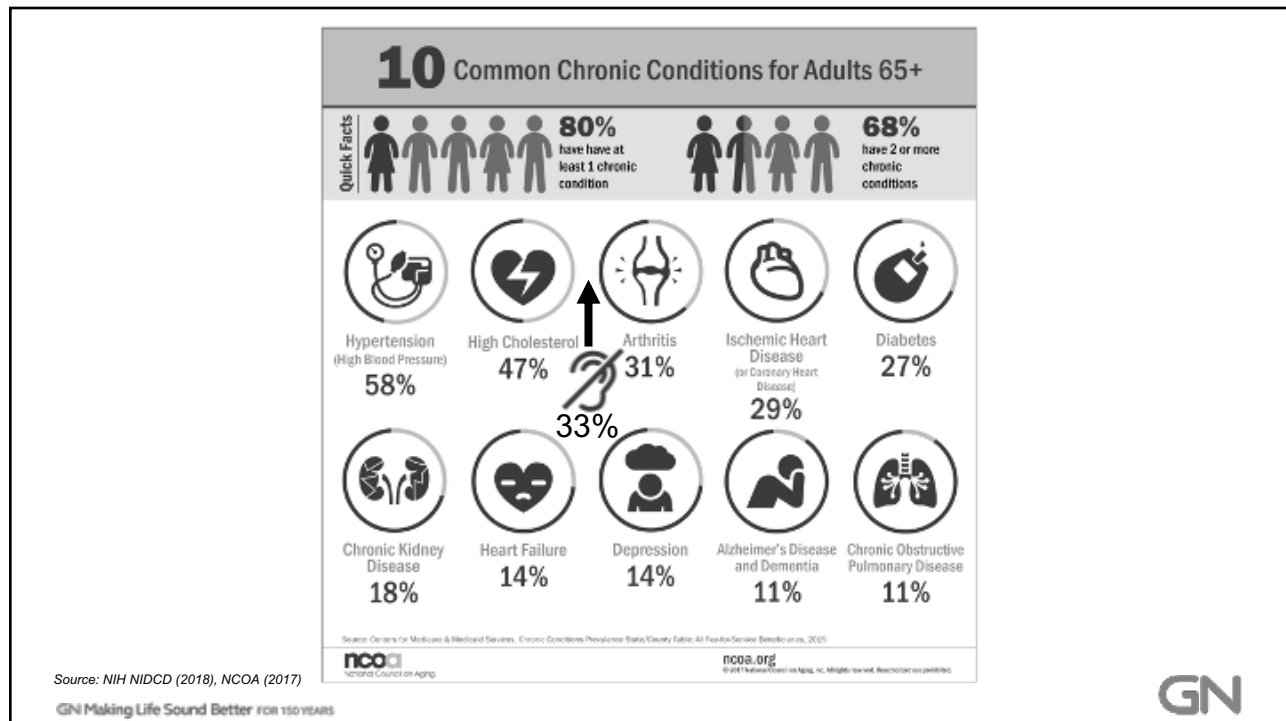


Source: NIH NIDCD (2015)

GN Making Life Sound Better FOR 150 YEARS

GN

4

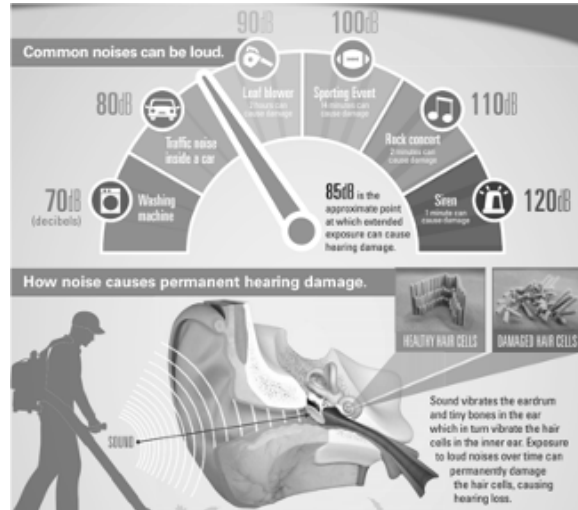


5



6

## Noise-induced Hearing Loss



Source: NIH

GN Making Life Sound Better FOR 150 YEARS

7

# 1 in 2

More than 1 in 2 US adults with hearing damage from noise do not have noisy jobs.

# 40 Million

About 40 million US adults aged 20-69 years have noise-induced hearing loss.

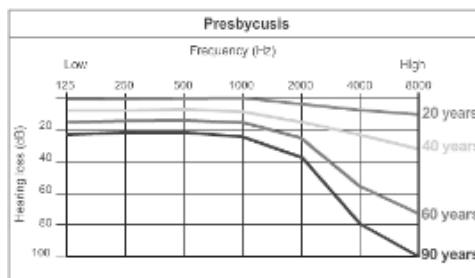
GN

7

## Age-related Hearing Loss

### Presbycusis

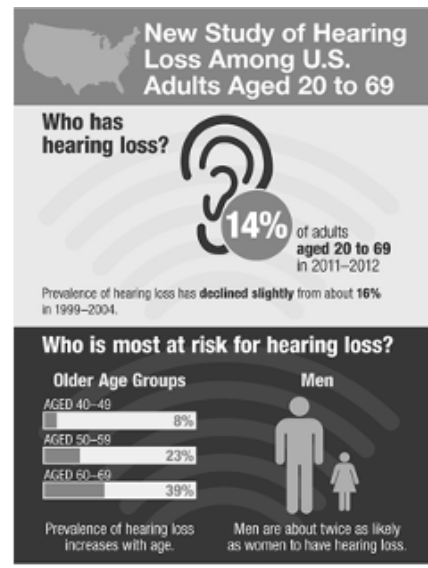
- Gradually occurs in most of us as we grow older
- Accelerated by previous noise exposure



Source: NIH, Cochlea.org

GN Making Life Sound Better FOR 150 YEARS

8



National Institute on  
Deafness and Other  
Communication Disorders

<https://www.nidcd.nih.gov/>

<https://twitter.com/nidcd>

GN

8

# Health impact on hearing thresholds

9

9

## High Blood Pressure



### Connection between Hypertension and Hearing loss

- Patients with hypertension have greater increase in hearing loss compared to those without
- Hearing system susceptible to vascular changes



Source: NIH, Agarwal et al., 2013

GN Making Life Sound Better FOR 150 YEARS

10

GN

10

## Sleep apnea is linked to:

- ✓ High blood pressure
- ✓ Atrial fibrillation
- ✓ Sudden cardiac death
- ✓ Heart failure

More than  
**18 MILLION**  
Americans have it.



## Connection between Sleep Apnea and Hearing loss

- 31% increased risk of HF HL
- 38% increased risk of any HL
- 90% increased risk of LF HL



Source: American College of Cardiology, Chopra et al., 2014

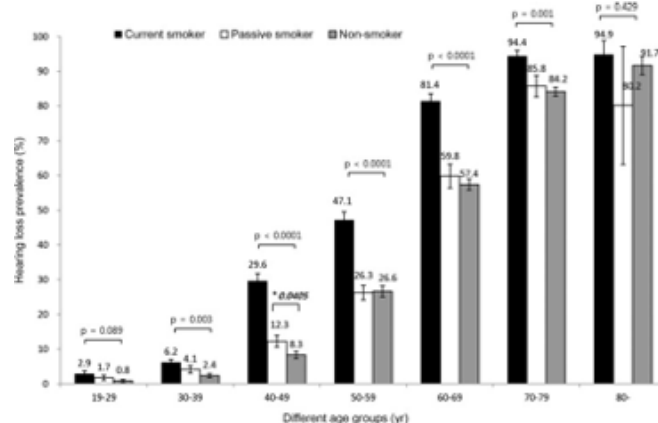
GN Making Life Sound Better FOR 150 YEARS

11

GN

11

## Smoking



Prevalence of bilateral HF HL

Source: CDC, Chang et al, (2016)

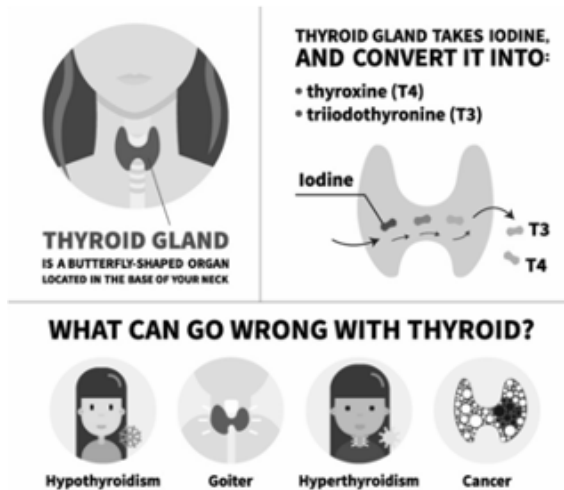
GN Making Life Sound Better FOR 150 YEARS

12

GN

12

## Thyroid Disease



### Hypothyroidism

- Iodine is essential for thyroid function
  - Thyroid hormone needed for auditory system maturation
- HL is more than twice as high for those with low iodine levels (ped)

### Hyperthyroidism

- Propylthiouracil (Rx)
  - Cytoplasmic antibody-associated small-vessel vasculitis

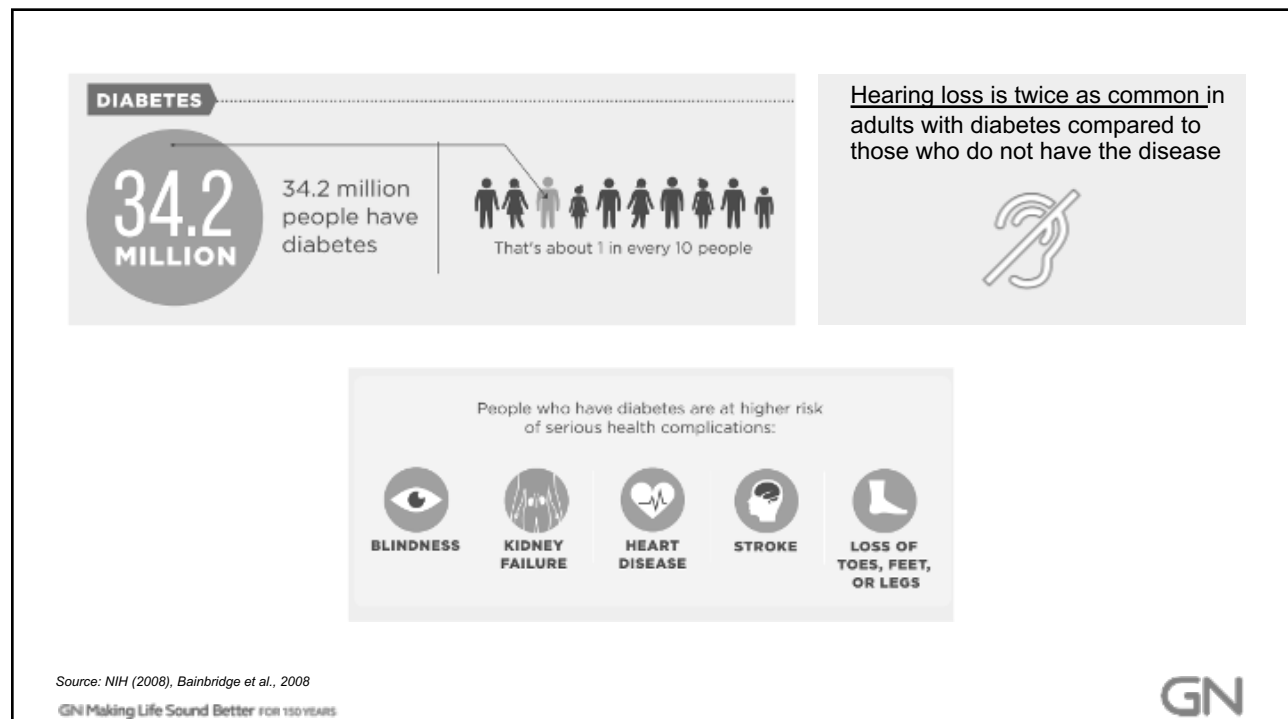
Source: St. Clair Hospital, Sano et al (2014), Scinicariello and Buser (2018)

GN Making Life Sound Better FOR 150 YEARS

13

GN

13



GN

14

## Ototoxicity

>200

OTC and Rx Meds

Common examples:

- Salicylates – Aspirin
- Antibiotics - Aminoglycosides,
- Loop Diuretics - Lasix, Edecrin, Bumex
- Chemotherapeutic Agents - Cisplatin, Nitrogen Mustard, Vincristine
- Nonsteroidal Anti-inflammatory Drugs (NSAIDS) - Advil, Aleve, Motrin



Chronic Kidney Disease  
18%

Source: NIH NIDCD (2018), NCOA (2017)

GN Making Life Sound Better FOR 150 YEARS

GN

15

## Obesity

Increased incidence of



**Connection with Hearing loss**

- 21.5% rate of SNHL
  - 13.44% in non-obese
- 1.73-fold increase in odds of SNHL



Source: CDC, Kohnberg et al., 2018

GN Making Life Sound Better FOR 150 YEARS

16

GN

16



## Covid-19 (Coronavirus)



Current infection rate: US

10,804 per 1M

- Reduced TEOAE and HF hearing (Mustafa, 2020; Karimi-Galougahi et al., 2020)
- Some balance symptoms noted (Karimi-Galougahi et al., 2020)
- Possible impact
  - Viral infection – impact on hair cell function
  - Hypoxia – respiratory illness
  - Ototoxic medication (Ciorba et al., 2020)
    - azithromycin, favipiravir, remdesivir, lopinavir, and hydroxychloroquine



Source: Stokes et al., 2020; CDC.gov; Mustafa, 2020; Karimi-Galougahi et al., 2020; Ciorba et al., 2020

GN Making Life Sound Better FOR 150 YEARS

17

GN

17

## Hearing loss impact on health

18

18

## Social and Emotional Impact of Hearing Loss

Source: Kochkin, 2007, 2011



Irritability, negativism and anger



Fatigue, tension, stress, and depression



Avoidance or withdrawal from social situations



Social rejection and loneliness



Reduced alertness and increased risk to personal safety



Reduced job performance and earning power



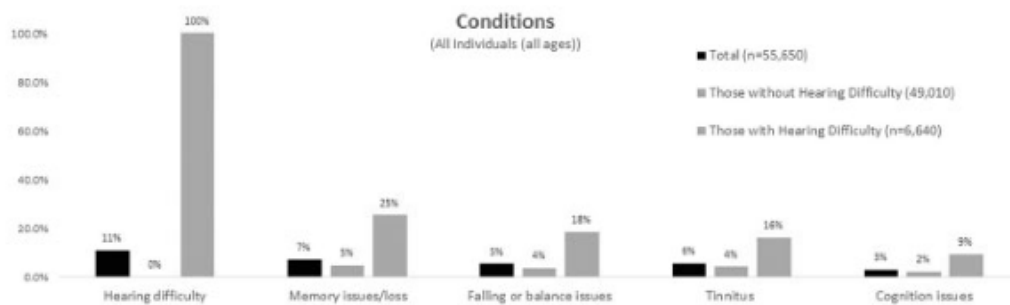
Diminished psychological and overall health

19

19

## MarkeTrak 10 (Harvey, 2020)

Those with hearing difficulty are 3.5+ times more likely to have each of the conditions below.



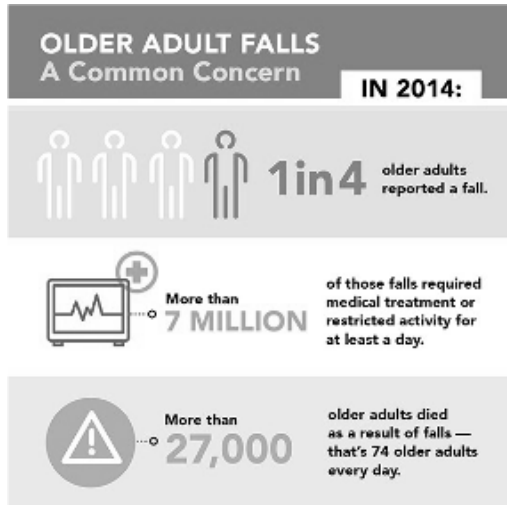
**Figure 4** Those with hearing difficulty are 3.5+ times more likely to have each of the conditions listed within the graph.

GN Making Life Sound Better FOR 150 YEARS

GN

20

## Falls



Source: CDC

GN Making Life Sound Better FOR 150 YEARS

21

GN

- People with a 25-decibel hearing loss, classified as mild, were nearly 3X more likely to have a history of falling
- Every additional 10-decibels of hearing loss increased the chances of falling by 1.4-fold



21

## Health care burden and Hospitalizations

Uncorrected hearing loss may raise the risk of mental and physical health problems and leads to higher hospitalization rates and health care costs.

- Analysis of health data from more than 150,000 people 50 and older reporting age-related hearing loss and no evidence of hearing aid use
- Untreated hearing loss is associated with a greater risk of
  - Depression (41% greater risk over 10 years)
  - Dementia (52% greater risk over 10 years)
  - Heart attack
  - Falls (30% greater risk over 10 years).
- 50% more hospital stays, and a 44% higher risk of being readmitted to the hospital within 30 days (over a 10-year period)

JAMA (Reed et al., 2018)

GN Making Life Sound Better FOR 150 YEARS

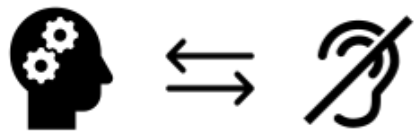
22

GN

22

Relationship between cognition and hearing loss

## Cognition and hearing loss



GN Making Life Sound Better FOR 150 YEARS

GN

23



## THE ABNORMAL AGING BRAIN

24

## Dementia Epidemiology – Worldwide\*

- 35.6 million estimated 2010 (24.2M 2001; 4.6M new cases/yr)
  - 46% Asia
  - 30% Europe
  - 12% North America
- Doubling ~ every 20 years
  - 65.7M 2030; 115.4M 2050
- Majority (57.7%) live in low- and middle-income countries
  - 40% increase Europe over next 20 yrs
  - 63% ↑ North America
  - 77% ↑ southern Latin America; 134-146% rest of Latin America
  - 89% ↑ Asia Pacific; 117% East Asia; 107% South Asia
  - 125% ↑ North Africa and Middle East

- \$315 B (2005 US \$) costs for dementia care/yr worldwide

\* Alzheimer's Disease International World Report, 2009 [www.alz.co.uk/worldreport](http://www.alz.co.uk/worldreport) ; Ferri et al., 2005; Wimo et al., 2003

*Slide courtesy of Angela C. Roberts, PhD*

GN Making Life Sound Better FOR 150 YEARS



25

## All-Cause Dementia – NIA and AA (McKhann et al., 2011)

- Revised version of NINCDS-ADRDA (McKhann, et al. 1984; Sensitivity 81%, Specificity 70%)

Cognitive or behavioural (neuropsychiatric) symptoms that:

1. Interfere with ability to function at work or usual activities
2. Represent a decline from previous levels of functioning and performing
3. Are not explained by delirium or major psychiatric disorder
4. Cognitive impairment detected and diagnosed through:
  - a. History from client and knowledgeable informant
  - b. Objective cognitive assessment (mental status or neuropsychological testing)

*Slide courtesy of Angela C. Roberts, PhD*

GN Making Life Sound Better FOR 150 YEARS



26

## All-Cause Dementia – NIA and AA (McKhann et al., 2011)

5. Cognitive or behavioural impairment involves a minimum of two of the following.
  - Impaired:
    - a. ability to acquire and to remember new information (e.g., repetitive questions or conversations, misplacing personal items, forgetting events or appointments, etc.)
    - b. reasoning and handling of complex tasks (e.g., poor understanding of safety risks, poor-decision making, inability to manage finances, etc.)
    - c. visuospatial abilities (i.e., agnosia and apraxia) (e.g., inability to recognize faces, common objects, or environment; inability to operate simple implements or orient clothing to body

Slide courtesy of Angela C. Roberts, PhD  
GN Making Life Sound Better FOR 150 YEARS



27

## All-Cause Dementia – NIA and AA (McKhann et al., 2011)

- d. Impaired language functions (e.g., speaking, reading, writing difficulty thinking of common words while speaking, hesitations; speech, spelling and writing errors)
- e. Changes in personality, behaviour or comportment (e.g., uncharacteristic mood fluctuations – agitation, impaired motivation and initiative, apathy, loss of drive, social withdrawal, decreased interest in previous activities, loss of empathy, compulsive or obsessive behaviours, socially unacceptable behaviours)

Slide courtesy of Angela C. Roberts, PhD  
GN Making Life Sound Better FOR 150 YEARS

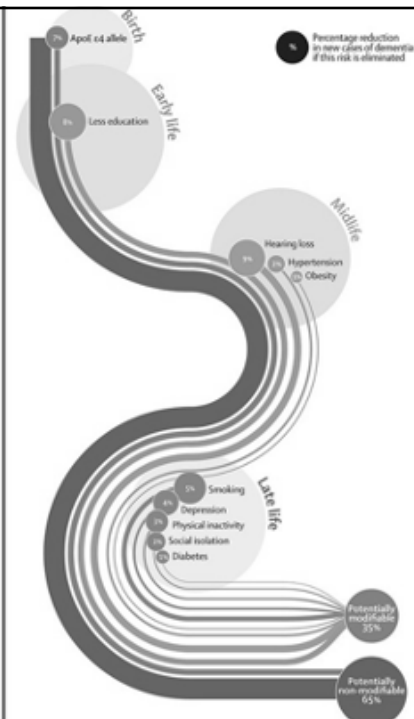


28

## 35% of Risk Factors for Dementia are Modifiable

Source: Lancet, 2017

GN Making Life Sound Better FOR 150 YEARS



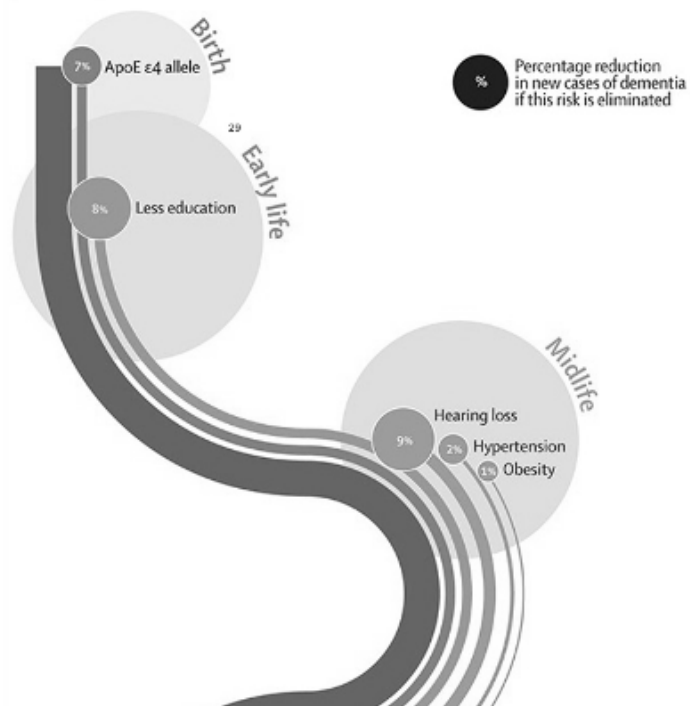
GN

29

## Birth, Early life, Midlife

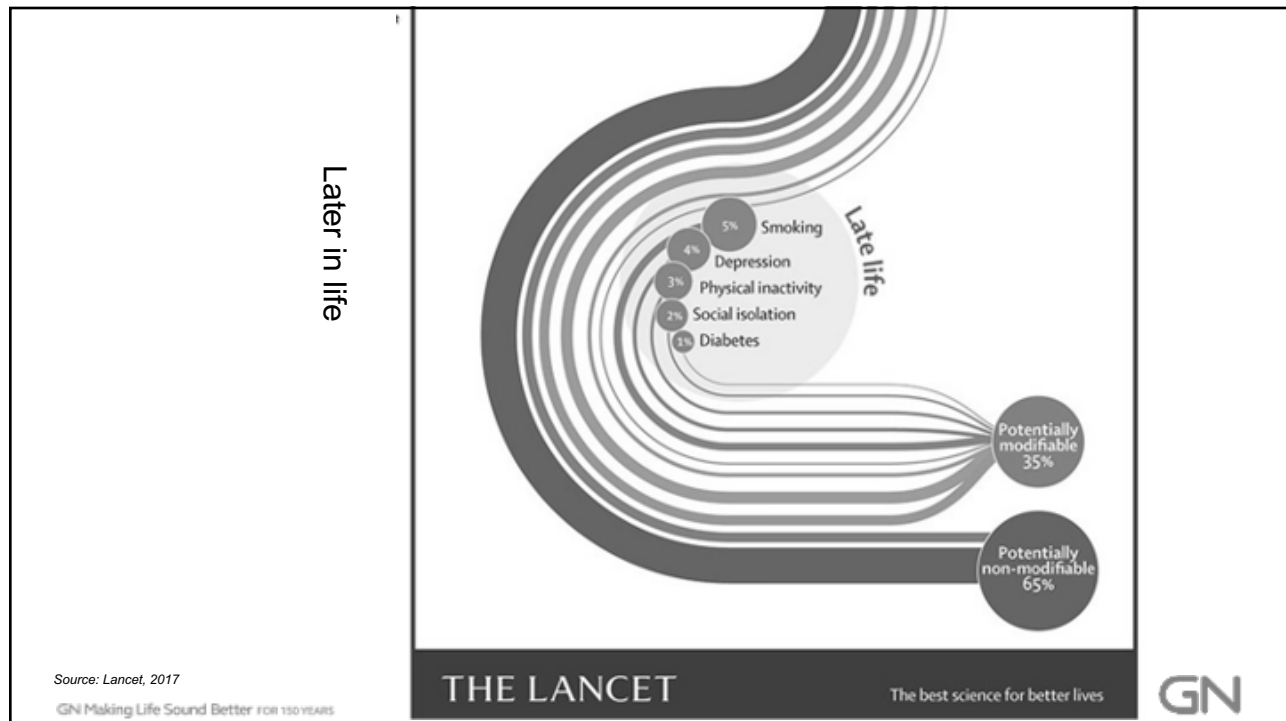
Source: Lancet, 2017

GN Making Life Sound Better FOR 150 YEARS

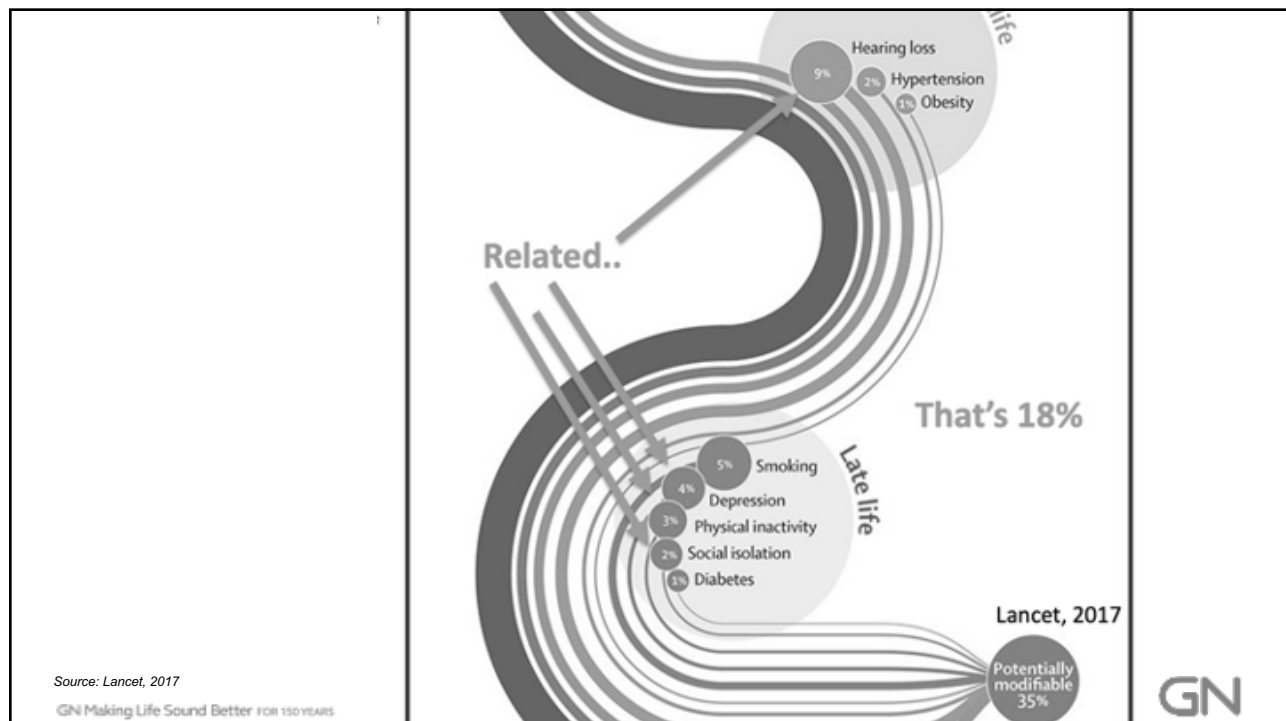


GN

30



31



32



## Relationship between Hearing Loss and Cognitive Decline

Greater cognitive decline in individuals with Alzheimer's who had HI at baseline compared with individuals with AD and NH (Uhlmann et al., 1986)

Correlation between the amount of hearing loss and the severity of cognitive impairment

Every additional 10 dB of hearing loss over a 25 dB hearing loss, 20% increase in risk of developing dementia (Lin et al., 2011)

Pichora-Fuller et al., 2013

GN Making Life Sound Better FOR 150 YEARS

GN

33

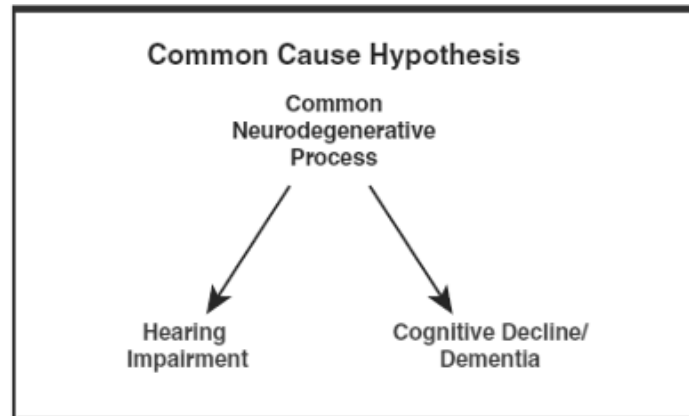
## How are hearing and cognition decline related?

No definitive answers yet, but possible theories are...

GN Making Life Sound Better FOR 150 YEARS

GN

34

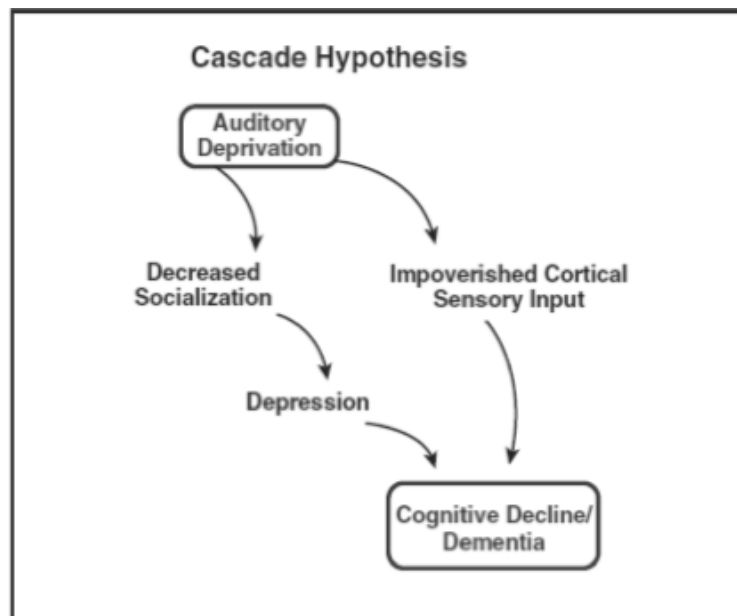


Stahl, 2017

GN Making Life Sound Better FOR 150 YEARS

GN

35

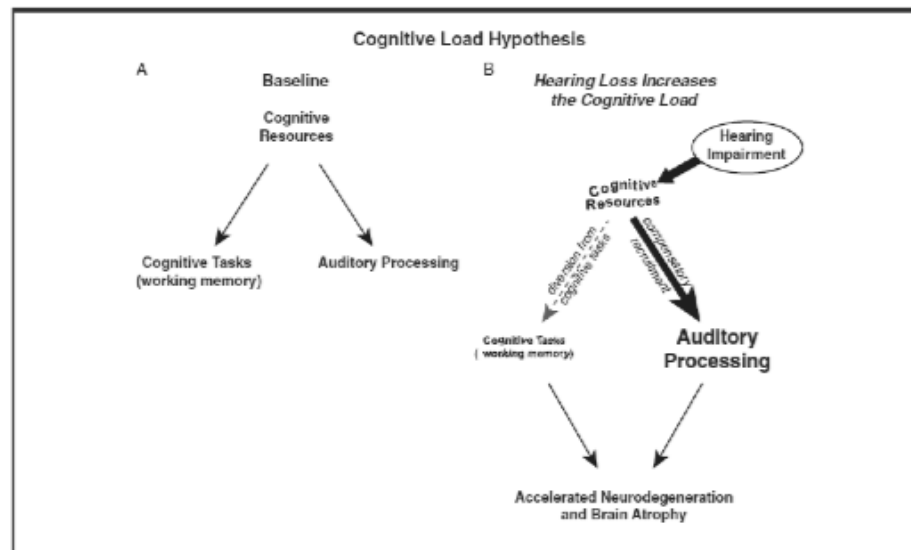


Stahl, 2017

GN Making Life Sound Better FOR 150 YEARS

GN

36



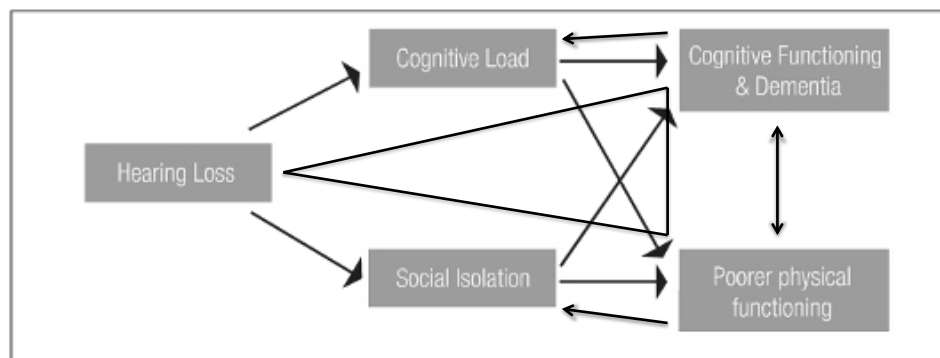
Stahl, 2017

GN

GN Making Life Sound Better FOR 150 YEARS

37

## Listening effort, hearing loss, and cognitive decline



Conceptual model of hearing loss with cognitive and physical functioning in older adults.

Adapted: The Hearing Review International, Spring 2013

GN Making Life Sound Better FOR 150 YEARS

GN

38

## How to reduce listening effort?

GN Making Life Sound Better FOR 150 YEARS

39

GN

39

## Optimize Technology and Communication

### Hearing aids

- Remediation of hearing loss
- Can improve signal-to-noise ratio
- Reduce listening effort (Picou et al., 2013)

### Remote Microphone Systems

- Improve signal-to-noise ratio

### Therapeutic Intervention

- Communication Strategies
- AR Classes
- Self-advocacy

GN Making Life Sound Better FOR 150 YEARS

GN

40

There is hope!

GN Making Life Sound Better FOR 150 YEARS

GN

41

## PROTECT (Brooker et al., 2019)

Poster presented at American Alzheimer's Association Conference

- PROTECT is an innovative online UK based study for cognitively healthy adults aged 50 and over
- Participants were invited to perform a range of cognitive tests, up to three times over seven days. They also self-reported current problems with their hearing and use of hearing aids.
- 4372 participants reported hearing loss, of whom 1557 used a hearing aid and 2815 did not
- Measures of attention and working memory showed higher cognitive performance in individuals using hearing aids at baseline
- Measures of attention, working memory and episodic memory showed a significantly worse trajectory over three years in participants who did not use hearing aids.

GN Making Life Sound Better FOR 150 YEARS

GN

42

## Multi-site study (Frank Lin et al.)

- ACHIEVE - The Aging and Cognitive Health Evaluation in Elders (ACHIEVE) study
  - Investigating two different treatments that may promote healthy aging and cognitive health in older adults.
  - Treatments include a successful aging education program and a hearing loss program.
  - Study participants will be randomly selected to either receive the successful aging education or the hearing program.
  - Post baseline, participants will be followed semi-annually for 3 years.
  - At the end of the study, participants can then get the other program if they wish.

<https://clinicaltrials.gov/ct2/show/NCT03243422>

GN Making Life Sound Better FOR 150 YEARS

43

GN

43

## Death, Depression, Disability, and Dementia Associated with Self-Reported Hearing Problems: A 25 Year Study

**Table 4.** Estimated Hazard Ratios of Self-reported Hearing Loss at Baseline on the Risks of Death, Depression, Disability, and Dementia Stratified According to Hearing-Aid Use: PAQUID Study

	Events <i>n</i> (%)	HR*	95% CI	<i>p</i> -Value
<b>Death (<i>n</i> = 3,588)</b>				
No hearing trouble reported	2,025 (88.1)			
Self-reported hearing trouble with no hearing aids	1,038 (93.3)	0.99	0.92–1.07	.81
Self-reported hearing trouble with hearing aids	164 (93.2)	1.03	0.87–1.21	.75
<b>Depressive symptoms (<i>n</i> = 3,080)</b>				
No hearing trouble reported	324 (15.8)			
Self-reported hearing trouble with no hearing aids	163 (18.6)	1.18	0.97–1.44	.09
Self-reported hearing trouble with hearing aids	20 (13.6)	1.05	0.66–1.65	.85
<b>Disability in ADL (<i>n</i> = 2,857)</b>				
No hearing trouble reported	547 (29.4)			
Self-reported hearing trouble with no hearing aids	301 (34.8)	1.28	1.11–1.48	<.01
Self-reported hearing trouble with hearing aids	27 (20.3)	0.81	0.55–1.20	.30
<b>Disability in IADL (<i>n</i> = 2,185)</b>				
No hearing trouble reported	979 (64.6)			
Self-reported hearing trouble with no hearing aids	395 (69.4)	1.13	1.00–1.27	.05
Self-reported hearing trouble with hearing aids	64 (64.0)	1.09	0.84–1.41	.53
<b>Dementia (<i>n</i> = 3,588)</b>				
No hearing trouble reported	556 (24.2)			
Self-reported hearing trouble with no hearing aids	291 (26.2)	1.21	1.05–1.40	.01
Self-reported hearing trouble with hearing aids	29 (16.5)	0.86	0.59–1.26	.45

Notes: ADL = Activities of daily living; CI = Confidence interval; HR = Hazard ratio; IADL = Instrumental activities of daily living.  
\* Adjusted for age, gender, education, and comorbidities.

GN Making Life Sound Better FOR 150 YEARS

Source: Amieva et al., 2018

GN

44

## Hospitalizations

Table 2. Unadjusted Data of Nationally Representative Health Care Costs and Use Outcomes Among Older People With Self-reported Hearing Loss<sup>a</sup>

Patient Characteristic	Total	Hearing Aids		Difference (95% CI)
		Without	With	
No. of patients	1336	734	602	
Total cost, mean (SD), \$				
Health care	12 839 (20 478)	12 254 (20 254)	13 435 (20 082)	1181 (-1247 to 3609)
Out of pocket	1727 (4448)	1463 (4792)	1997 (4098)	534 (94 to 973) <sup>b</sup>
Medicare	8293 (169 50)	8269 (17 000)	8317 (16 793)	48 (-1928 to 2024)
Any hospitalization, % (95% CI)	21 (19 to 24)	21 (17 to 24)	22 (18 to 26)	1 (-4 to 6)
Any ED visits, % (95% CI)	26 (23 to 29)	26 (22 to 31)	25 (21 to 30)	-1 (-7 to 4)
Any office visits, % (95% CI)	95 (93 to 96)	93 (90 to 95)	98 (95 to 99)	5 (2 to 7) <sup>b</sup>
Health care intervention, No. (SD)				
Hospitalization	1.60 (7.00)	1.80 (8.85)	1.39 (4.82)	-0.41 (-1.16 to 0.34)
ED visits	0.45 (1.21)	0.47 (1.35)	0.42 (1.07)	-0.05 (-0.18 to 0.08)
Office visits	14 (17.61)	13 (19.20)	15 (15.86)	2.71 (0.86 to 4.57) <sup>b</sup>

Abbreviation: ED, emergency department.

<sup>a</sup> Source: The 2013-2014 Medical Expenditure Panel Survey, Household Component Files.<sup>22</sup>

<sup>b</sup> Significant at  $\alpha = .05$ .

Source: Mahmoudi et al., 2018

GN Making Life Sound Better FOR 150 YEARS

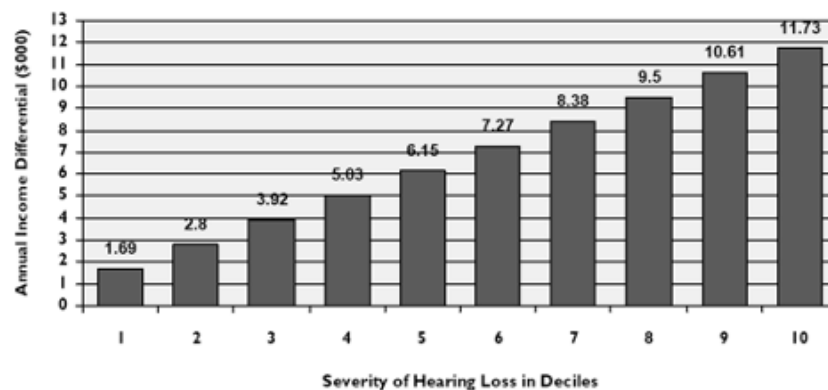
45

GN

45

## Income

Figure 3. Household income differential - aided versus unaided by severity of hearing loss (linear model)



Source: Better Hearing Institute, Kochkin, 2005

GN Making Life Sound Better FOR 150 YEARS

GN

46

## MarkeTrak 10 (Harvey, 2020)

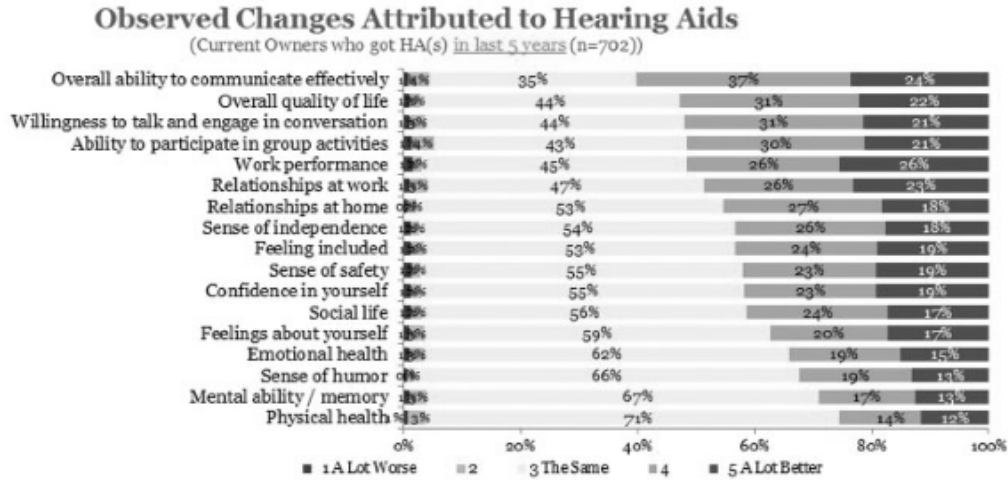


Figure 6 Observed changes attributed to hearing aids.

GNI Making Life Sound Better FOR 150 YEARS

GN

47

## MarkeTrak 10 (Harvey, 2020)

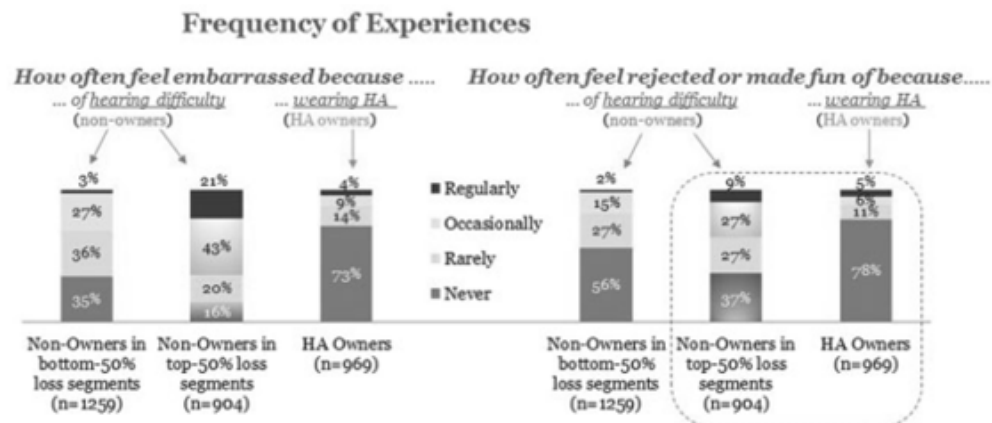


Figure 3 Frequency of experiences.

GNI Making Life Sound Better FOR 150 YEARS

GN

48



### Take Home Message

- Several different medical or health-related issues may impact hearing thresholds
- Untreated hearing loss may impact different aspects of health or well-being
  - Social / emotional
  - Falls
  - Cognition
  - Hospitalizations
  - Income
- Data shows that hearing aids may reduce the prevalence of several of the above items
- People are more likely to feel embarrassed because of hearing difficulties than of hearing aids

GN Making Life Sound Better FOR 150 YEARS

**GN**