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Hearing Loss and the Risk for Cognitive Impairment

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DISCLOSURES

Member of Audiology Advisory Board for:

- Advanced Bionics
- Cochlear Americas
- MED-EL

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Learning Objectives

After this course, participants will be able to:

- List key articles on the topic of hearing loss and cognitive impairment.
- Describe key findings from recent articles on the topic of hearing loss and cognitive impairment.
- Explain how key findings from recent articles on the topic of hearing loss and cognitive impairment are relevant to audiology patient care.

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Presbycusis/Dementia Link

- Presbycusis has been linked to:
  - **poorer cognitive functioning**
    - Lin et al. (2011). *Neuropsychology. 25:763–770.*
    - Lin et al. (2013). *JAMA Intern Med*. 173: 293-9.
  - **dementia**
    - Lin et al. (2011). *Arch Neurol. 68:214–220.*
    - Lin et al. (2013). *JAMA Intern Med*. 173: 293-9.
- Older individuals with severe+ hearing loss have a 5-fold increased risk of developing dementia.

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Lin et al. (2011). *Arch Neurol* . 68: 214–220.

- Baltimore Longitudinal Study of Aging (BLSA)
- 639 participants, 36 – 90 years
- Inclusion critieria:
  - audiometric testing and
  - Dementia free,1990-1994
- Potential covariates
  - Diabetes
  - Hypertension
  - Race
  - Education
  - Smoking status
  - Hearing aid use

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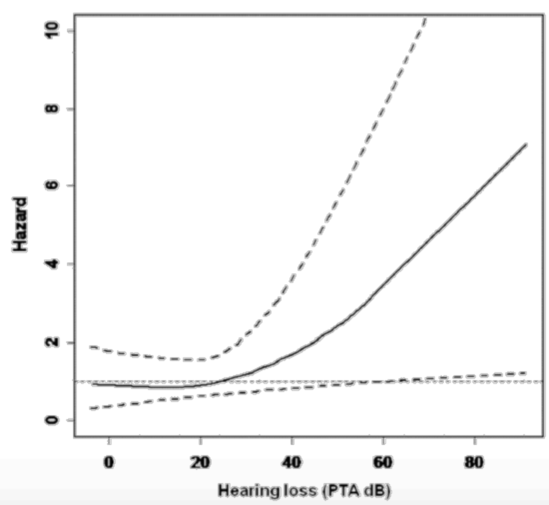
Lin et al. (2011). *Arch Neurol* . 68: 214–220.



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Presbycusis/Dementia Link

- Underlying mechanism not known
- Possibilities include:
  - Hearing loss affecting cortical processing
    - Peelle et al. (2011). *J Neurosci.31:12638–12643.*
    - Dawes et al. (2015). PLoS ONE. 10(3): e0119616.
  - Increased cognitive load
    - Wingfield et al. (2005). *Curr Dir Psychol Sci.14:144–148.*
  - Social isolation

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Lin et al. (2013). *JAMA Intern Med.* 173: 293-9.

- Health, Aging and Body Composition (Health ABC) study
- 639 participants, 36 – 90 years
- Audiometric testing administered in Year 5
- 2206 participants had hearing testing
  - 1984 had no evidence of cognitive impairment (Modified Mini-Mental State Exam, 3MS)
  - 3MS & Digit Symbol Substitution (DSS) test were administered in Years 5, 8, 10, and 11
- Same covariates were used in analysis

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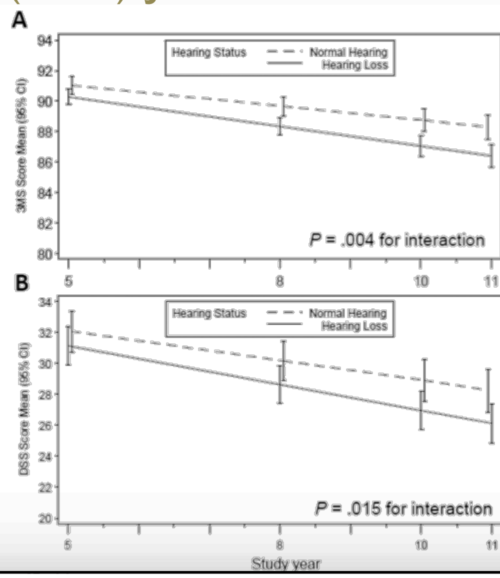
Lin et al. (2013). *JAMA Intern Med.* 173: 293-9.



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Lin et al. (2013). *JAMA Intern Med.* 173: 293-9.

- hearing loss was independently associated with accelerated cognitive decline and incident cognitive impairment
  - general population of community dwelling older adults
- individuals with hearing loss exhibited a 30–40% accelerated rate of cognitive decline and a 24% increased risk of incident cognitive impairment over a 6-year period
- *HA use was not significantly associated with a lower risk of incident cognitive impairment*

HA and/or CI for older individuals: weighing risk/benefit

- What will be lost in terms of LF hearing and general auditory function?
- What will be gained in terms of speech perception and communication?
- Might HA or CI use reduce the risk of cognitive decline?

Review of recent peer-reviewed literature

Mosnier et al. (2015) JAMA Otolaryngol Head Neck Surg. 141: 442-50.

- prospective, longitudinal multi-center study
- PURPOSE: assess speech perception, cognitive abilities, & quality-of-life pre & post-CI (6 - 12months) for individuals 65+ years
- INCLUSION CRITERIA:
  - bilateral sev-to-profound SNHL
  - ≤50% correct, French open-set disyllabic words @ 60 dBA
- EXCLUSION CRITERIA:
  - inability to complete required procedures suggestive of severe cognitive or medical disorder

Mosnier et al. (2015) JAMA Otolaryngol Head Neck Surg. 141: 442-50.

- n = 94
  - September 1, 2006 - June 30, 2009
  - mean age at CI = 72 years (range= 65-85 years)
- AB = 17; Cochlear = 23; MED-EL = 26; Neurelec = 29
- All patients entered a post-CI aural rehab
- individual sessions with SLP twice weekly for at least 6 months
- Disyllabic words were presented in quiet and with a co-located white noise
  - SNRs ranged from +15 to 0 dB

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Mosnier et al. (2015) JAMA Otolaryngol Head Neck Surg. 141: 442-50.

- Cognitive Measures, QOL, &Depression Scale
- All measures were administered pre- and post-CI via neuropsychologist
- Episodic memory, visuospatial abilities, attention span, processing speed, mental flexibility, rule of compliance, & executive function
  - Mini mental state exam (MMSE)
  - 5-word test (FWT)
  - clock-drawing test
  - verbal fluency test
  - d2 test of attention
  - Trail Making Test parts A and B (TMT-A and TMT
  - Nijmegen Cochlear Implant Questionnaire (NCIQ)
  - Geriatric Depression Scale (GDS-4)

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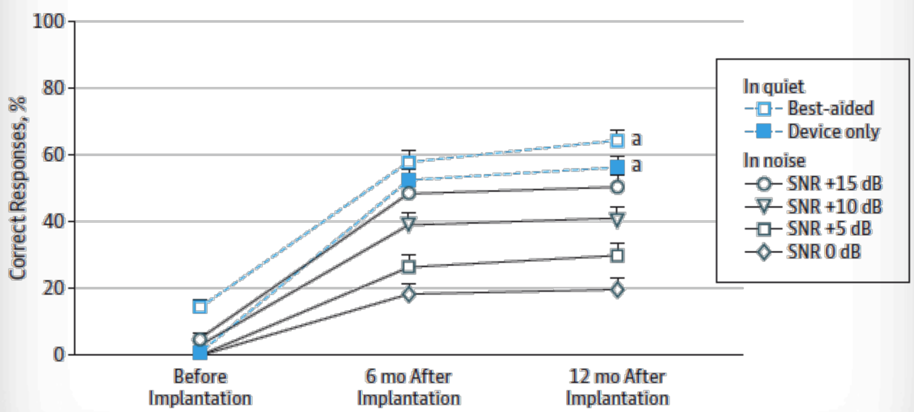
Mosnier et al. (2015) JAMA Otolaryngol Head Neck Surg. 141: 442-50.



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Mosnier et al. (2015) JAMA Otolaryngol Head Neck Surg. 141: 442-50.

Table 1. Abnormal Test Scores 12 Months After Cochlear Implantation in 94 Patients

Cognitive Test (Missing Data at Baseline)	No. (%) of Patients[a]					
	Abnormal Scores Before Implantation	Abnormal Scores After Implantation	Missing Data	Normal Scores Before Implantation	Abnormal Scores After Implantation	Missing Data
MMSE (0)	13 (14)	3 (3)	2	81 (86)	4 (4)	2
5-Word test (0)	22 (23)	10 (11)	2	72 (77)	11 (12)	3
Clock-drawing test (0)	4 (4)	1 (1)	1	90 (96)	0	4
Fluency tests						
Categories (2)	10 (7)	1 (1)	0	82 (89)	2 (2)	4
Letters (2)	6 (7)	0	0	86 (93)	1 (1)	4
d2 Test of attention						
Errors (3)	11 (12)	1 (1)	0	80 (88)	3 (3)	4
Speed (3)	39 (43)	14 (16)	4	52 (57)	13 (13)	0
Trail Making Test						
Part A (1)	19 (20)	5 (6)	0	74 (80)	3 (3)	4
Part B (3)	23 (25)	6 (7)	2	68 (75)	5 (6)	2

Abbreviation: MMSE, Mini-Mental State Examination.

[a] The percentages indicate the number of patients with normal and abnormal scores among patients who performed the test before and after implantation. Of 94 patients, educational level was unknown for 1 individual, so interpretation of the verbal fluency test and the Trail Making test was not possible. The d2 test of attention was also missing for this patient. Before implantation, 2 patients did not complete all cognitive tests. After implantation, cognitive data were missing for 4 patients (including 1 patient who did not complete all cognitive tests before implantation) and 1 patient performed only the MMSE.

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Mosnier et al. (2015) JAMA Otolaryngol Head Neck Surg. 141: 442-50.

Table 2. Effect of Cochlear Implantation on Mean Cognitive Test Scores in 94 Patients

Cognitive Test	Before, Mean (SD)	Group (No.)[a]	6-mo Mean (SD)	Differences, Mean (95% CI)	*P* Value[b]	12-mo Mean (SD)	Differences, Mean (95% CI)	*P* Value[b]
MMSE	22.1 (3.4)	Abnormal (13)	25.8 (2.7)	3.7 (0.6 to 6.8)	.02	26.3 (2.7)	3.8 (1.0 to 6.6)	.01
	27.8 (1.7)	Normal (81)	27.9 (1.8)	0.04 (−0.4 to 0.5)	.85	28 (1.8)	0.2 (−0.3 to 0.6)	.45
FWT[c]	8.2 (3.2)	Abnormal (22)	9.6 (0.1)	1.4 (0.5 to 2.3)	.004	9.4 (0.7)	1.3 (0.6 to 1.9)	<.001
	10.0 (0.0)	Normal (72)	9.7 (0.1)	−0.4 (−0.6 to −0.1)	.002	9.7 (0.8)	−0.7 (−0.7 to −0.2)	.002
Clock-drawing test[d]	2.5 (0.6)	Abnormal (4)	3.3 (0.6)	0.7 (−0.8 to 2.1)	.18	4 (2.6)	1.3 (−6.3 to 9.0)	.53
	6.1 (0.9)	Normal (90)	6.1 (1.0)	0 (−0.3 to 0.3)	.99	6.3 (0.9)	0.2 (0.03 to 0.4)	.046
d2 Test (errors)[e]	27.7 (9.0)	Abnormal (11)	21.0 (14.6)	−6.6 (−18.3 to 5.0)	.23	9.4 (7.1)	−18.3 (−25.3 to −11.9)	<.001
	6.2 (4.7)	Normal (80)	6.2 (6.2)	−0.2 (−1.8 to 1.4)	.82	5.7 (5.6)	−0.6 (−2.1 to 0.8)	.37
d2 Test of attention (speed)[e]	276 (62.8)	Abnormal (39)	321 (79.0)	46.4 (13.0 to 79.8)	.008	342 (81.7)	60.1 (30.5 to 89.6)	<.001
	429 (81.2)	Normal (52)	411 (82.0)	−19.3 (−44.4 to 4.7)	.11	409 (76.5)	−19.6 (−42.8 to 3.6)	.09
TMT-A[f]	77.3 (43.0)	Abnormal (19)	60.2 (14.1)	−17.9 (−39.7 to 3.8)	.09	52.2 (11.3)	−25.1 (−46.3 to −3.9)	.02
	43.8 (10.9)	Normal (74)	43.1 (12.8)	0.01 (−3.2 to 3.2)	.99	44.3 (12.6)	1.2 (−1.9 to 4.4)	.43
TMT-B[f]	181 (56.0)	Abnormal (23)	152 (64.7)	−29.5 (−55.9 to −3.9)	.03	142 (65.9)	−32.5 (−61.5 to 3.6)	.03
	105 (33.9)	Normal (68)	106 (41.2)	2.7 (−5.9 to 11.3)	.52	111 (46.7)	4.9 (−4.6 to 14.5)	.30

Abbreviations: FWT, five-word test; MMSE, Mini-Mental State Examination; TMT, Trail Making Test; TMT-A, TMT part A; TMT-B, TMT part B.

[a] Before implantation, results of each test were expressed as normal and abnormal, considering age, educational level, and normative data for the MMSE, d2 test of attention, and TMT.

[b] For each test, and in each group (normal and abnormal), mean cognitive scores at 6 and 12 months after cochlear implantation were compared with scores before implantation using paired *t* tests.

[c] Scores are reported as the number of recalls (scores <10 were abnormal).

[d] Scores of less than 10 were abnormal.

[e] Scores are reported as the total percentage of errors and as the number of items processed (speed).

[f] Scores were based on the total time of test completion (seconds).

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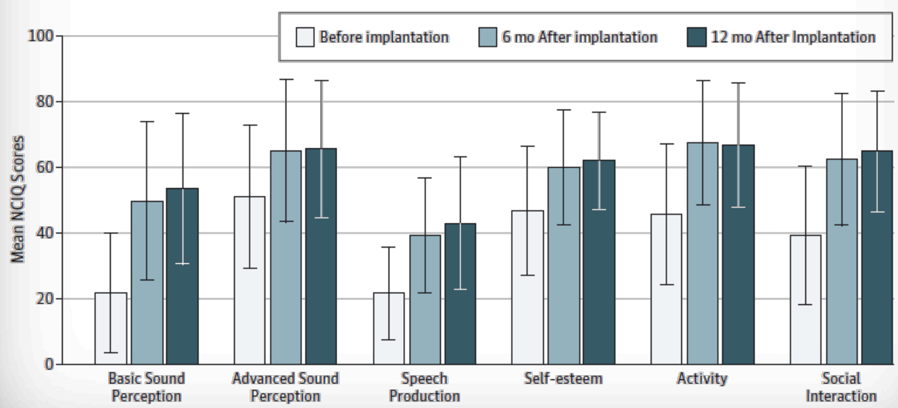
Mosnier et al. (2015) JAMA Otolaryngol Head Neck Surg. 141: 442-50.

Figure 3. Mean Scores of the 6 Subdomains of the Nijmegen Cochlear Implant Questionnaire (NCIQ) Before and After Cochlear Implantation



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Mosnier et al. (2015) JAMA Otolaryngol Head Neck Surg. 141: 442-50.

- CI → improves speech understanding in older CI users in quiet and in noise at 6 months after CI
- Speech in quiet improved between 6 & 12 months and was stable in noise between 6 & 12 months
- CI → improvement in cognitive function in all cognitive domains as early as 6 months following activation in elderly recipients who had abnormal preop scores
    - "improvement" in cognitive function?
    - learning effects?
    - CI? Aural rehab? Both?
- verbal fluency test for letters (long-term memory) was the only cognitive test correlated with speech perception in noise

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What about hearing aids?

Dawes et al. (2015). PLoS ONE 10(3): e0119616. doi:10.1371/journal.pone.0119616

UK Biobank data set (n = 164,770) of UK adults aged 40 to 69 years

<u>Goal</u>: model statistical association b/tw hearing loss, cognition, social isolation, depression, and HA use

Theories of association b/tw hearing loss and dementia:

1) common cause: age-relate neurodegeneration
2) cascade hypothesis: auditory deprivation → cognitive deficit
3) Compensatory effort: use of limited cognitive resources

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Dawes et al. (2015). PLoS ONE 10(3): e0119616. doi:10.1371/journal.pone.0119616

UK Biobank data set (n = 164,770) of UK adults aged 40 to 69 years

Hypotheses:
•A positive association b/tw hearing loss & cognitive performance → consistent with both the cascade and common cause hypotheses
•But if auditory deprivation → cognitive decline—as suggested by cascade—HA use should lead to better cognitive performance

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Dawes et al. (2015). PLoS ONE 10(3): e0119616. doi:10.1371/journal.pone.0119616

Speech Perception
- Digit Triplet Test (DTT): adaptive speech-in-noise test

Cognitive Tests
- Reaction Time
- Pairs Matching
- Fluid Intelligence (problem solving & logic)

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Dawes et al. (2015). PLoS ONE 10(3): e0119616. doi:10.1371/journal.pone.0119616

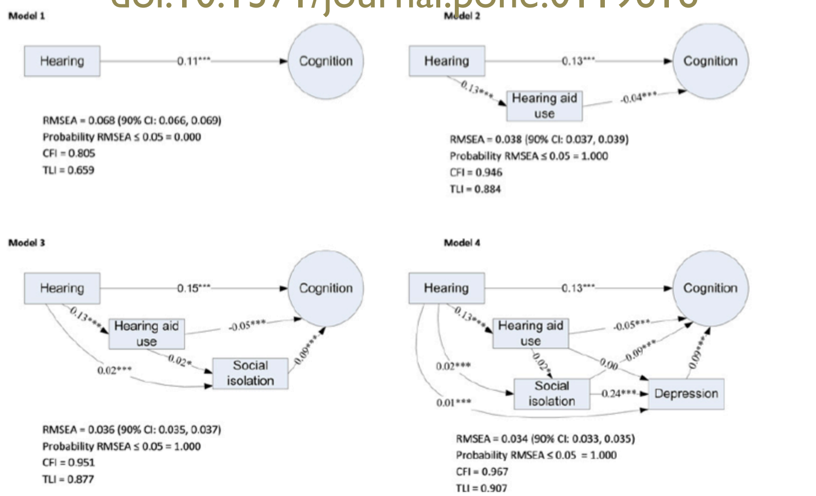

Fig 1. Structural equation models of standardised path coefficients between hearing, cognition, hearing aid use, social isolation and depression. Notes: ****p*<0.001, **p*<0.05. Root Mean Square Error of Approximation (RMSEA). A value less than 0.05 indicates good fit. Comparative Fit Index (CFI) and Tucker Lewis Index (TLI), with a number greater than 0.95 indicating good fit.

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Dawes et al. (2015). PLoS ONE 10(3): e0119616. doi:10.1371/journal.pone.0119616

Conclusions

- HA use → better cognition
  - consistent with the cascade hypothesis—where auditory deprivation may lead to cognitive decline
- The association b/tw HA & cognition was independent of an association of HA use on social isolation or depression
  - So, the effect of HA use on cognition is not likely a result of hearing loss affecting social isolation and/or depression
- HA benefit is likely due to increased audibility
  - But what is the mechanism? How might HA use → better cognition?

Dawes et al. (2015). PLoS ONE 10(3): e0119616. doi:10.1371/journal.pone.0119616

How might HA use → better cognition?

•HA use → improved self-efficacy
  • Hearing loss is associated with reduced self-efficacy (Kramer et al., 2002. J Aging Health. 14: 122–137)

•Unexpected outcomes 1) no association b/tw HA use & depression, and 2) increased social isolation with HA use.

•better cognition in HA users suggests that restoring audibility can reduce cognitive decline
  • Correlation, not causation
  • Further study is needed

Presbycusis/Dementia Link

•Underlying mechanism not known

•Possibilities include:

- Deprivation affecting cortical processing
  - "Cascade" hypothesis
  - Peelle et al. (2011). *J Neurosci.31:12638–12643.*
  - Dawes et al. (2015). PLoS ONE. 10(3): e0119616.
- Increased cognitive load
  - Wingfield et al. (2005). *Curr Dir Psychol Sci.14:144–148.*
- Social isolation (but see Dawes et al., 2015)

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Presbycusis/Dementia Link

- CI → improved cognition
  - Mosnier et al. (2105). JAMA Otolaryngol Head Neck Surg. 141: 442-50.
  - Significant aural rehab was also involved
- HA use → improved cognition
  - Dawes et al. (2015). PLoS ONE. 10(3): e0119616.
  - But see Lin et al. (2013).
- Both studies suggest correlation, not causation
- Need RCT to investigate whether audiologic intervention can ameliorate the effects of cognitive decline
  - Dosage? Timing? Addition of aural rehab?

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Thank you for your attention!
Questions? Comments?