Central Auditory Dysfunction in Age-Related Hearing Loss

George A. Gates, M.D.

Hearing Care for Adults
November 16, 2009
Chicago

COLLABORATORS

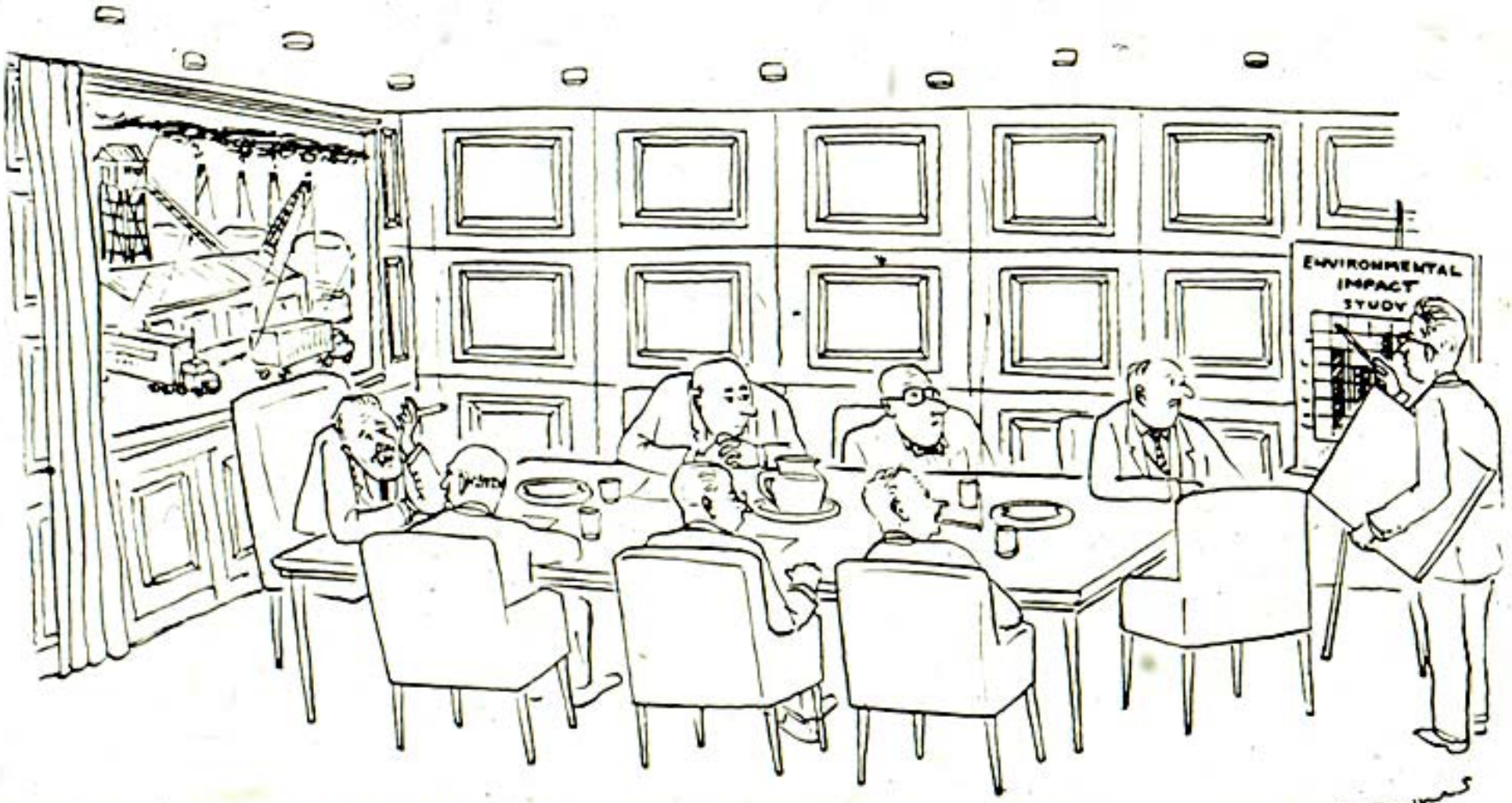
- Boston University: Phil Wolf, Richard Myers, Clint Baldwin, Alexia Beiser, Ralph D'Agostino, Janet Cobb, Byung-ho Nam, Nat Couropmitree
- Framingham Heart Study: Peter Wilson, Richard Linn, Bill Castelli, Bill Kannel, Phil Wolf
- Audiology: Nancy Miller, Arlene Fraher, John Cooper, Margo Skinner, Jerry Popelka, Sharon Kujawa, Susan Norton, Pat Feeney
- University of Washington: Wayne Blinne, Janet Kelly, Peter Schmid, Aimee Verrall, Eric Larson, Sue McCurry, Paul Crane, Laura Gibbons

Presbycusis (Age-Related Hearing Loss)
Goals

- Describe the key role of central auditory dysfunction in presbycusis (phonemic regression)
- Stress the need for routine central auditory testing in new geriatric hearing loss cases and referral for neuropsych evaluation p.r.n.
- Discuss the need for auditory training for presbycusic patients with central dysfunction

Presbycusis (Age-Related Hearing Loss)
Background

- Third most common chronic disability (10%)
- Pure presbycusis (strial aging) plus sum of age-related disease and acquired conditions
- Involves peripheral and central auditory systems
- Impaired speech perception, especially with competing sounds (party, restaurant) – audibility vs processing ability: think cognitive decline



"Did he say *someday* we'd be sorry or *Sunday* we'd be sorry?"

Age-Related Hearing Loss

Important Points

- Prevalence: increases exponentially with age – 25% at 65 yrs, 75% by 75 yrs, 99% by 100 yrs
- Societal costs: diagnosis and rehabilitation
- Personal costs: isolation and depression
- Amplification benefits general health as well as communication (Mulrow et al.), but only 23% of cases that might benefit have hearing aids
- Aural rehab/training is a largely neglected area for patient care and clinical research.

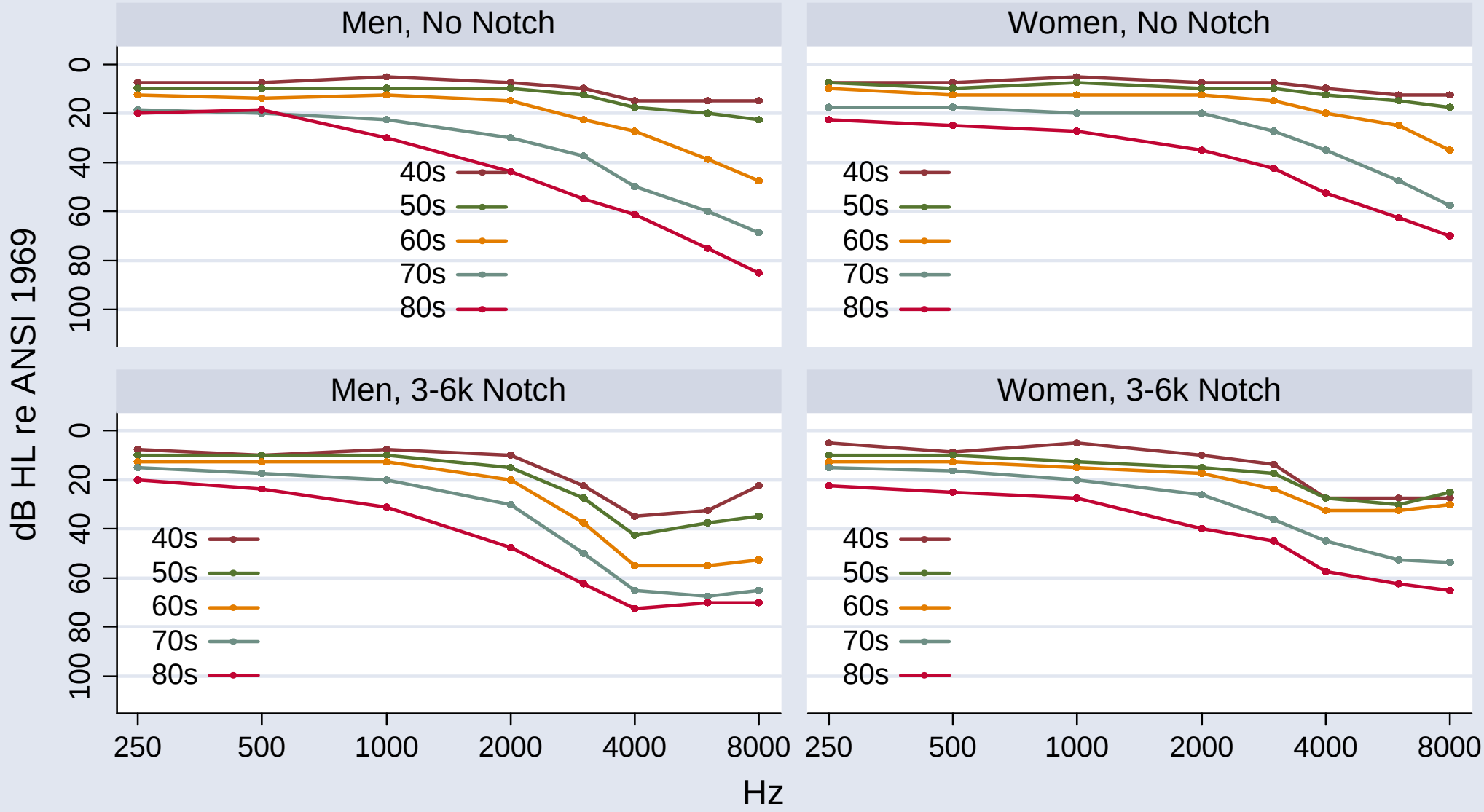
Age-related Hearing Loss
Central Presbycusis

- "I can't understand when its noisy" – the classic sign of central presbycusis (age-related auditory processing disorder)
- Variety of speech-in-noise paradigms to evaluate this complaint (SSI, DSI, DDT, ? QuickSIN)
- Associated with deficits in brain processing as occur in memory loss and dementia
- Areas: early AD, predictor of AD, associated with memory loss and, now, executive function

Presbycusis (Age-Related Hearing Loss)
Newest Concepts

- Aging of the stria vascularis results in reduced power for hair cell transduction (Mills)
- After about age 70, central presbycusis (processing dysfunction) becomes an increasingly larger part of the communication problem (Ear & Hearing 2008)
- Speech-in-noise tests (SSI-ICM, DSI) are surrogates for cognitive function (Arch OHNS 2008); very poor performance is an early sign for later dementia (J Am Geriatr Soc 2002)

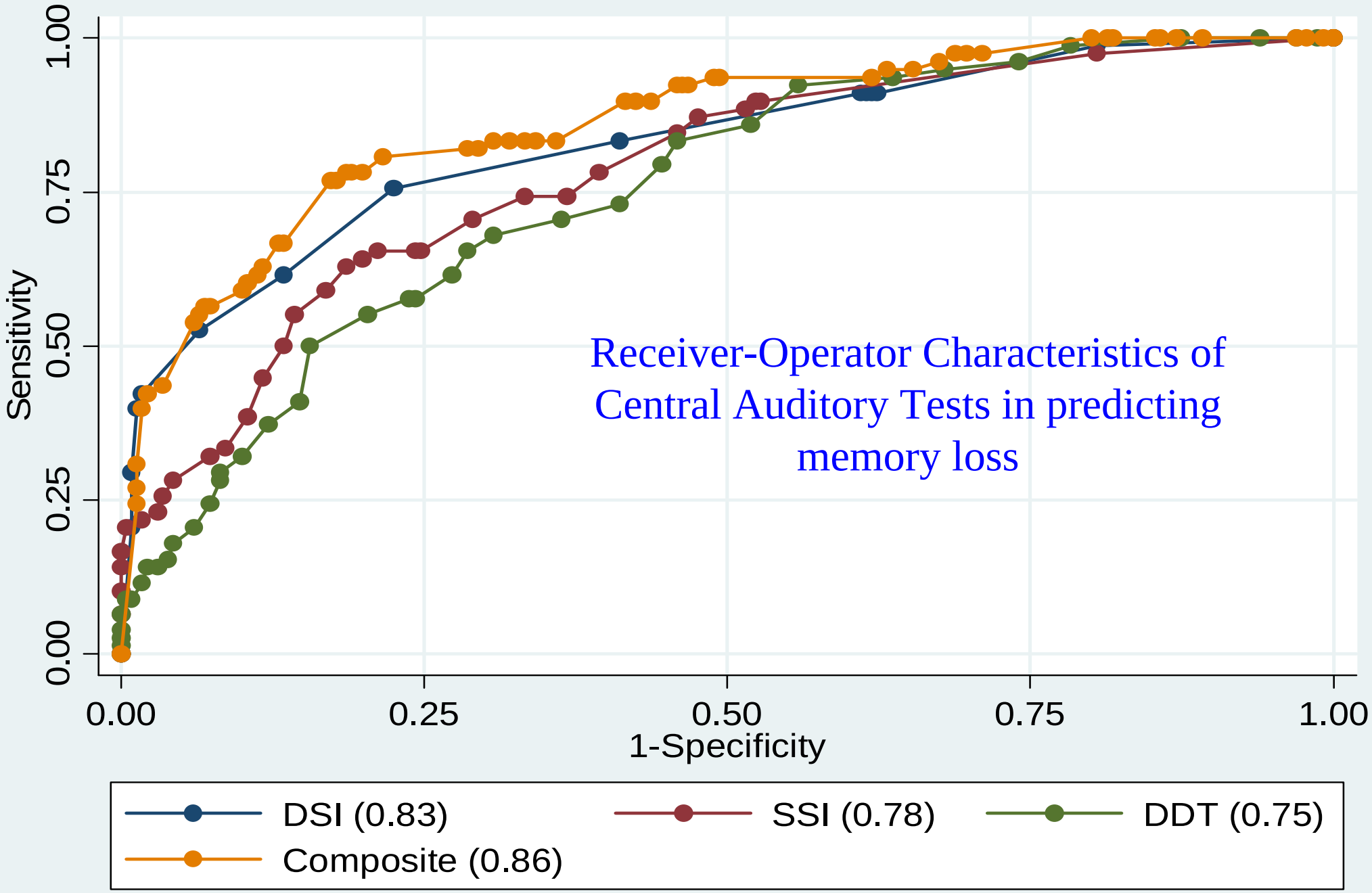
Median Thresholds by Decade

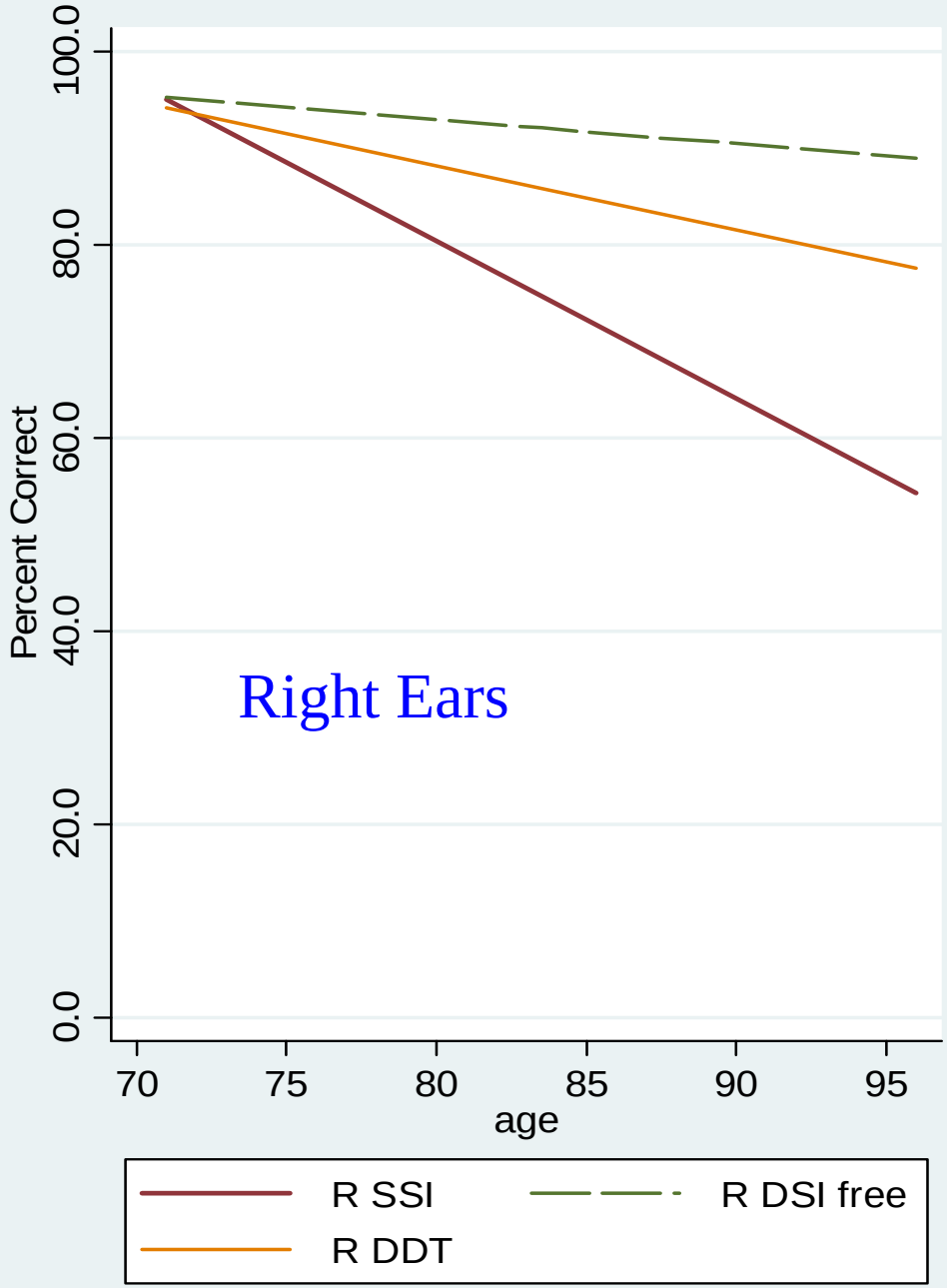


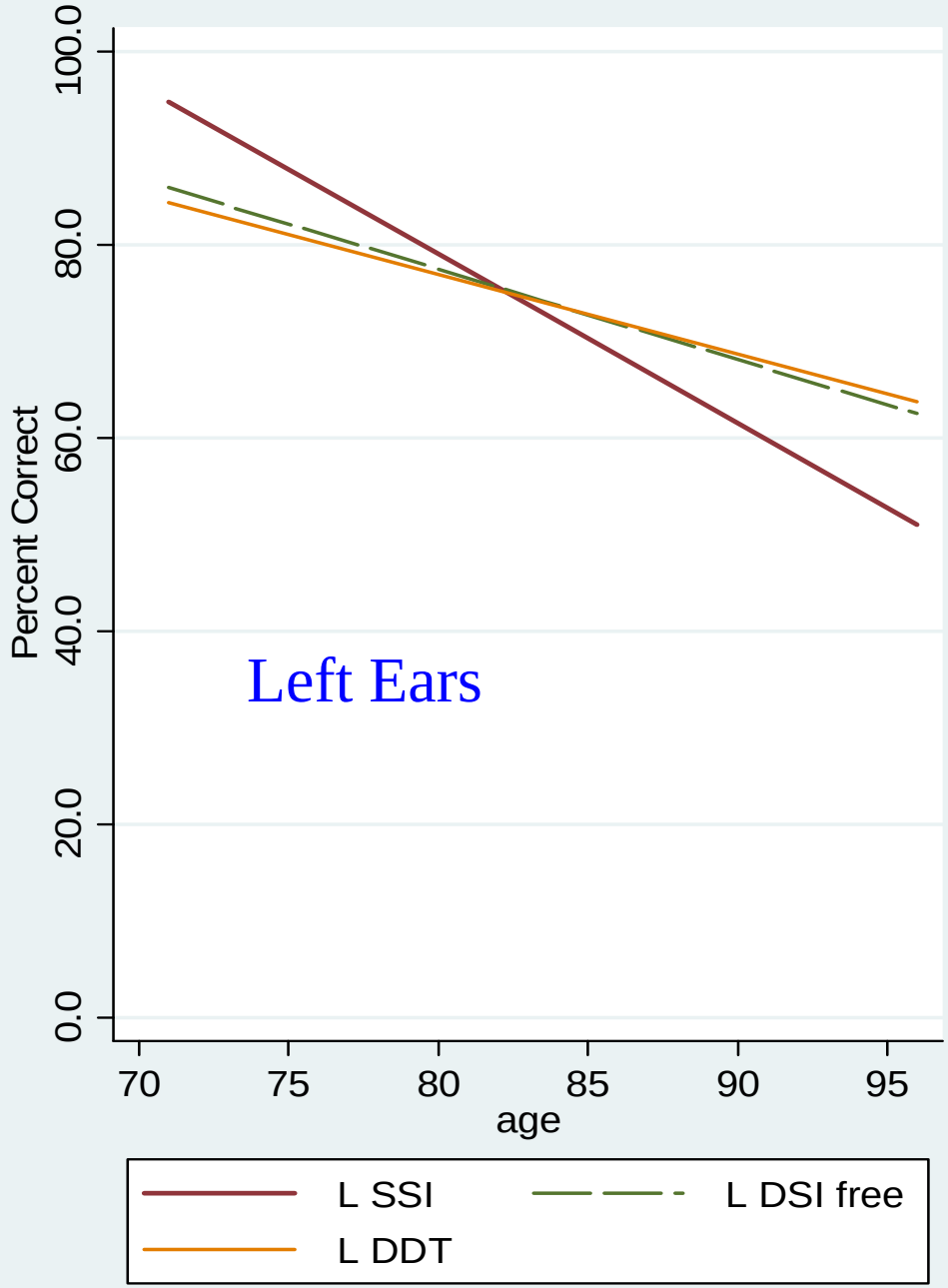
Graphs by sex and notch

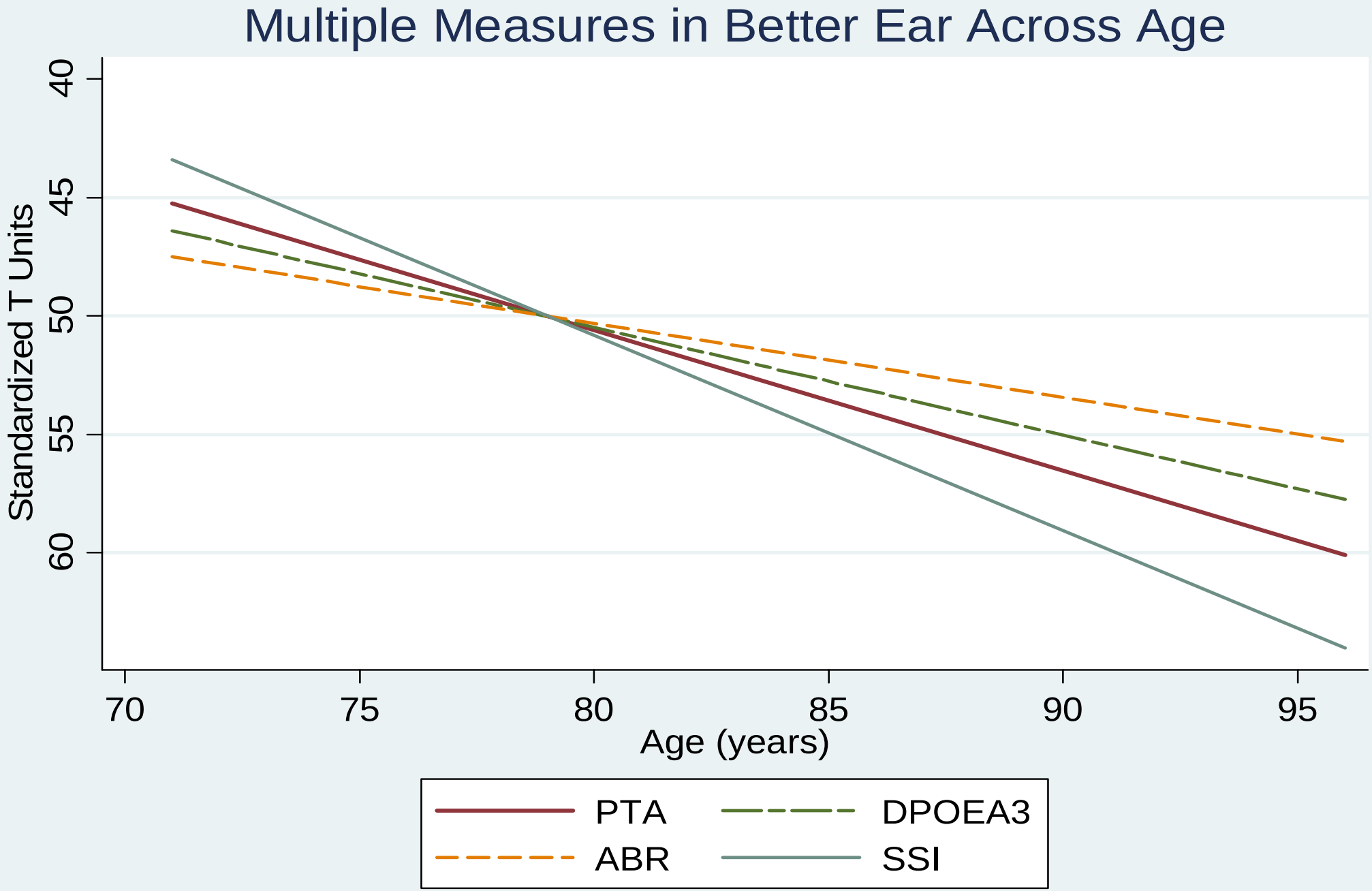
Central Presbycusis
Processing Dysfunction

- Central auditory tests decline faster than pure-tone thresholds in 7^{th}-9^{th} decades (EarHear 2008)
- Central auditory dysfunction (i.e. neurologic aspects of aging) is strongly correlated with neuropsych performance, memory loss, and dementia, and precedes dementia.
- Understanding speech-in-noise uses cognitive resources (short term memory, attention)


Receiver-Operator Characteristics of Central Auditory Tests in predicting memory loss
Sensitivity
0.00
0.25
0.50
0.75
1.00
1-Specificity
0.00
0.25
0.50
0.75
1.00
DSI (0.83)
SSI (0.78)
DDT (0.75)
Composite (0.86)


Percent Correct
0.0
20.0
40.0
60.0
80.0
100.0
70
75
80
85
90
95
age
Right Ears
R SSI
R DSI free
R DDT


Percent Correct
0.0
20.0
40.0
60.0
80.0
100.0
70
75
80
85
90
95
age
Left Ears
L SSI
L DSI free
L DDT

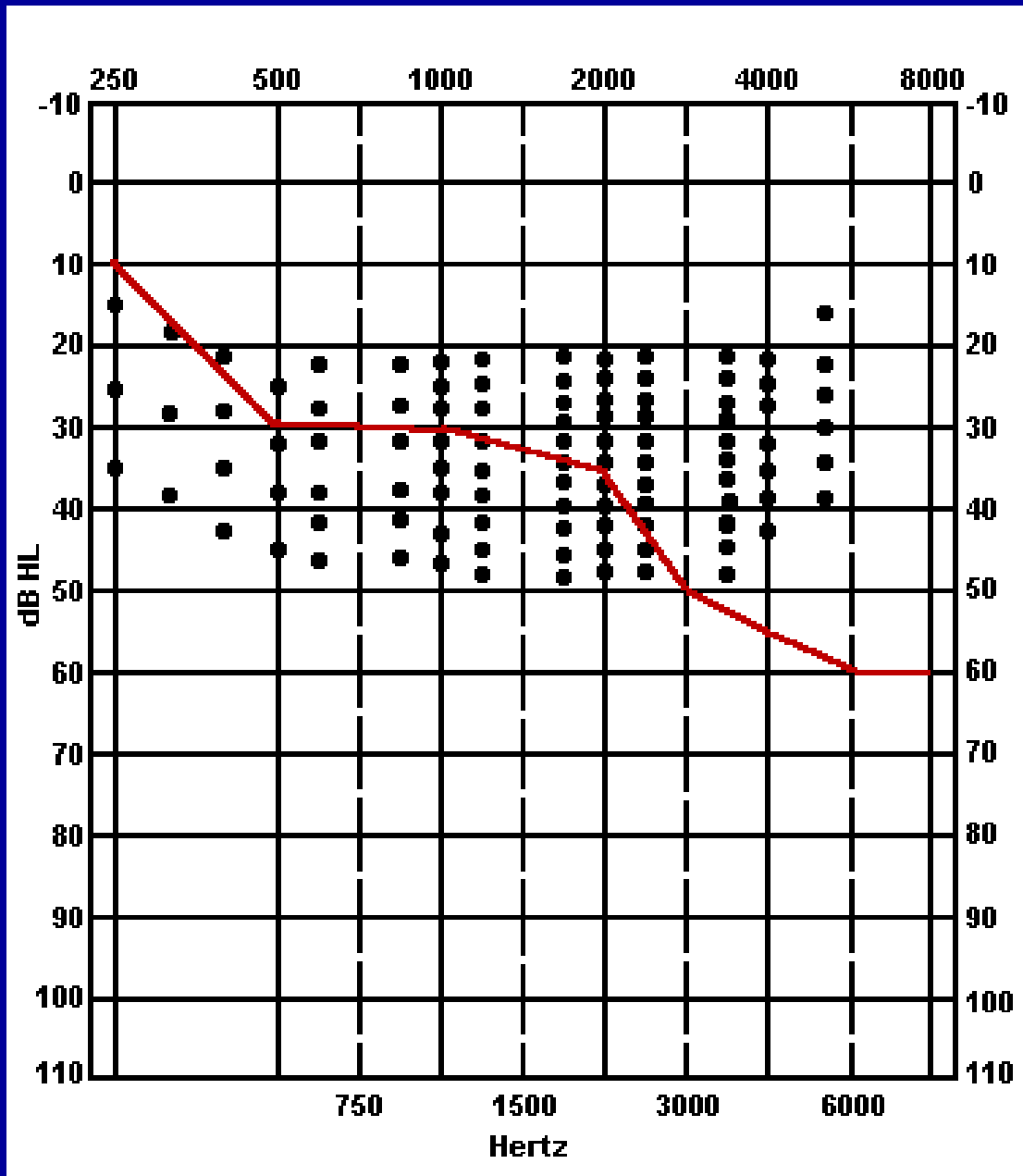

Multiple Measures in Better Ear Across Age
Standardized T Units
40
45
50
55
60
70
75
80
85
90
95
Age (years)
PTA
DPOEA3
ABR
SSI

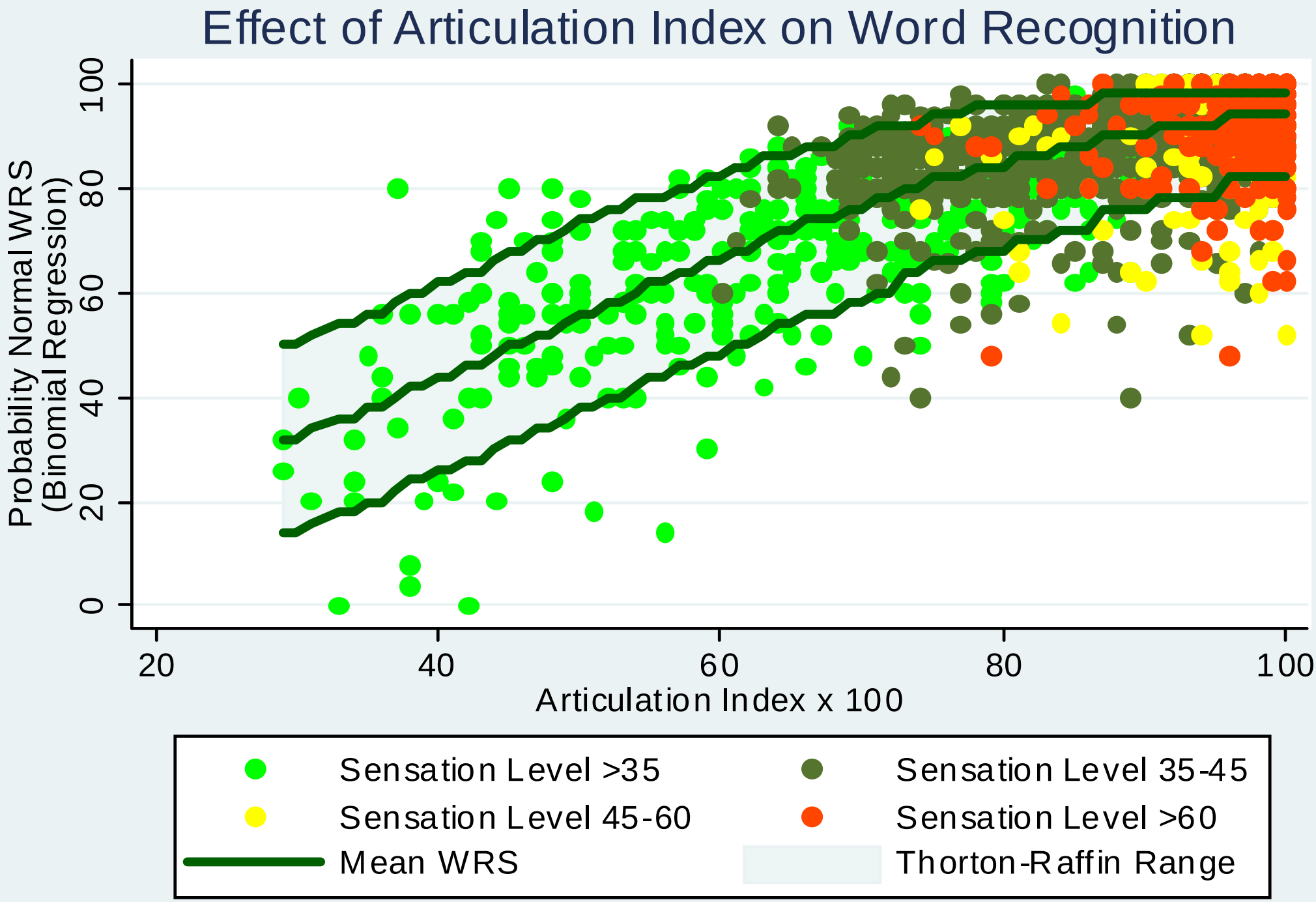
"Nerve Deafness"
(Reduced Speech Understanding)

- "I can hear you but I can't understand what you said"
- Compare speech in quiet, i.e. word recognition score (WRS) to the Articulation Index (AI) for disproportionate reduction in speech understanding
- Most "cases" of bilateral low WRS are due to outer hair cell loss; rarely VIII nerve dysfunction (auditory neuropathy)
- Neural presbycusis shows reduced spiral ganglion cell population (Schuknecht, Nadol)
- Criteria for diagnosis vague.

Articulation Index (simple method of Killion)

44% of the dots are audible. Predicted word recognition score should be around 44% with an A.I. of 0.44




Effect of Articulation Index on Word Recognition
Probability Normal WRS
(Binomial Regression)
0
20
40
60
80
100
20
40
60
80
100
Articulation Index x 100
Sensation Level >35
Sensation Level 35-45
Sensation Level 45-60
Sensation Level >60
Mean WRS
Thorton-Raffin Range

CENTRAL AUDITORY TESTS
Synthetic Sentence Identification

- Select a “sentence” from 10 item list
- High context background story
- Training test at + 10 dB message to competition ratio (MCR)
- Test done with 0 dB MCR at 40 dB SL
- 80% or better is normal
- WRS minus SSI-ICM = 20% or less

SYNTHETIC SENTENCE IDENTIFICATION TEST

1. Small boat with a picture has become
2. Built the government with the force almost
3. Go change your car color is red
4. Forward march said the boy had a
5. March around without a care in your

SYNTHETIC SENTENCE IDENTIFICATION
Alzheimer's Disease (pAD)

- Very sensitive to even early AD (94%)
- SSI-ICM more sensitive than SSI-CCM
- Grossly abnormal (<50%) SSI-ICM predicts AD up to 12 years in advance: 23% sensitivity and 48% specificity; RR > 8
- Cortical association areas, short-term memory
- Strong association of memory loss and decreased central auditory function. (Arch Oto July 2008)

CENTRAL AUDITORY TESTS
Alzheimer's Disease (AD)

- 741 subjects from prospective dementia cohort of the FHS with normal MMSE at biennial examination 15 and ...
- Central auditory tests at biennial exam 15
  - Word recognition at 40 dB SL
  - SSI-ICM at 50 dB HL, 0 MCR
  - SSW
- F/U 3-12 yrs (mean 7.7 yrs) with MMSE

Logistic Regression for AD

	Very low SSI-ICM		Very low SSI-ICM Plus Normal Word Recognition	
	Risk Ratio	95% CI	Risk Ratio	95% CI
Adjusted for				
Age	8.3	3.5-19.6	12.3	5.1-29.6
Age, Gender	8.4	3.5-20.0	12.2	5.1-29.5
Age, Gender, apoE4	7.8	2.6-22.9	17.9	6.3-50.9
Age, Gender, apoE4, PTA-WE	9.2	2.7-31.4	19.6	6.2-61.6

EXECUTIVE FUNCTION AND CENTRAL PRESBYCUSIS

- EF is the cognitive manager of the brain. Frontal and temporoparietal lobes involved. Affected early in Alzheimer's disease
- Involves short term memory, decision, attention.
- Trails A and B, clock drawing, Stroop color test
- SSI/DSI require decision and memory: "which sentence was the one I heard"
- Strong association of EF with central presbycusis

Hearing Care for Adults 2009 – The Challenge of Aging

The data presented is currently under peer review for publication and can not be shown here.

Thank you for your understanding.

November, 16–18, 2009
Hyatt Regency
Chicago, USA

An International Conference sponsored by Phonak

PHONAK life is on

EXECUTIVE FUNCTION AND CENTRAL PRESBYCUSIS

- We have demonstrated that NP tests (Trails A and B, clock drawing, Stroop color test) and Central Auditory Tests covary. (In review)
- People with memory-loss-only perform poorly on Central Auditory Tests (Arch OHNS 2008)
- This evidence suggests that central auditory dysfunction is an early manifestation of cognitive impairment or that both are due to a third factor

Testing for Central Auditory Dysfunction

- Seldom done routinely because:
  - Not traditional
  - Uncertainty about billing
  - Lack of specific therapy until now (L.A.C.E., eg)
- Recommend doing Dichotic Sentence Identification in free report to exclude CAPD at initial visit and repeat for those with problems

REHAB for ARHL and CAPD

Proactive

- Assure cognitive status at initial visit with central auditory function test
- Modify fitting strategies as needed: enhance SN ratio, unilateral fit, counsel patients
- Enroll patient in auditory training program (L.A.C.E.) or equivalent
- Monitor progress closely. Consider neuropsych testing for those who do not improve.

CPT Codes
Texas

- 92620 - Evaluation of central auditory function, with report; initial 60 minutes $71.11
- 92507 - Treatment of speech, language, voice, communication, and/or auditory processing disorder; individual. Non-facility $60.62 / $25.84
- 92633 - Auditory rehabilitation; postlingual hearing loss. $0.00
- 92636 - Evaluation of auditory rehabilitation status; first hour $77.80 / $18.91 q 15 mins