Hearing and Cognition

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Ho Chi Minh city, 24 november 2019

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From Hearing to Cognition

How to screen cognitive deficits in the elderly

What does it mean for presbycusis management

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From Hearing Sensitivity to Cognition

- **Hearing =** ***hearing sensitivity*** **+** ***auditory processing***
- **PTA alone don't tell you much**
- **Strong interaction with cognition**
- **Cognitive reservoir depends on hearing**

Introduction

- **1989**: First reported association between hearing loss (HL) and dementia (**Uhlmann et al**. *J of the Am Med Assoc)*
- Not much data until **2011** and the research conducted by **Frank Lin and colleagues** at Johns Hopkins School of Medicine, Baltimore, USA

Arch Neurol. 2011 February ; 68(2): 214–220. doi:10.1001/archneurol.2010.362.

Hearing Loss and Incident Dementia

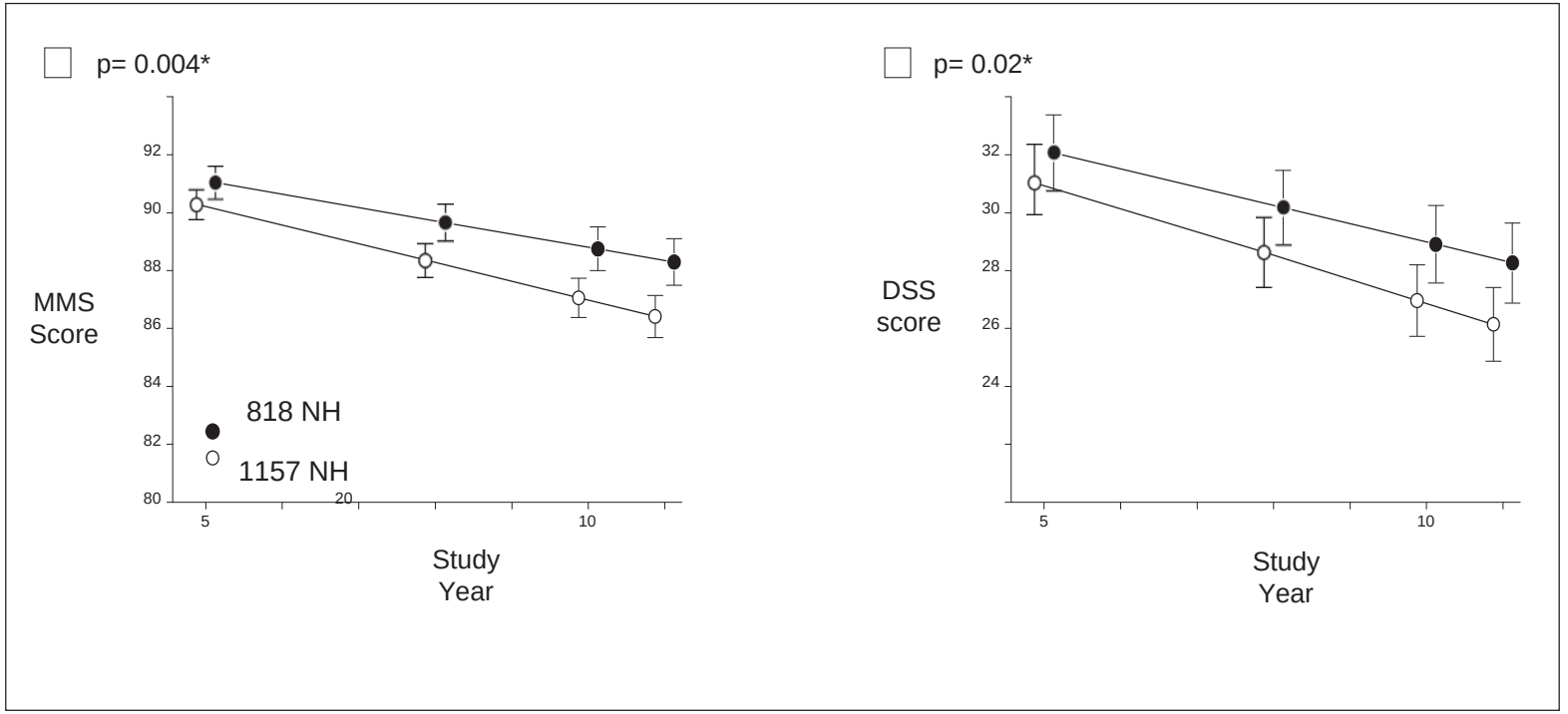
Frank R. Lin, MD PhD[1], E. Jeffrey Metter, MD[2], Richard J. O'Brien, MD PhD[3], Susan M. Resnick, PhD[4], Alan B. Zonderman, PhD[4], and **Luigi Ferrucci, MD PhD[2]**

- Prospective study of 640 participants (age 36 – 90 y) w no dementia in 1990' || follow-up of 12 yrs, 58 cases of incident all-cause dementia (IACD), including 37 Alzheimer Disease cases (AD)
- Risk of IACD ↗ linearly with HL severity (1.27 per 10 db loss)
- Hazard ratio for IACD = **1.89** for mild HL, **3.00** for moderate HL, and **4.94** for severe HL
- HL is independently associated with IACD

Hearing Loss and Cognitive Decline in Older Adults

Frank R. Lin, MD, PhD; Kristine Yaffe, MD; Jin Xia, MS; Qian-Li Xue, PhD; Tamara B. Harris, MD, MS; Elizabeth Purchase-Helzner, PhD; Suzanne Satterfield, MD, DrPH; Hilsa N. Ayonayon, PhD; Luigi Ferrucci, MD, PhD; Eleanor M. Simonsick, PhD; for the Health ABC Study Group

JAMA Intern Med. 2013;173(4):293-299.



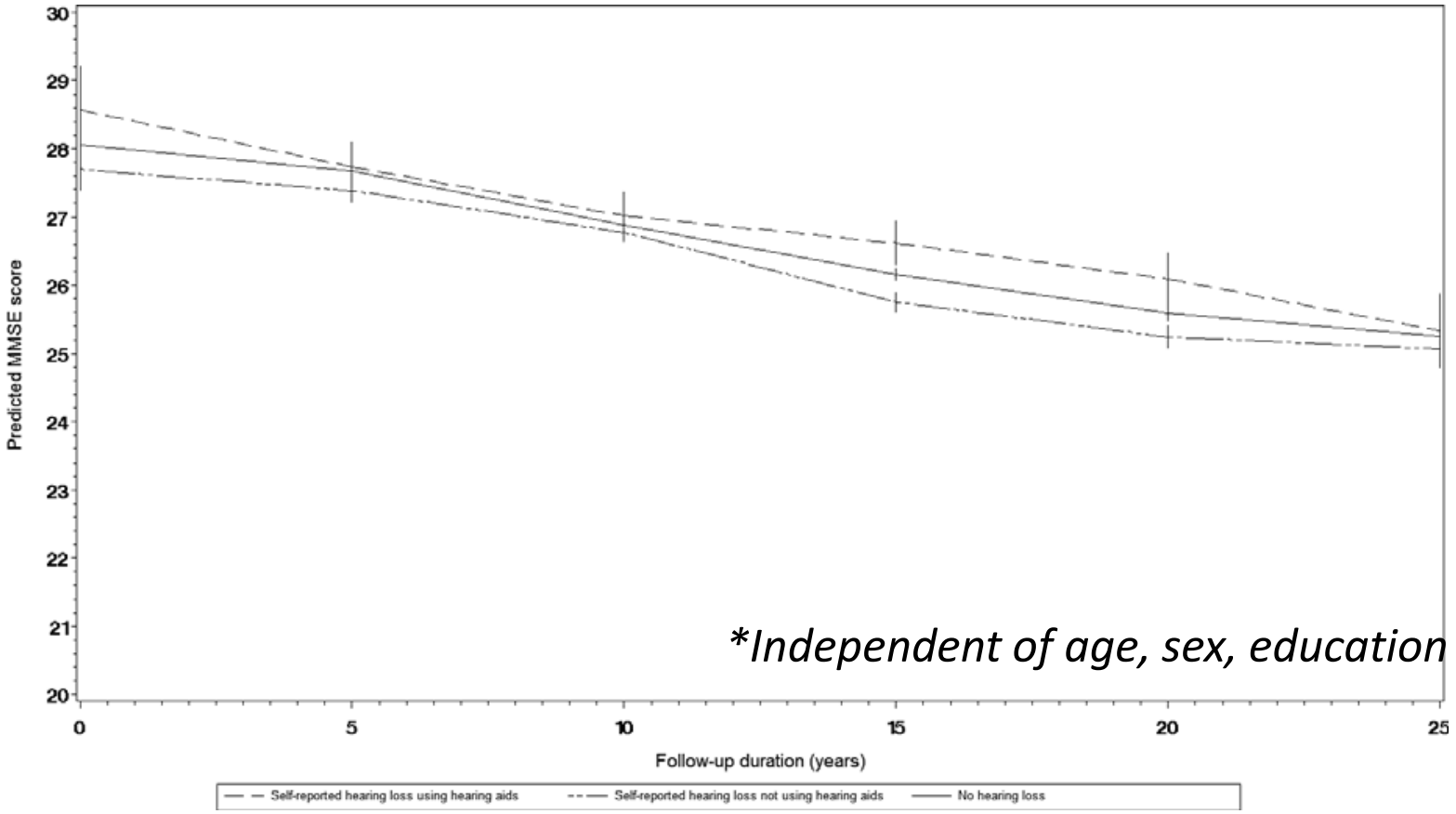
Rates of cognitive decline depending on hearing status: 11 yr-follow-up

**Adjusted for age, sex, race/ethnicity, education, study site, smoking status, Hypertension, diabetes mellitus, and stroke history*

Self-Reported Hearing Loss, Hearing Aids, and Cognitive Decline in Elderly Adults: A 25-Year Study

Hélène Amieva, PhD, Camille Ouvrard, MSc, Caroline Giulioli, MSc, Céline Meillon, MSc, Laetitia Rullier, PhD, and Jean-François Dartigues, MD, PhD

J Am Geriatr Soc 63:2099–2104, 2015



**Independent of age, sex, education*

Estimated change in Mini-Mental State Examination (MMSE) score over 25 years of follow-up (N = 3.670)

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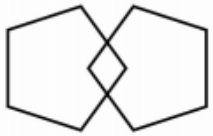
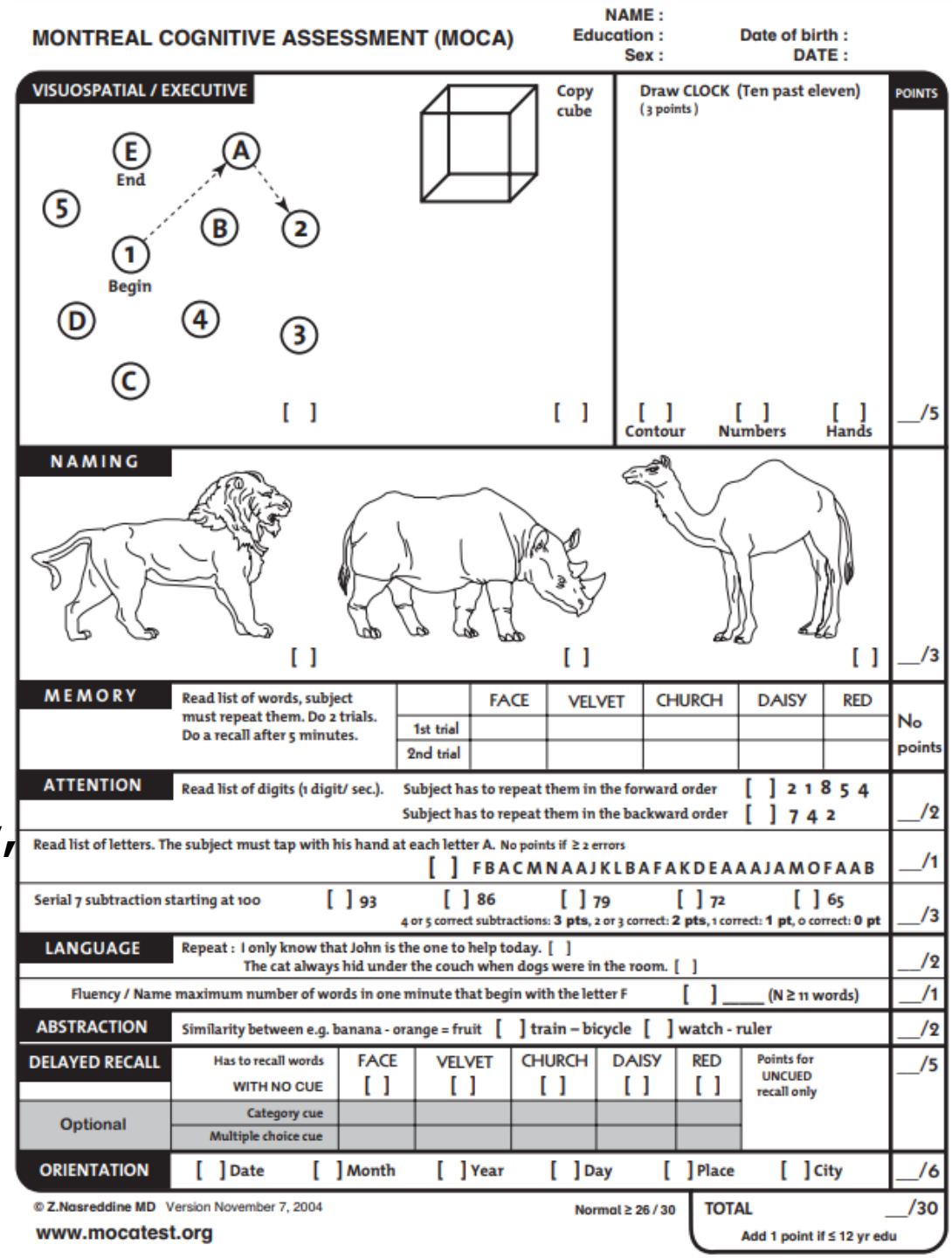
- ❑ **Has been used for decades as the gold standard for screening neuropsychiatric disorders**
- ❑ **Quick and easy, normal score > 26**
- ❑ **Low sensitivity in screening of mild cognitive impairment (MCI)**

MINI MENTAL STATE EXAMINATION (MMSE)

One point for each answer	DATE:		
ORIENTATION Year Season Month Date Time	...../ 5	...../ 5	...../ 5
Country Town District Hospital Ward/Floor	...../ 5	...../ 5	...../ 5
REGISTRATION Examiner names three objects (e.g. apple, table, penny) and asks the patient to repeat (1 point for each correct. THEN the patient learns the 3 names repeating until correct).	...../ 3	...../ 3	...../ 3
ATTENTION AND CALCULATION Subtract 7 from 100, then repeat from result. Continue five times: 100, 93, 86, 79, 65. (Alternative: spell "WORLD" backwards: DLROW).	...../ 5	...../ 5	...../ 5
RECALL Ask for the names of the three objects learned earlier.	...../ 3	...../ 3	...../ 3
LANGUAGE Name two objects (e.g. pen, watch).	...../ 2	...../ 2	...../ 2
Repeat "No ifs, ands, or buts".	...../ 1	...../ 1	...../ 1
Give a three-stage command. Score 1 for each stage. (e.g. "Place index finger of right hand on your nose and then on your left ear").	...../ 3	...../ 3	...../ 3
Ask the patient to read and obey a written command on a piece of paper. The written instruction is: "Close your eyes".	...../ 1	...../ 1	...../ 1
Ask the patient to write a sentence. Score 1 if it is sensible and has a subject and a verb.	...../ 1	...../ 1	...../ 1
COPYING: Ask the patient to copy a pair of intersecting pentagons 	...../ 1	...../ 1	...../ 1
TOTAL:	...../ 30	...../ 30	...../ 30

MMSE scoring
24-30: no cognitive impairment
18-23: mild cognitive impairment
0-17: severe cognitive impairment

- **Designed in Montreal** (Nasreddine et al., 2005)
- **Also normal if score > 26**
- **11 distinct tests**
- **Targetting mental flexibility, 3D visuospatial processing, categorization skills**



MONTREAL COGNITIVE ASSESSMENT (MOCA)

NAME :
Education :
Sex :
Date of birth :
DATE :

VISUOSPATIAL / EXECUTIVE

Copy cube

Draw CLOCK (Ten past eleven) (3 points)

POINTS

E End, A, 5, B, 2, 1 Begin, D, 4, 3, C

[ ] [ ]

[ ] Contour [ ] Numbers [ ] Hands

__/5

NAMING

[ ] [ ] [ ]

__/3

MEMORY

Read list of words, subject must repeat them. Do 2 trials. Do a recall after 5 minutes.

	FACE	VELVET	CHURCH	DAISY	RED
1st trial					
2nd trial					

No points

ATTENTION

Read list of digits (1 digit/ sec.).

Subject has to repeat them in the forward order [ ] 2 1 8 5 4

Subject has to repeat them in the backward order [ ] 7 4 2

__/2

Read list of letters. The subject must tap with his hand at each letter A. No points if ≥ 2 errors

[ ] F B A C M N A A J K L B A F A K D E A A A J A M O F A A B

__/1

Serial 7 subtraction starting at 100 [ ] 93 [ ] 86 [ ] 79 [ ] 72 [ ] 65

4 or 5 correct subtractions: **3 pts**, 2 or 3 correct: **2 pts**, 1 correct: **1 pt**, 0 correct: **0 pt**

__/3

LANGUAGE

Repeat : I only know that John is the one to help today. [ ]

The cat always hid under the couch when dogs were in the room. [ ]

__/2

Fluency / Name maximum number of words in one minute that begin with the letter F [ ] ____ (N ≥ 11 words)

__/1

ABSTRACTION

Similarity between e.g. banana - orange = fruit [ ] train – bicycle [ ] watch - ruler

__/2

DELAYED RECALL

	Has to recall words WITH NO CUE	FACE	VELVET	CHURCH	DAISY	RED	Points for UNCUED recall only
		[ ]	[ ]	[ ]	[ ]	[ ]	
Optional	Category cue						
	Multiple choice cue						

__/5

ORIENTATION

[ ] Date [ ] Month [ ] Year [ ] Day [ ] Place [ ] City

__/6

© Z.Nasreddine MD Version November 7, 2004

www.mocatest.org

Normal ≥ 26 / 30

TOTAL __/30

Add 1 point if ≤ 12 yr edu

	MMSE	MOCA
Orientation	✓	✓
Abstraction	✗	✓
Memory		
- Free Recall	✓	✓
- Cued recall	✗	✓
- Recognition	✗	✓
Visuospatial Praxis		
- Copy	✓	✓
- Clock test	✗	✓
Attention		
- Digit series	✗	✓
- Reverse digit series	✗	✓
- Letter series	✗	✓
- Countdown	✓	✓
Executive (visual)	✗	✓
Language		
- Repetition	✓	✓
- Reading	✓	✗
- Writing	✓	✗
- Comprehension	✓	✗
- Fluency	✗	✓
Denomination		
- Real object	✓	✗
- Image	✗	✓

Mini Mental State Examination (MMSE) *vs* Montreal Cognitive assessment (MoCA)

	MMSE	MoCA
RELEVANT ITEMS	**9**	**15**

MoCA's sensitivity in detecting MCI reaches 90%, far superior to the MMSE's sensitivity (18%).

Zadikoff et al., 2008

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Take home messages

I) **Do the MoCa but do it properly**
II) Consider all possible co-morbidities
III) Test both hearing sensitivity and central auditory processes

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Development of Cognitive Screening Test for the Severely Hearing Impaired: Hearing-Impaired MoCA

Vincent Y. W. Lin, MD, FRCSC; Janet Chung, MD, FRCSC; Brandy L. Callahan, PhD, Psych; Leah Smith, MA, CCRA; Nils Gritters, BSc (Hons); Joseph M. Chen, MD, FRCSC; Sandra E. Black, OC, O.Ont. MD, FRSC, FAAN, FANA; Mario Masellis, MSc, MD, PhD, FRCPC

Laryngoscope 2017;173(4):293-299.

- MoCa requires verbal instructions that cannot be taken by the severely hearing impaired
- Lower MoCa scores in subjects with mild/moderate HL compared to NH (*Dupuis et al., Neuropsychol Dev Cogn B Aging Neuropsychol Cogn 2015*)

Take home messages

I) Do the MoCa but do it properly
II) Consider all possible co-morbidities
III) Test both hearing sensitivity and central auditory processes

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Original Article

Hearing Loss is Associated With Risk of Alzheimer's Disease: A Case-Control Study in Older People

N= 488 subjects ≥ 65 yr with newly diagnosed AD vs 1952 subjects without AD from 1998–2011

Odds ratios of Alzheimer's disease associated with hearing loss and other co-morbidities

Variable	Crude		Adjusted[a]	
	OR	(95% CI)	OR	(95% CI)
Sex (male vs female)	1.00	(0.82–1.22)	—	
Age (per 1 year increment)	1.04	(1.02–1.06)	1.03	(1.01–1.05)
Co-morbidities before index date				
Hearing loss	1.56	(1.19–2.04)	1.39	(1.05–1.84)
Cerebrovascular disease	1.05	(0.78–1.41)	—	
Chronic kidney disease	1.19	(0.79–1.78)	—	
Depression	2.16	(1.55–3.00)	1.68	(1.19–2.39)
Diabetes mellitus	1.41	(1.14–1.75)	1.23	(0.98–1.55)
Head injury	2.74	(1.76–4.27)	2.31	(1.46–3.66)
Hypertension	1.70	(1.35–2.13)	1.40	(1.10–1.79)
Hyperlipidemia	1.30	(1.03–1.62)	1.08	(0.84–1.37)
Parkinson's disease	5.45	(3.17–9.37)	4.44	(2.54–7.78)

CI, confidence interval; OR, odds ratio.

Quaranta et al., Audiol Neurotol 2014; 19 (suppl 1): 10-14

The Prevalence of Peripheral and Central Hearing Impairment and Its Relation to Cognition in Older Adults

N= 488 subjects ≥65 yr (mean age 72.8 years)

- Prevalence of a HL ≥ 25 dB HL = 64%
- Prevalence of Central Auditory Processing Disorder (CAPD) = 14 %
- MCI significantly associated with hearing impairment (CAPD and hearing threshold; odds ratio 1.6, p = 0.05)
- AD significantly associated with CAPD (odds ratio 4.2, p = 0.05)
- Up to 80% of MCI patients convert to AD ↔ adding auditory tests to cognitive screening can help early diagnosis of cognitive decline

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I) Do the MoCa but do it properly
II) Consider all possible co-morbidities
III) Test both hearing sensitivity and central auditory processes

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CENTRAL AUDITORY PROCESSING ASSESSMENT

- Listening in Noise (1)
- Dichotic listening (2)
- Temporal resolution
- Pattern recognition (pitch & duration)

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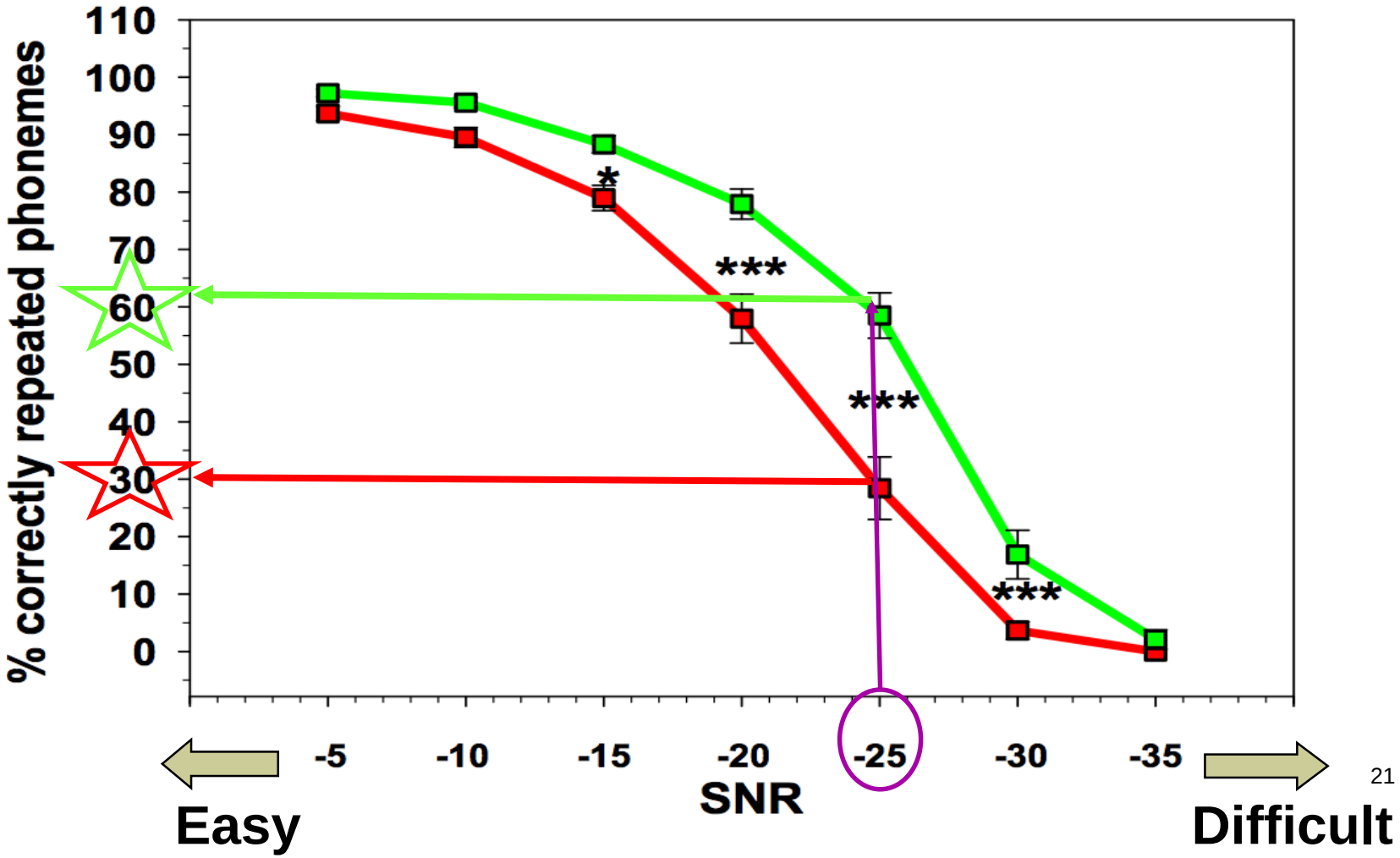
LISTENING IN NOISE

CAPD subjects

Normal central auditory processes

**Adjusted for PTA scores*



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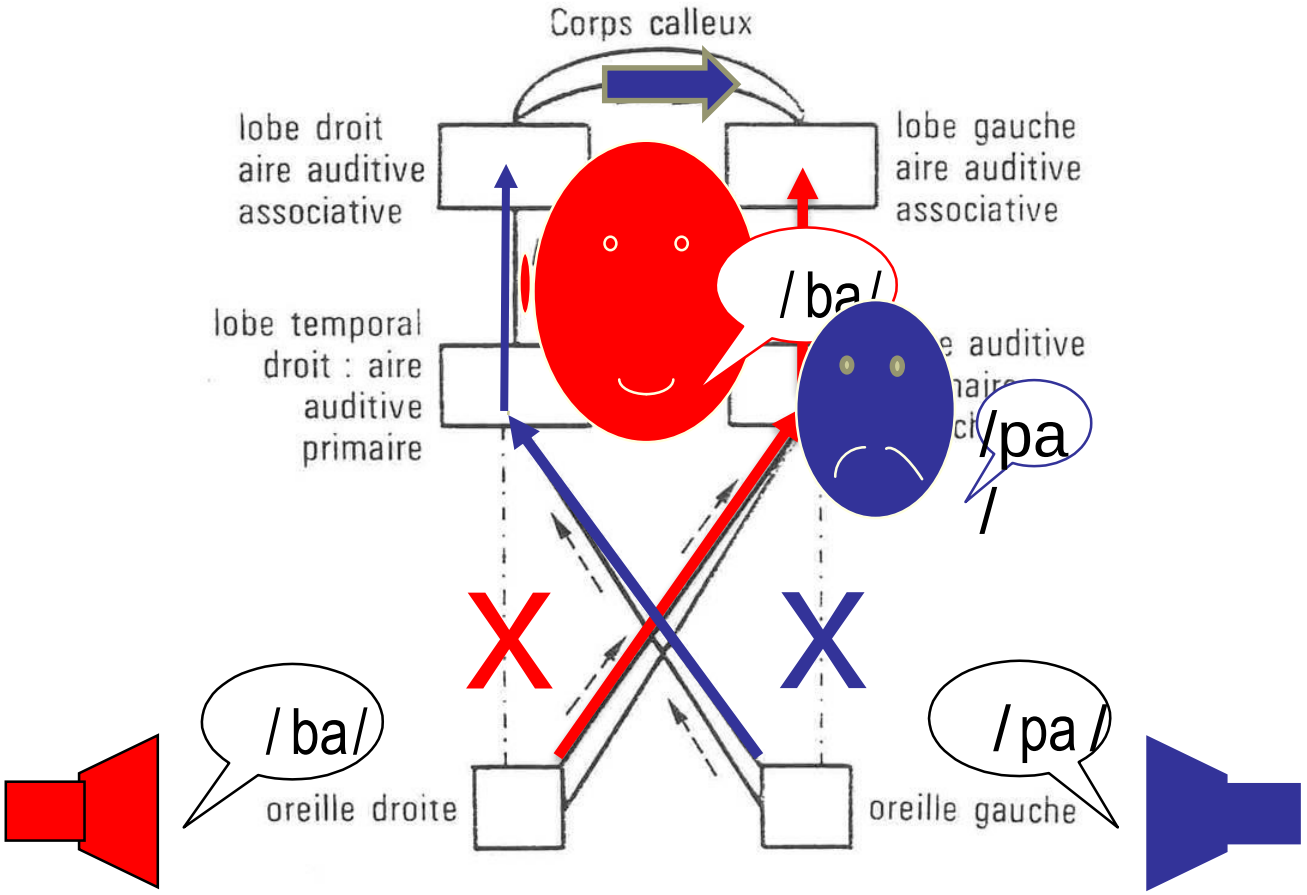
DICHOTIC TEST



From Sparks,Goodglass & Nickel

Key points for management

- Most recent studies report adjusted odds ratio of Alzheimer's disease ≥ 1.3 in people with HL
- In case of abnormal MoCa, refer to a trained professional for formal neuropsychological assessment

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Key points for management

- CAPD affect up to 70% of older adults

(Golding et al, Blue mountain hearing study, J Am Acad Audiol, 2004)

Listening strategies	❑ actions on sound environment (↘ noise level)
Listening devices	❑ FM devices; directional microphone (↗ SNR)
Auditory training	❑ Audiovisual tek, serious games; Onsite or remote training
Special needs	❑ Personalized medicine (e.g ., attention deficits)

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Thank you!

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