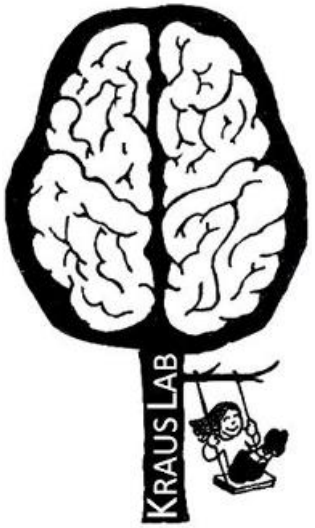
Aging

&

Making Sense of Sound

Nina Kraus, Ph.D.



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Disclosures

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Other financial relationships:
Equity in Synaural, Inc., a company working to develop a user-friendly measure of auditory processing.

Conflicts of interest:
None

Aging and Making Sense of Sound

EAR
- presbycusis
- hair cell damage
- synaptopathy

BRAIN
- central hearing loss

Action: feed the brain the best signal from the ear

Action: activities to promote CNS strength and plasticity

Factors that make an older adult successful at hearing in noise

SOUND…

Attributes of a "seen" object

Shape … sphere

Dimensionality … 3D

Color … yellow

Solidity … yes

concrete

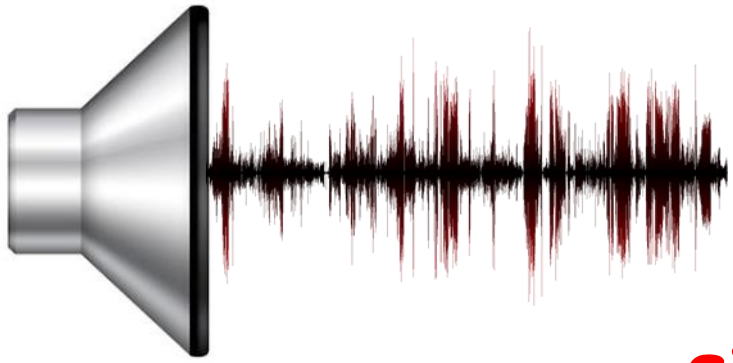
Pattern … none

Movement … no

Transparency … no

Texture … fuzzy

Attributes of sound



Pitch … high

Timbre … crunchy

Intensity … loud

Timing … fast

Consonance … dissonant

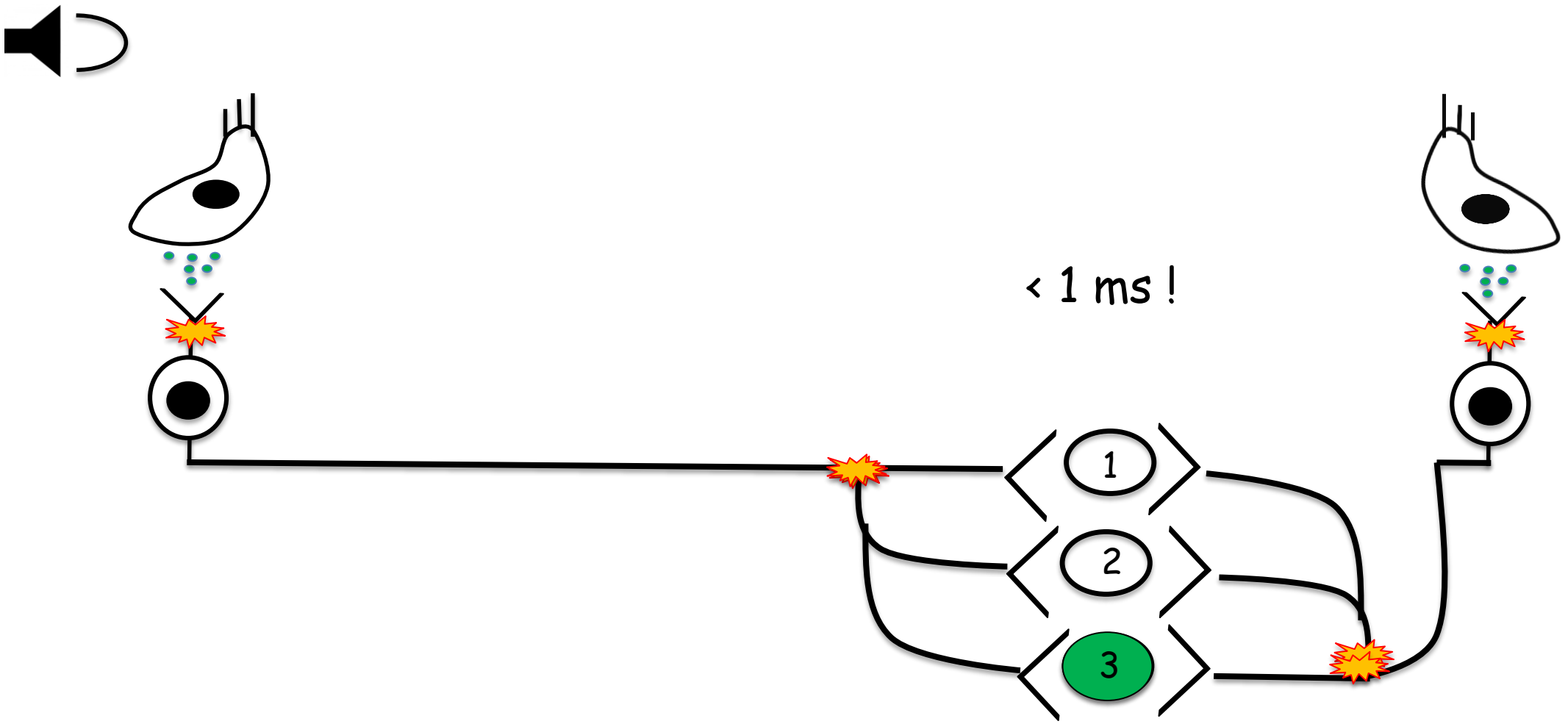
Location … straight ahead

Attack … gradual

Movement … left to right

abstract
fleeting

Auditory Processing Speed

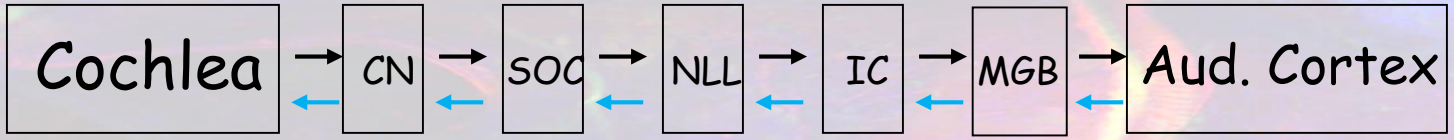


Left Ear

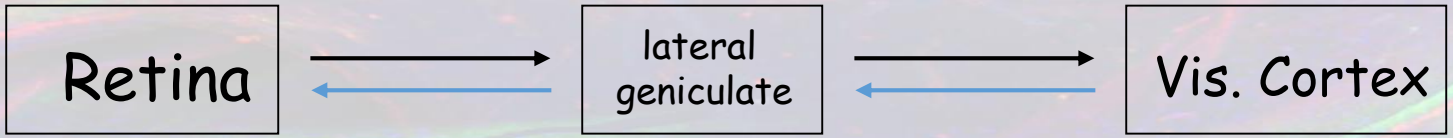
Auditory Brain

Right Ear

Auditory system

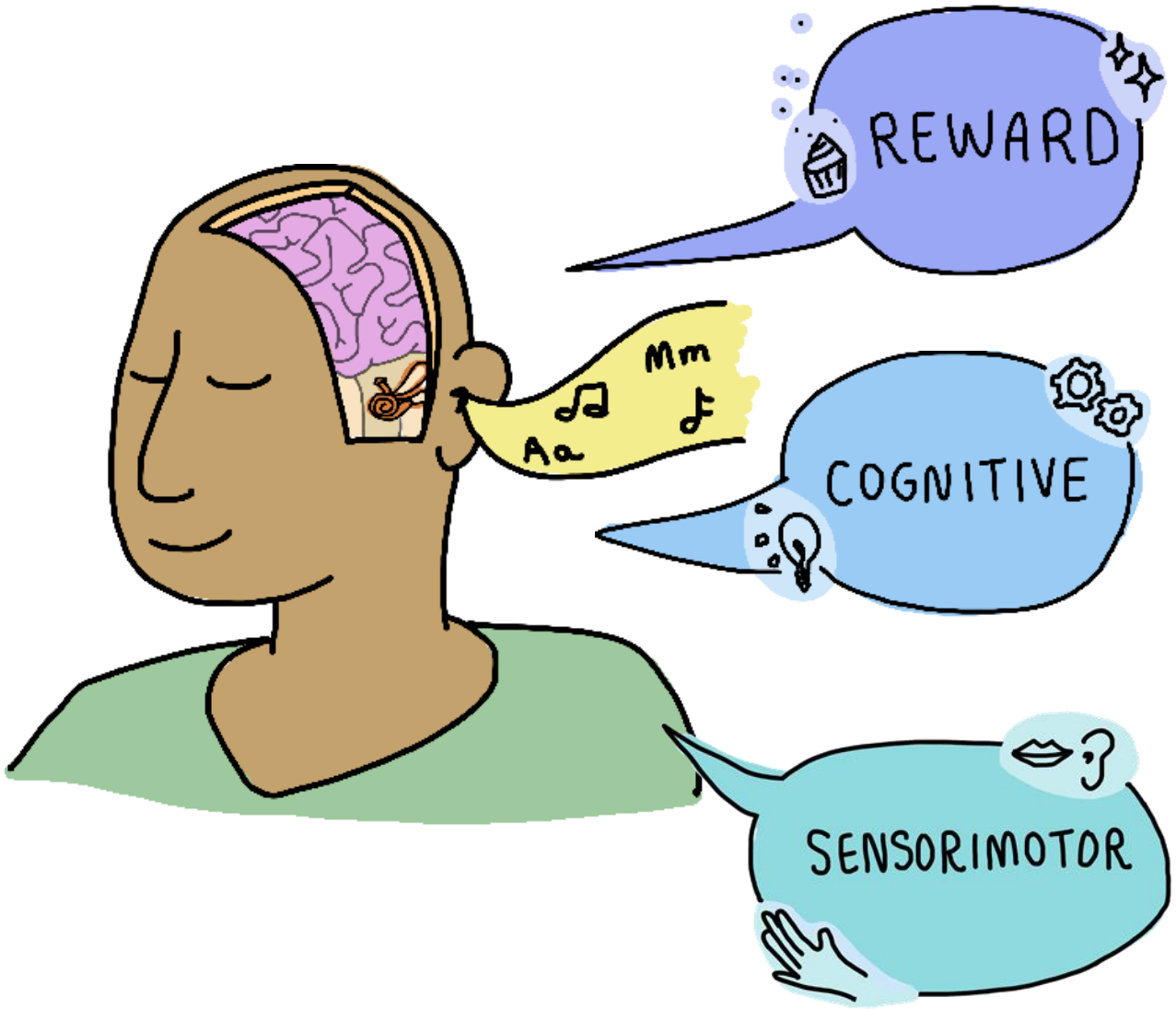


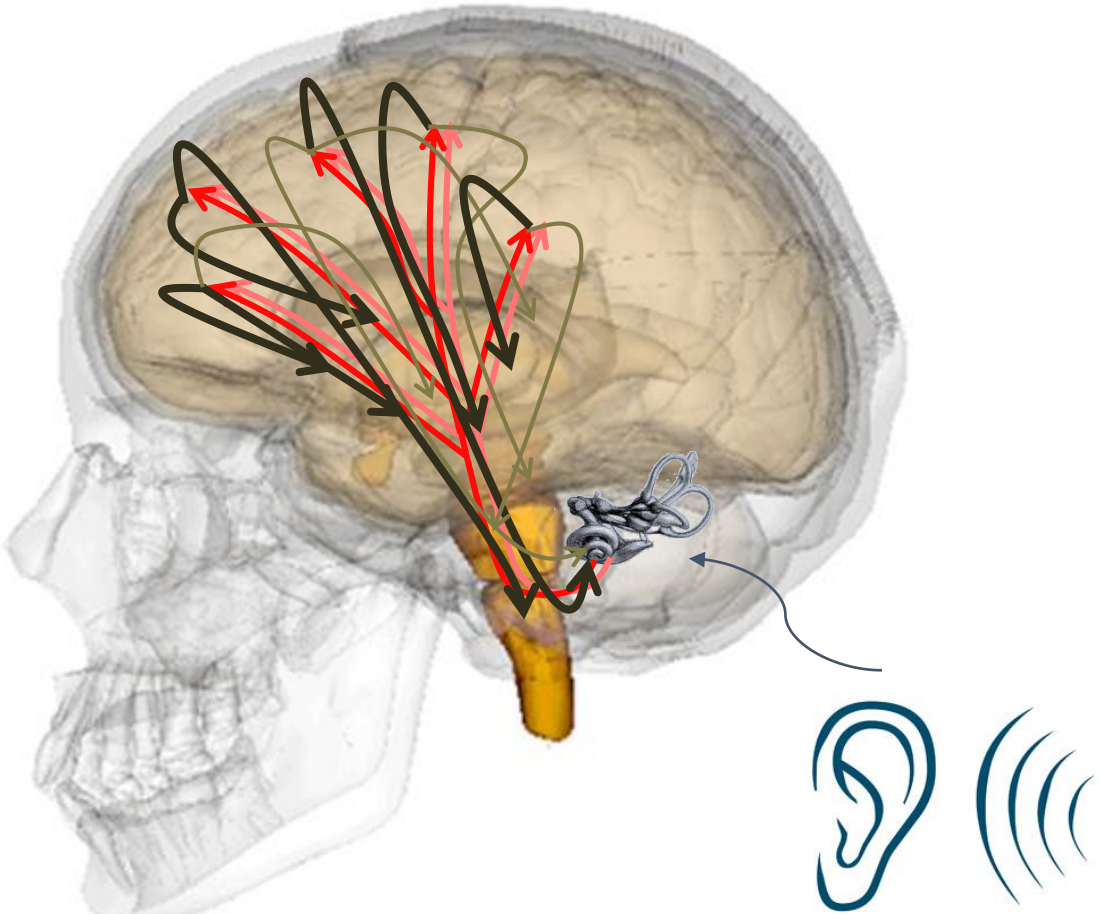
visual system



connectivity to non-auditory centers

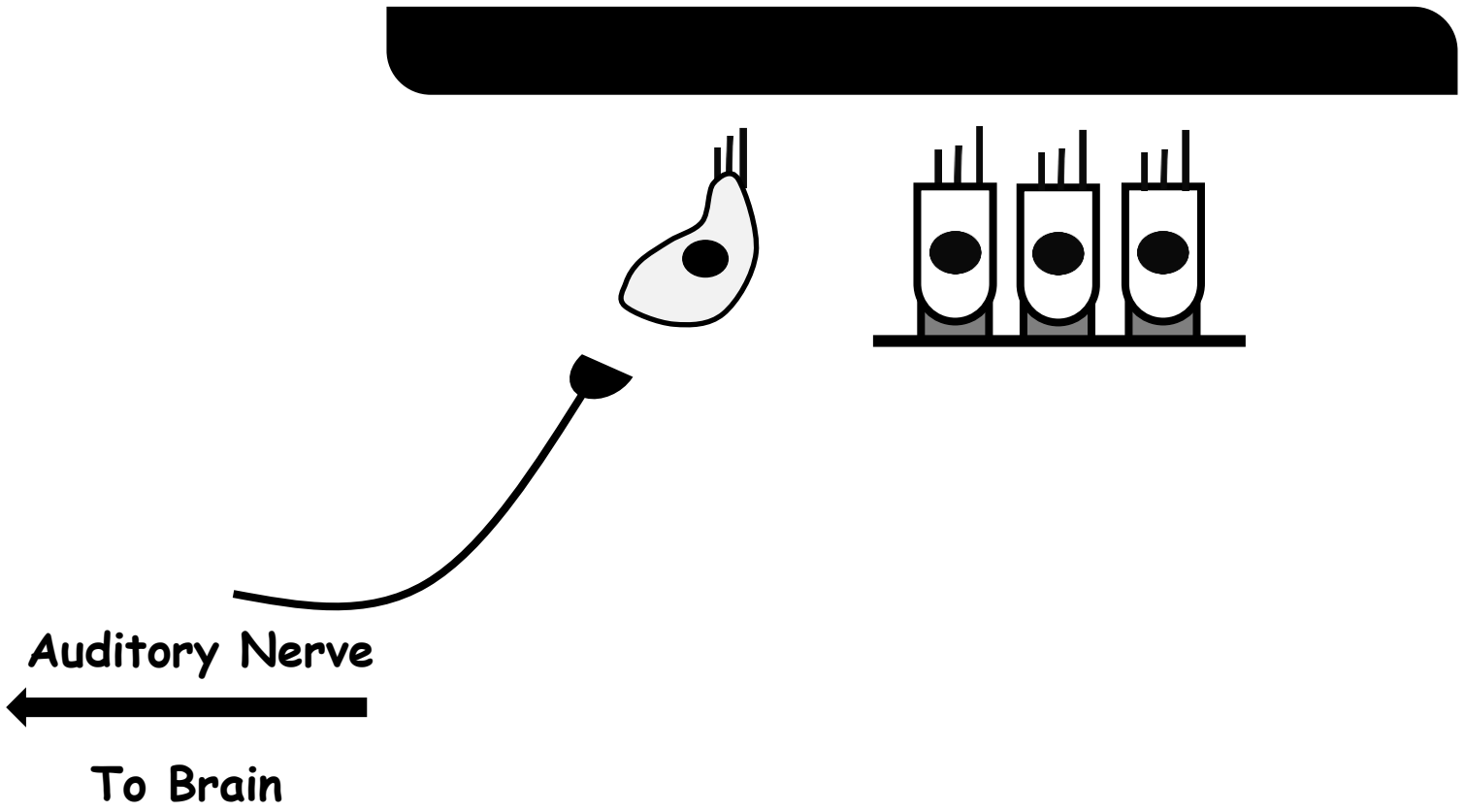
Making sense of sound



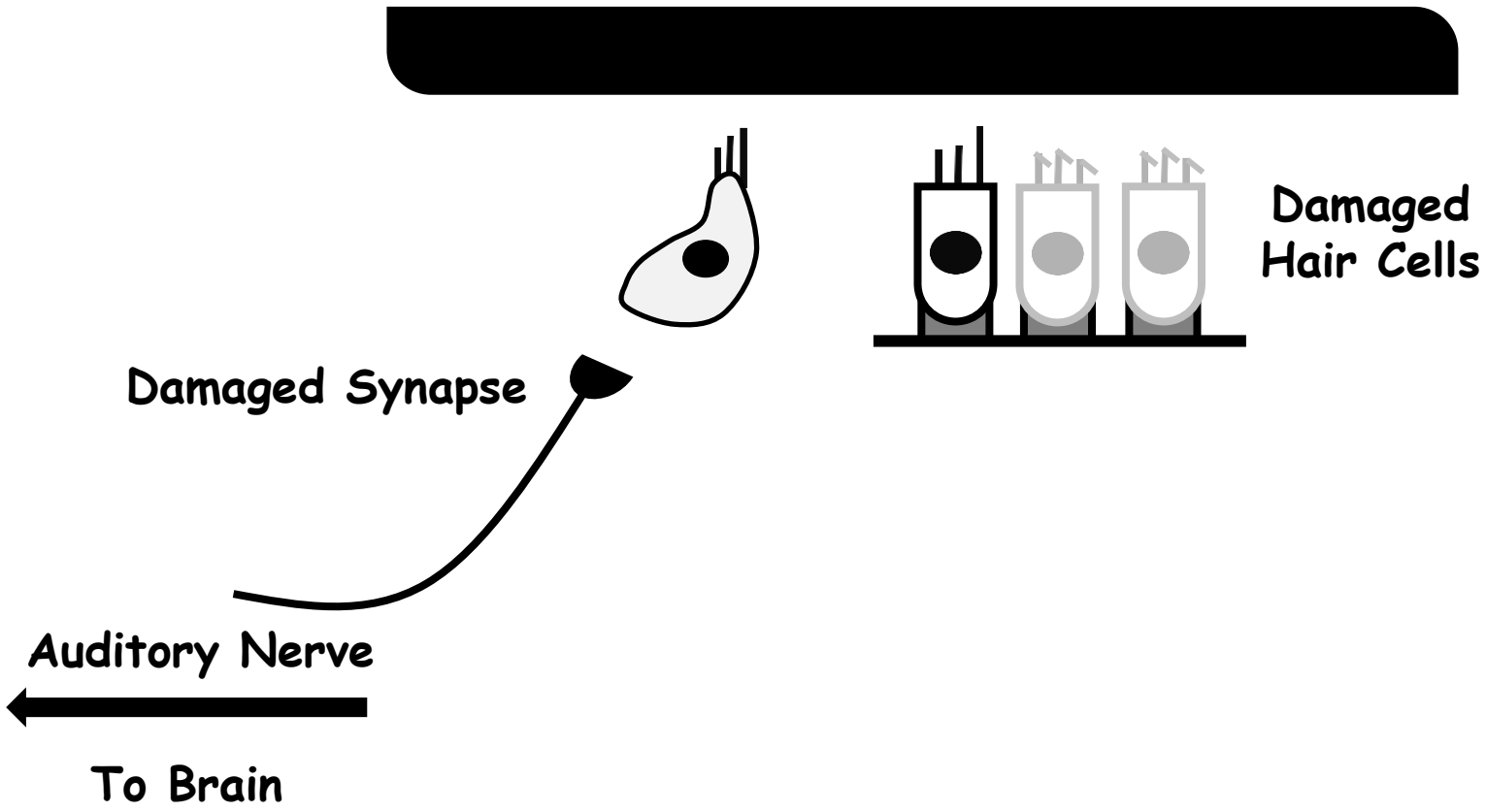


Kraus & White-Schwoch, *Trends Cog Sci*, 2015

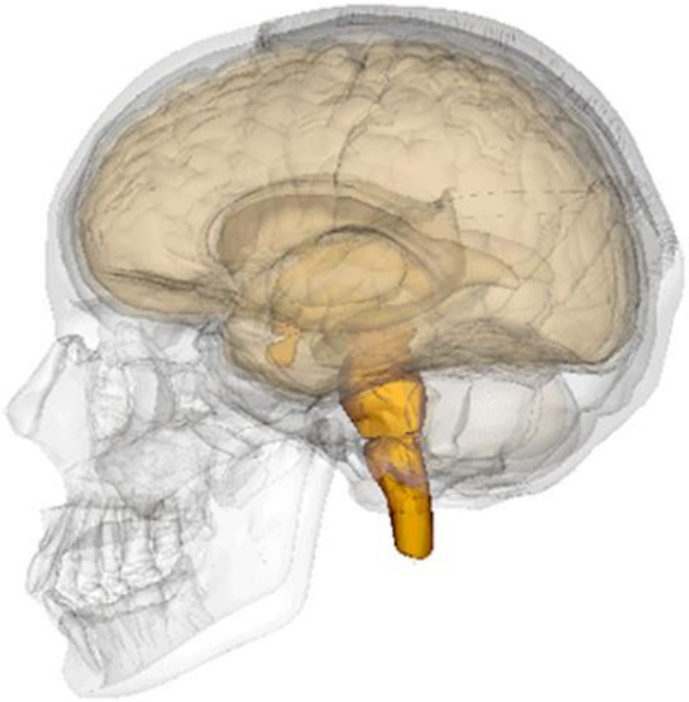
Normal Inner Ear



Damaged Hair Cells and Synapse

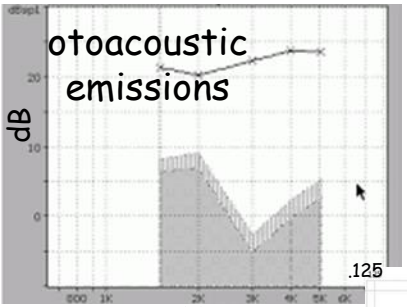


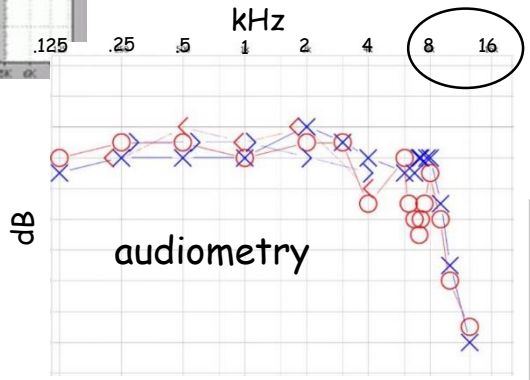
Kujawa & Liberman *J Neurosci* 2009



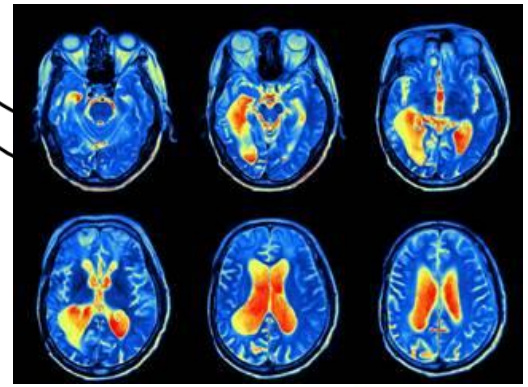
Take ear and brain into account

Individualized biological data

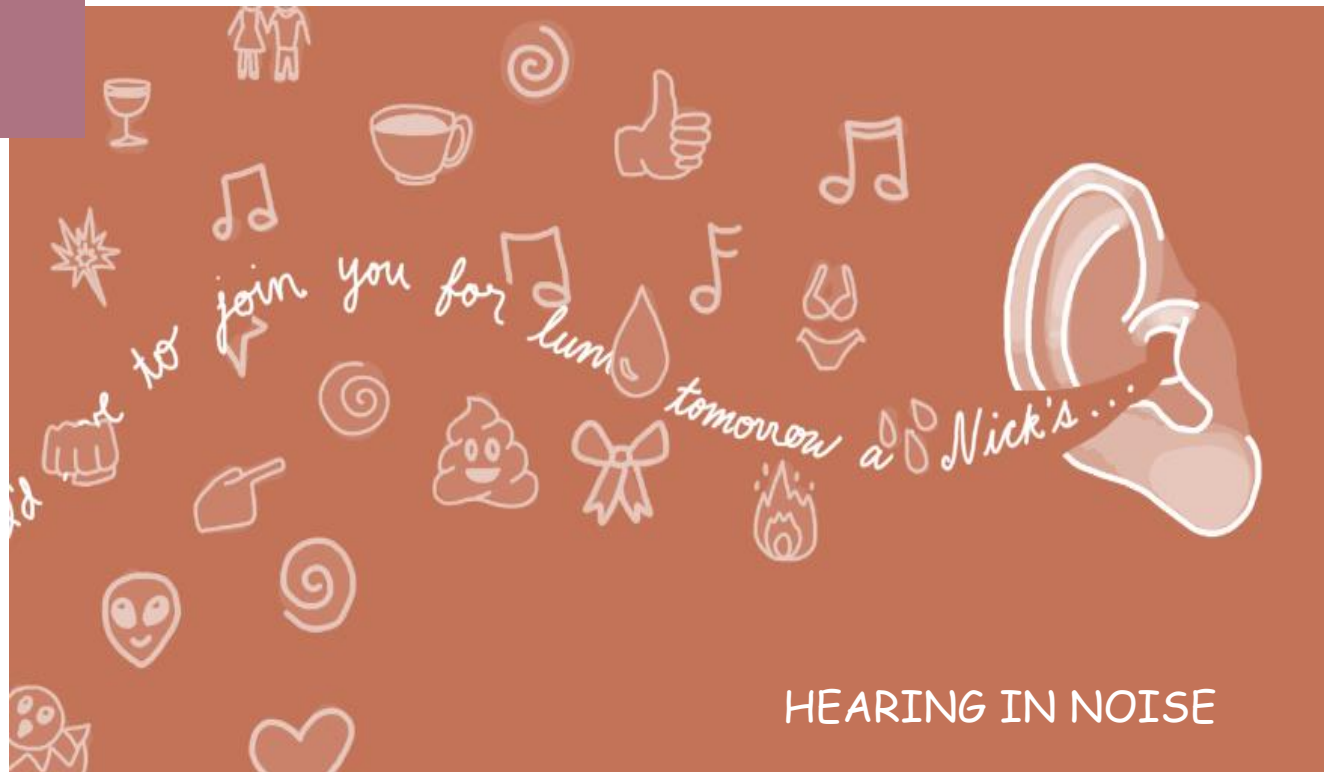

otoacoustic
emissions
dB
Hz


kHz
.125
.25
.5
1
2
4
8
16
dB
audiometry

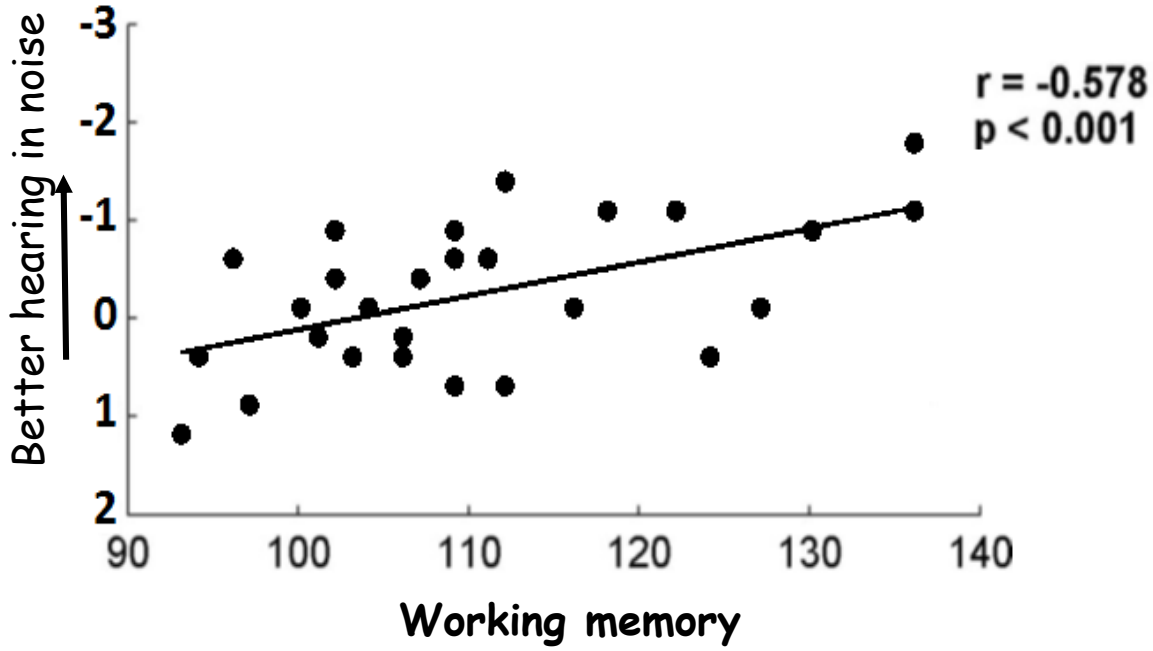

QuickSIN
HINT
WIN
Room
10 ft. x 8 ft.

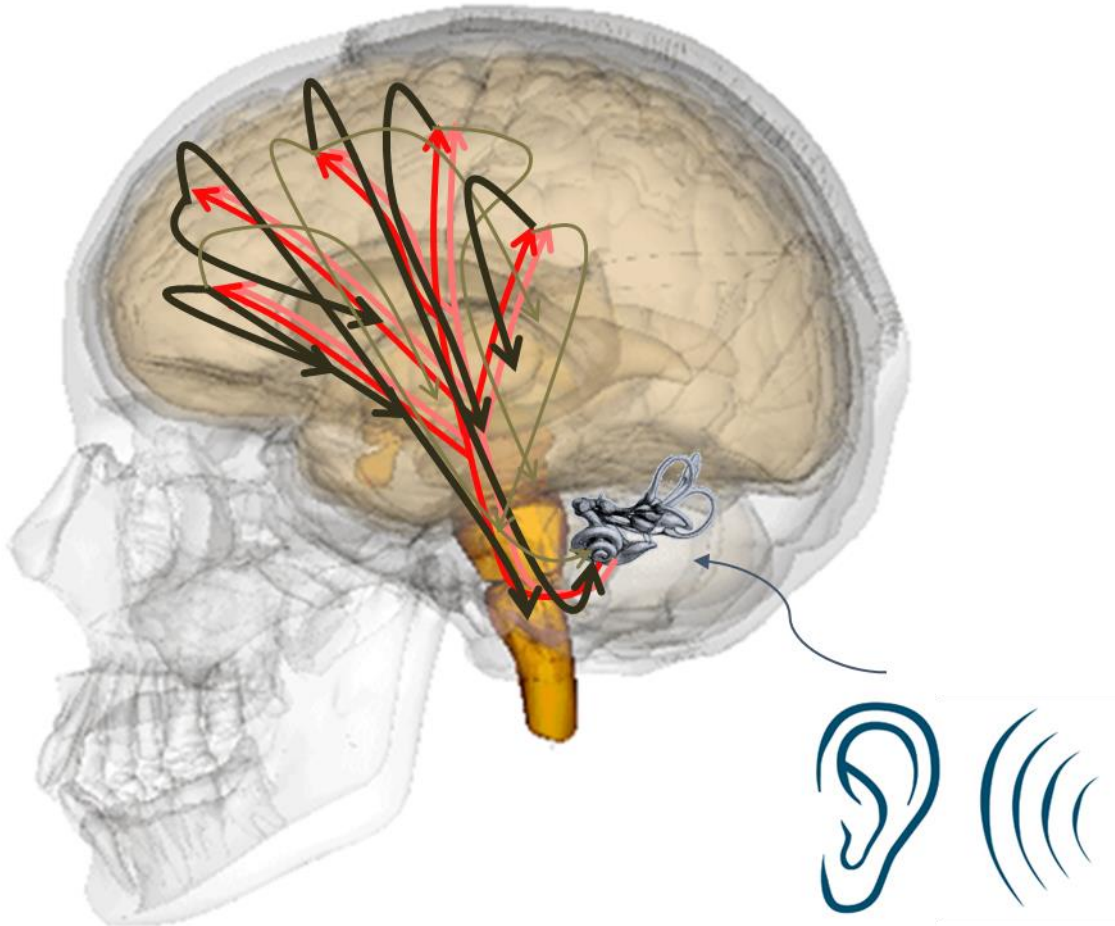



AGING


to join you for lunch tomorrow at Nick's...
HEARING IN NOISE

Hearing in Noise engages Cognition

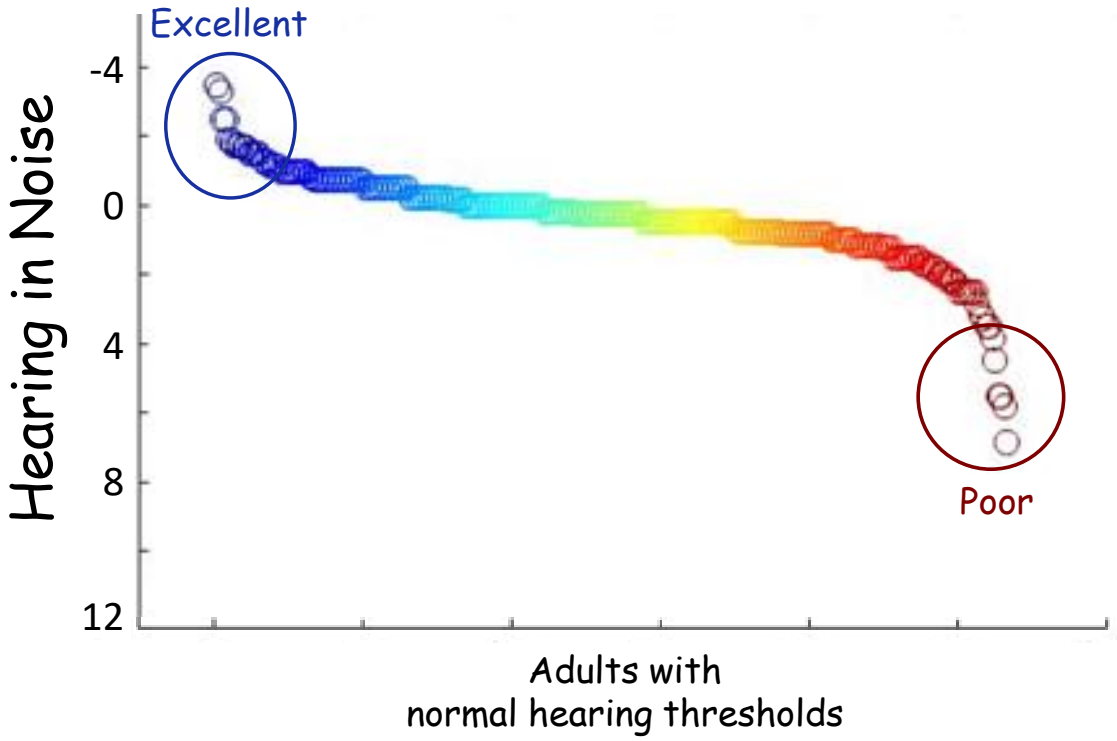


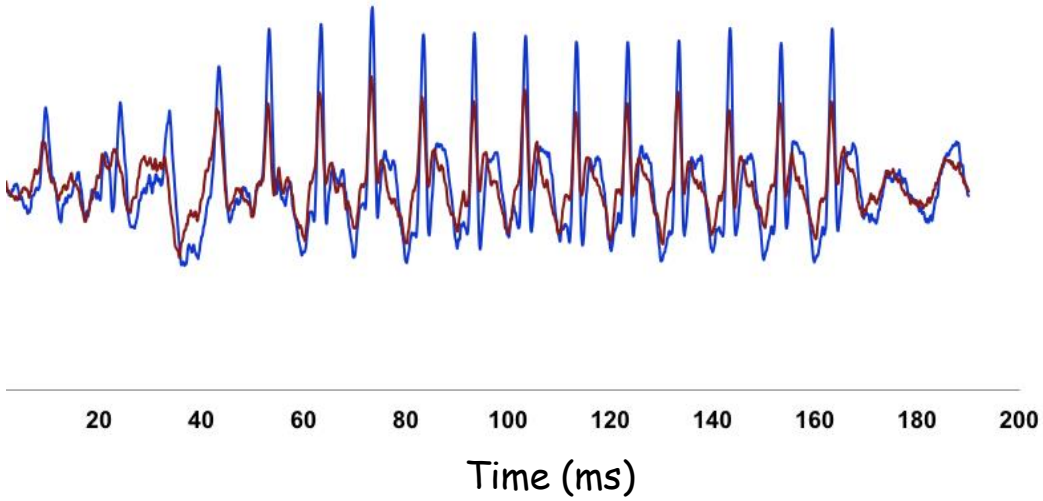


Moore et al., 2014, *PLoS ONE*

Hearing in Noise – Sound Processing in the Brain

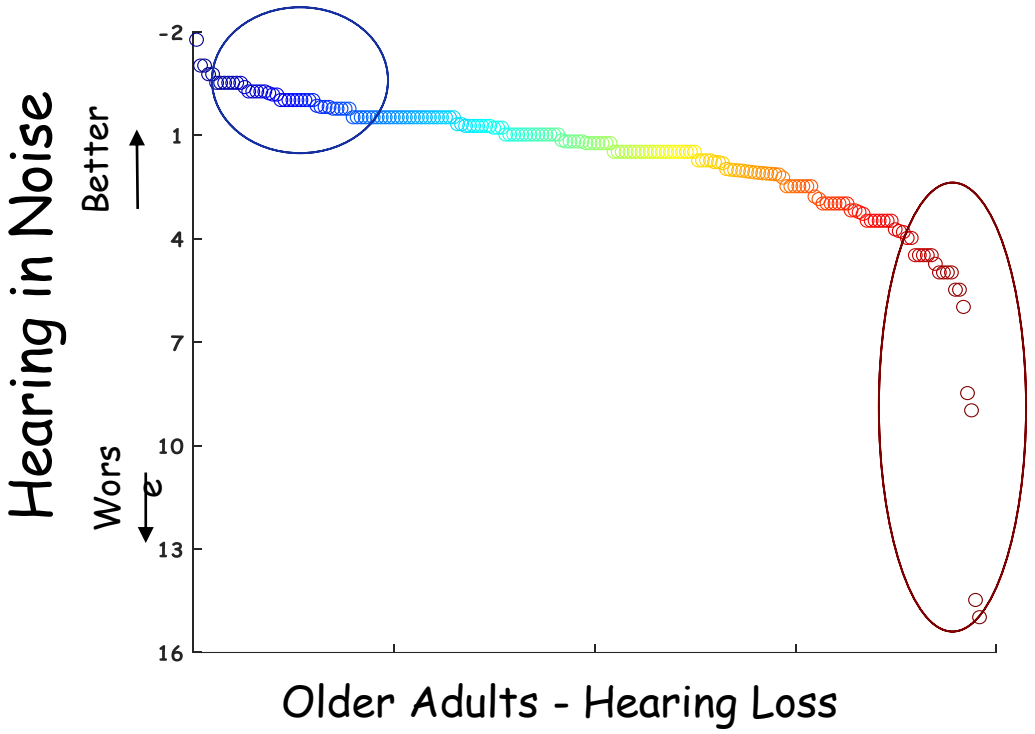
Normal Hearing Thresholds

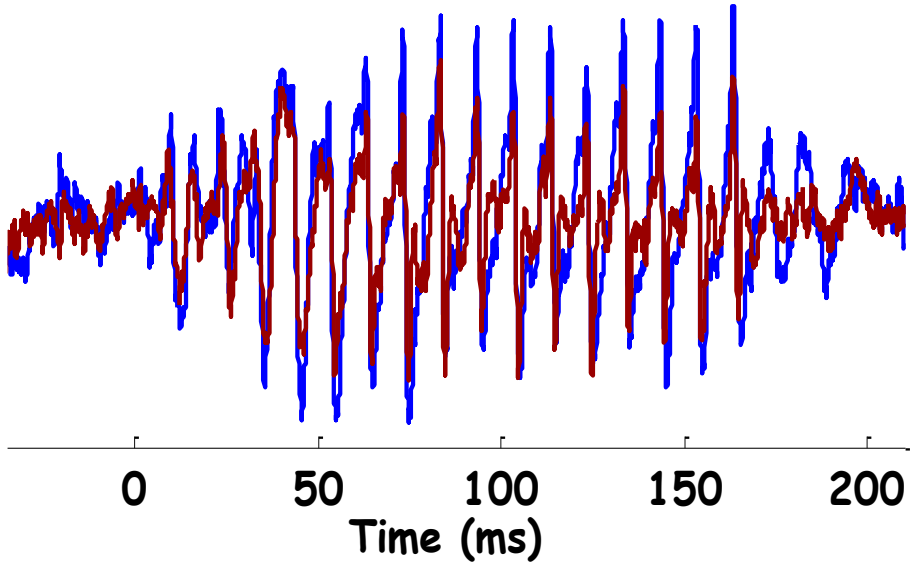




Hearing in Noise - Sound Processing in the Brain

Hearing Loss





COGNITION

Memory
Attention

.5

SOUND PROCESSING in the BRAIN

Pitch, Timing, Harmonics

.6

.4

LIFE EXPERIENCES

Music
Exercise

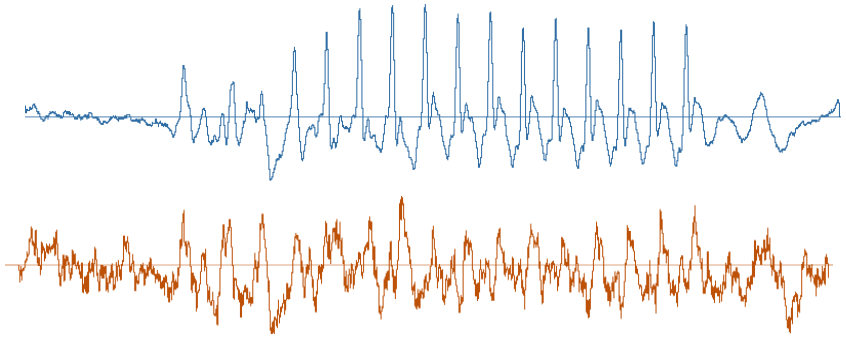
1.

EAR

Audiogram
OAEs

Anderson et al (2013) *Hear Res*

Biological *Aging*



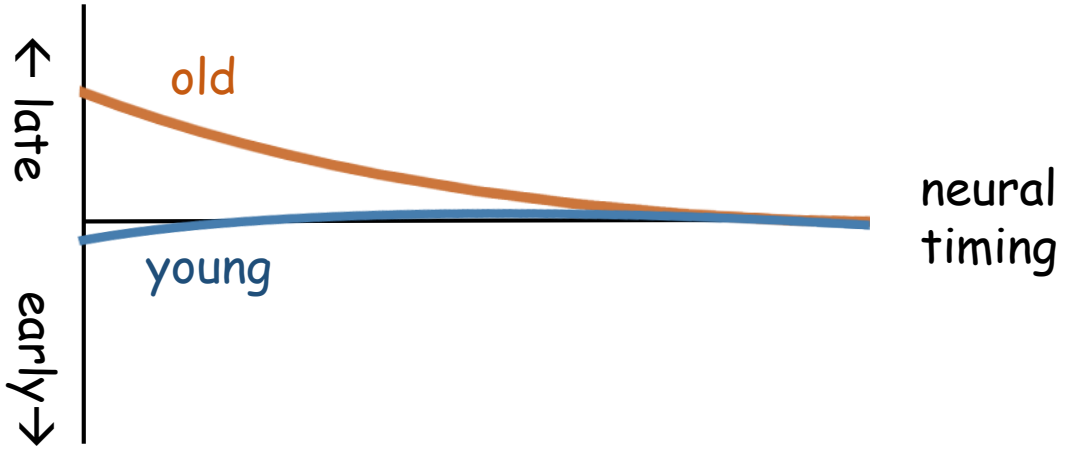
Breakdown in timing

Reduced inhibition

Increased spontaneous activity

Broader spatial tuning

Reduced cortical connectivity for spatial processing



Anderson et al, *J Neursoci* 2012
Caspary et al. , J Exp Biol 2008
Engle & Recanzone, *Front Aging Neurosci* 2013
Recanzone et al, *Hear Res* 2011
Juarez-Salinas et al, *J Neurosci* 2010

Biological Aging & Hearing Loss

Compensatory neurochemistry – protein expression

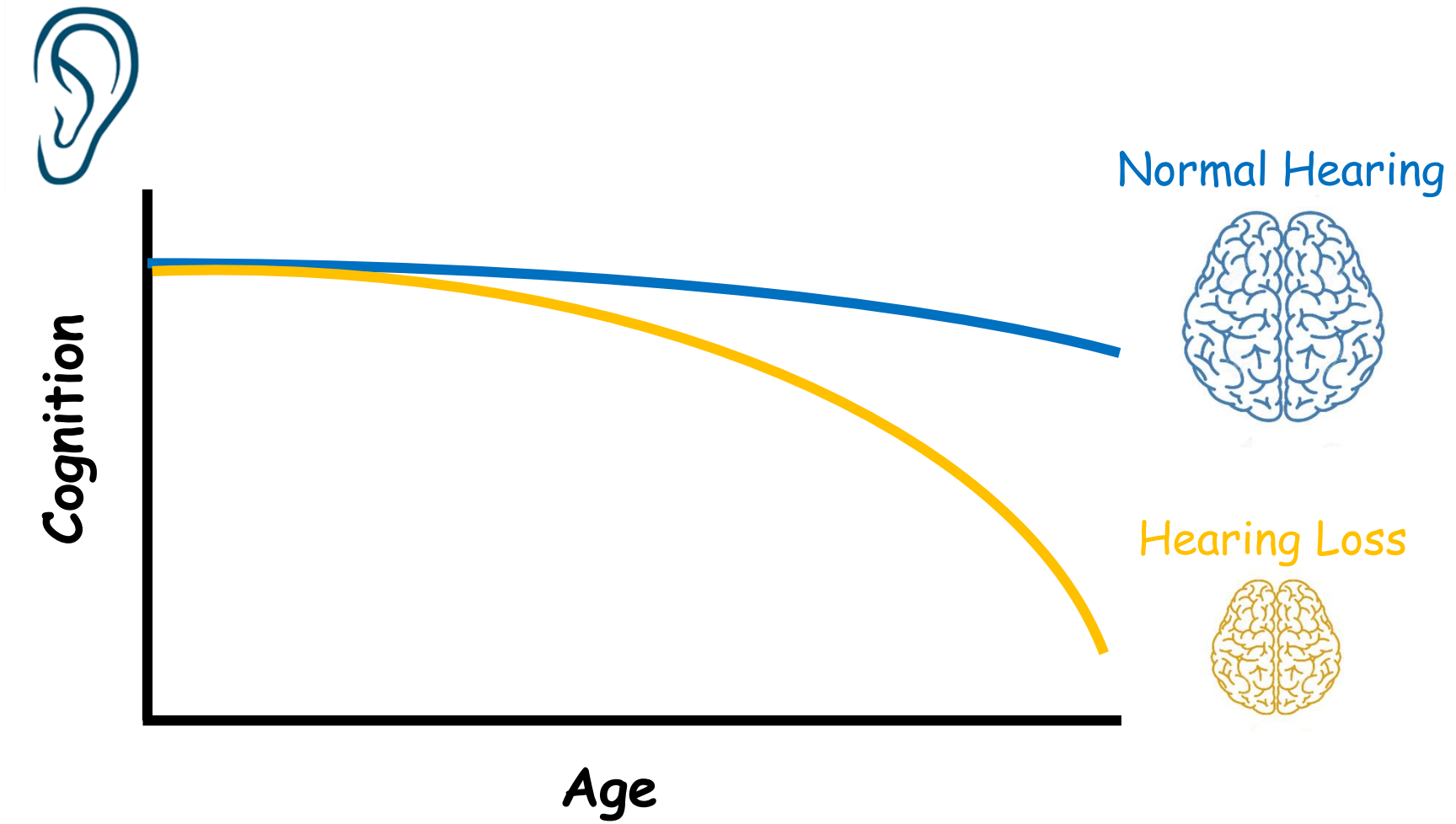
Reduced inhibition throughout auditory pathway

Reorganization of auditory and visual areas

Sharma & Glick *Brain Sciences*. 2016

Gray et al. *J Comp Neurol*, 2013; 2014
Engle & Recanzone, *Front Aging Neurosci* 2013
Overton & Recanzone *J Neurophysiol* 2016

Hearing loss impacts cognition



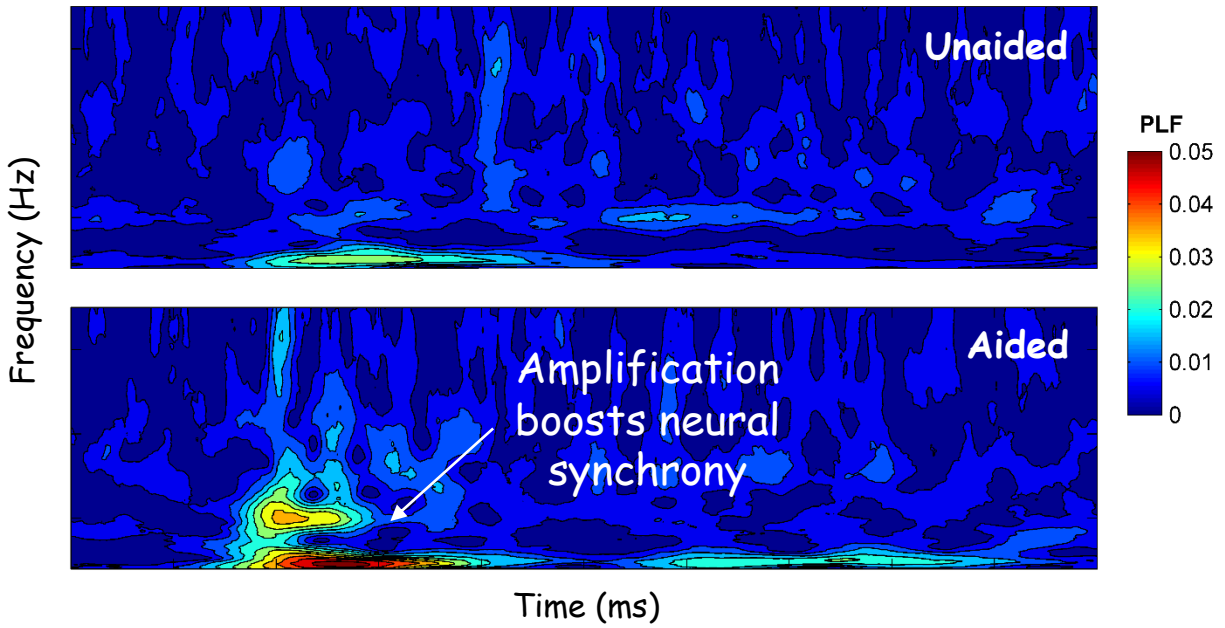
accelerates aging

Lin et al. (2013) JAMA Int Med
Lin et al. (2014) Neuroimage

Feed the brain the best input possible

Hearing aid/device fitting

informed by biology

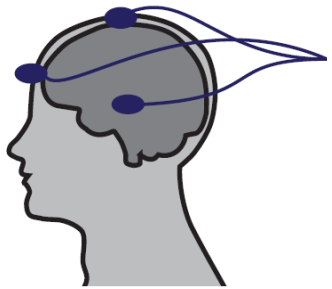


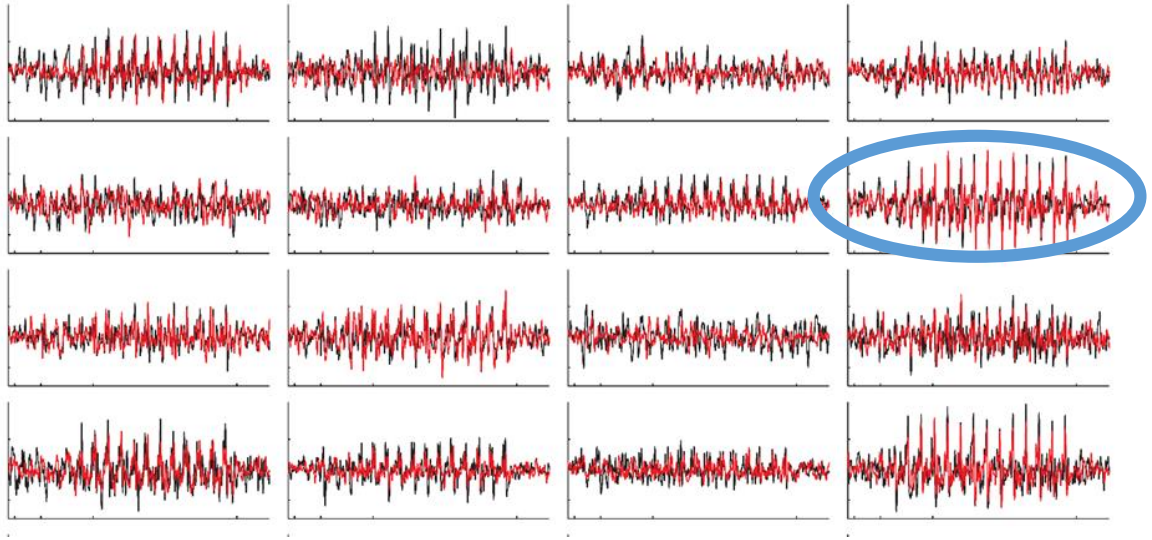
Anderson et al. (under review)

Hearing device/processing strategy

Automated Fitting

Collect EEG to dozens of algorithms to find the best fit for the brain



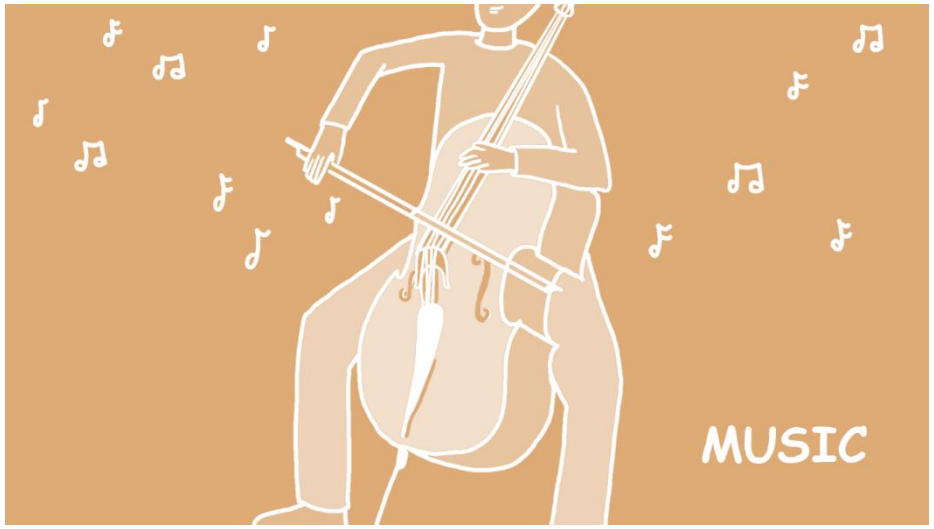


That's the one!

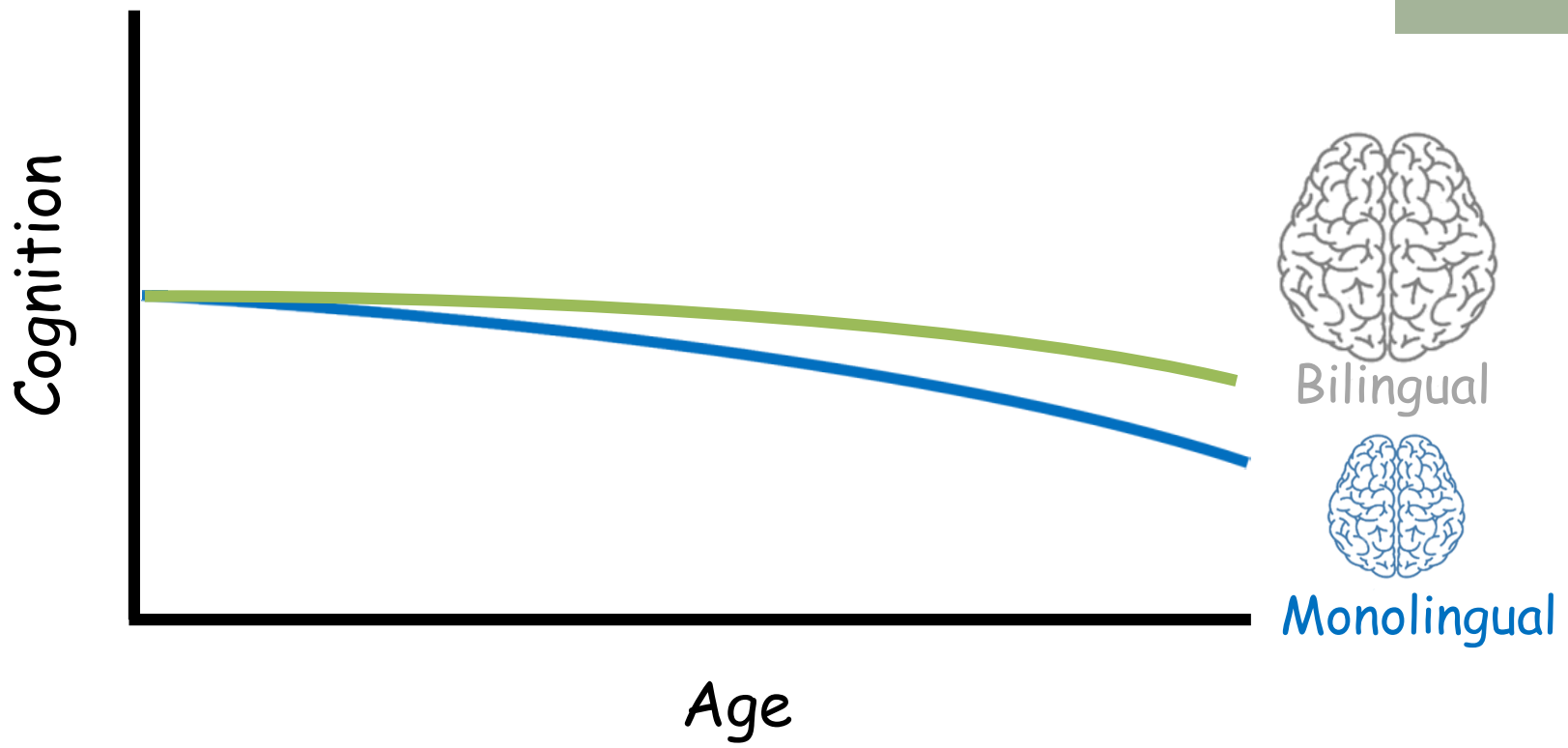
HEALTHY AGING

STRENGTHENING SOUND PROCESSING

Lifelong



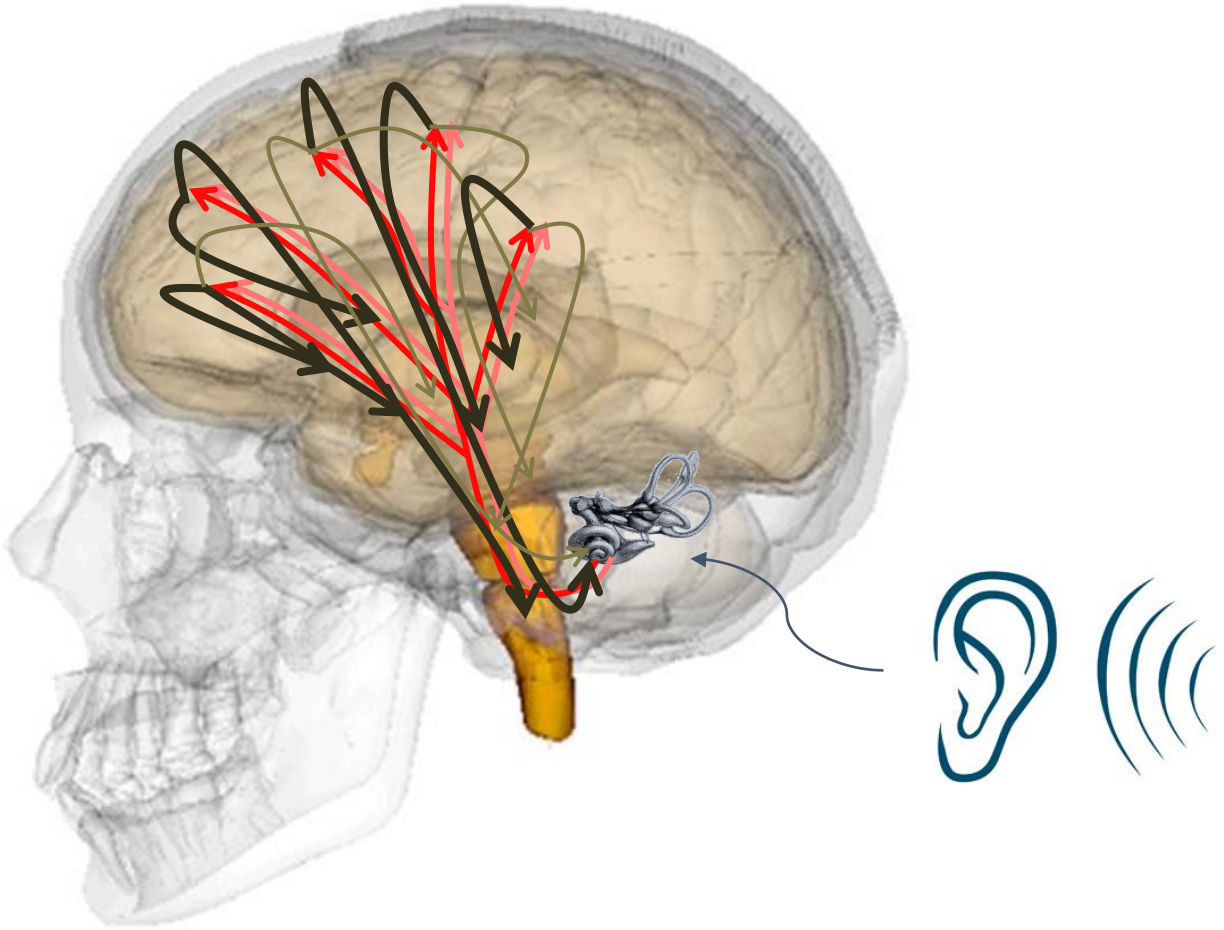
Initiated later in life



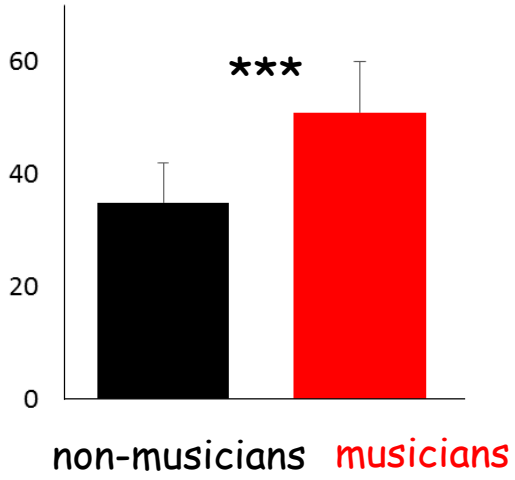
strengthens sound processing
consequences for hearing in noise

Krizman et al. *PNAS* 2012
Krizman et al. Biling: *Lang & Cogn* 2016
Bialystok et al. (2014) *Psychol Aging*
Bak et al. (2014) *Ann Neurol*
Guzmán-Vélez & Tranel (2015) *Neuropsychol*

MUSIC

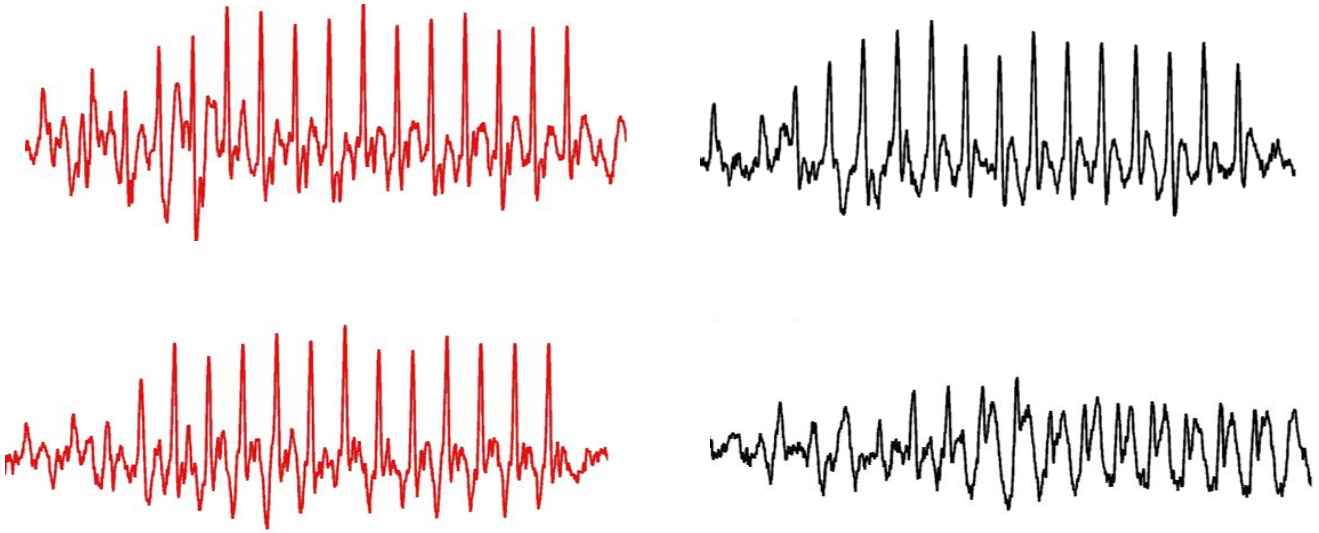


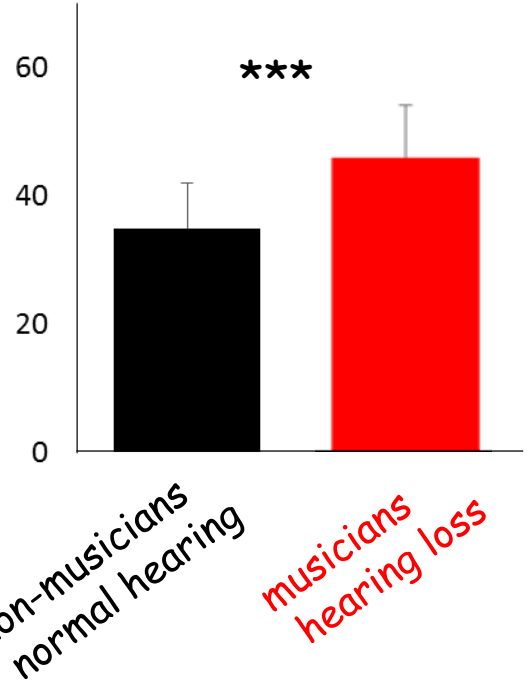
COGNITIVE, SENSORIMOTOR, REWARD



quiet

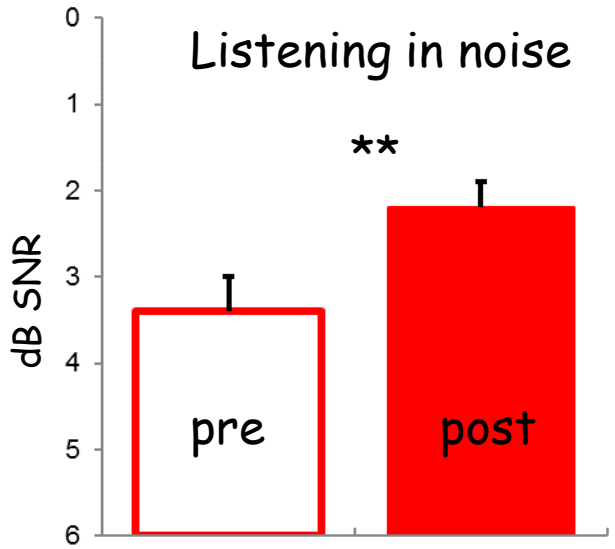
noise

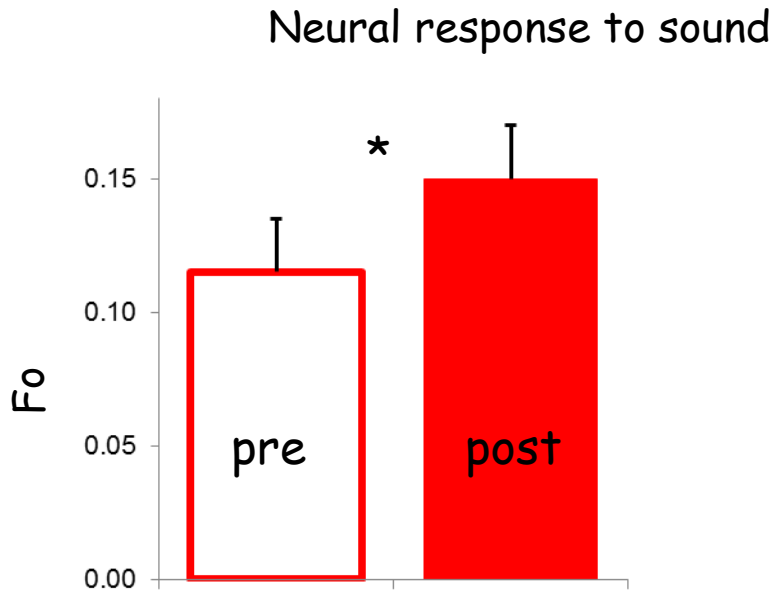




review: Kraus & White-Schwoch, Neuroscientist, 2016

Initiated later in life





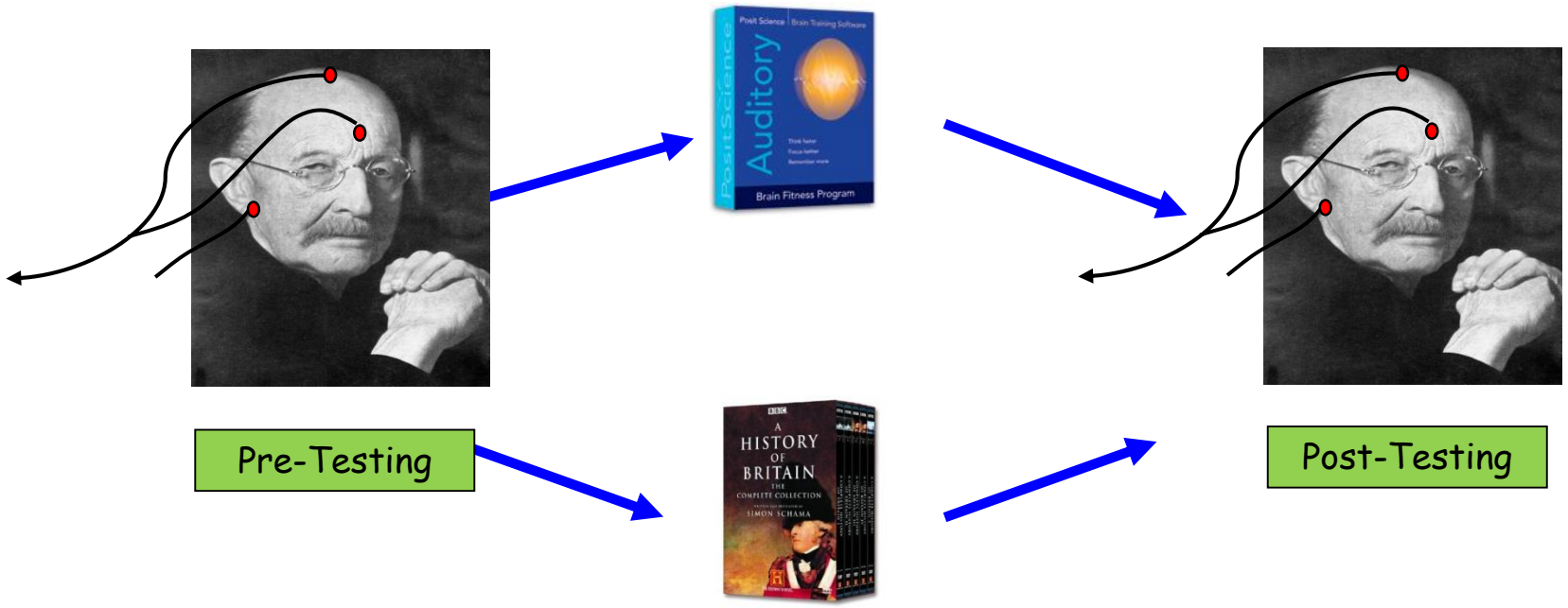
Russo, 2016, WCA

Ryerson University; Neuromusic 2017

Initiated later in life

75 older adults

Brain Fitness Program

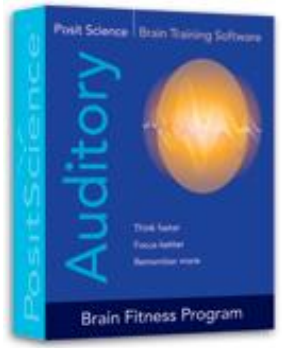


Educational Videos

Anderson et al. *PNAS*, 2013

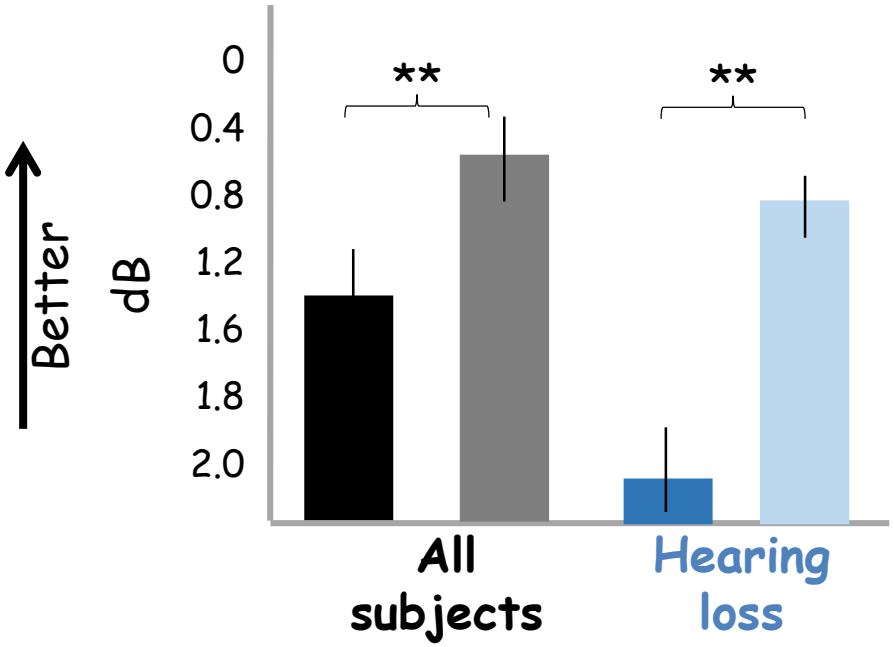
Anderson et al. *Front Sys Neurosci* 2013

Initiated later in life

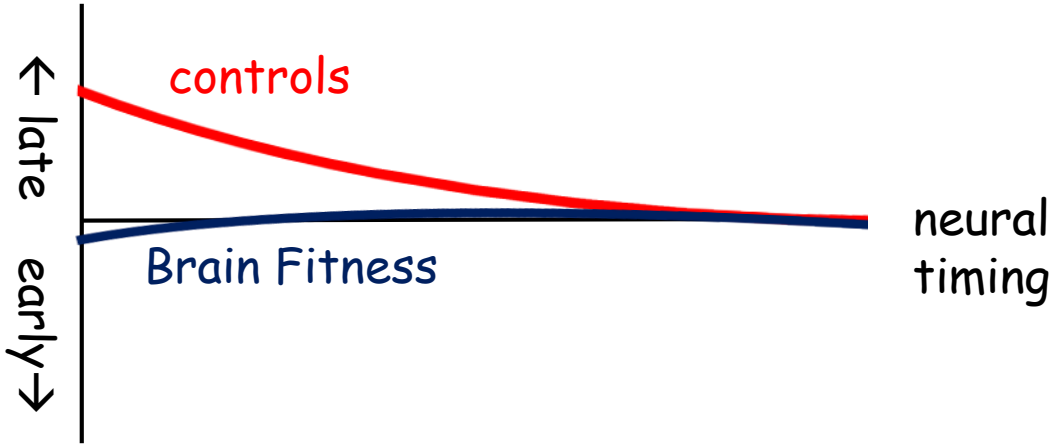


pre-training
post-training

Hearing in Noise

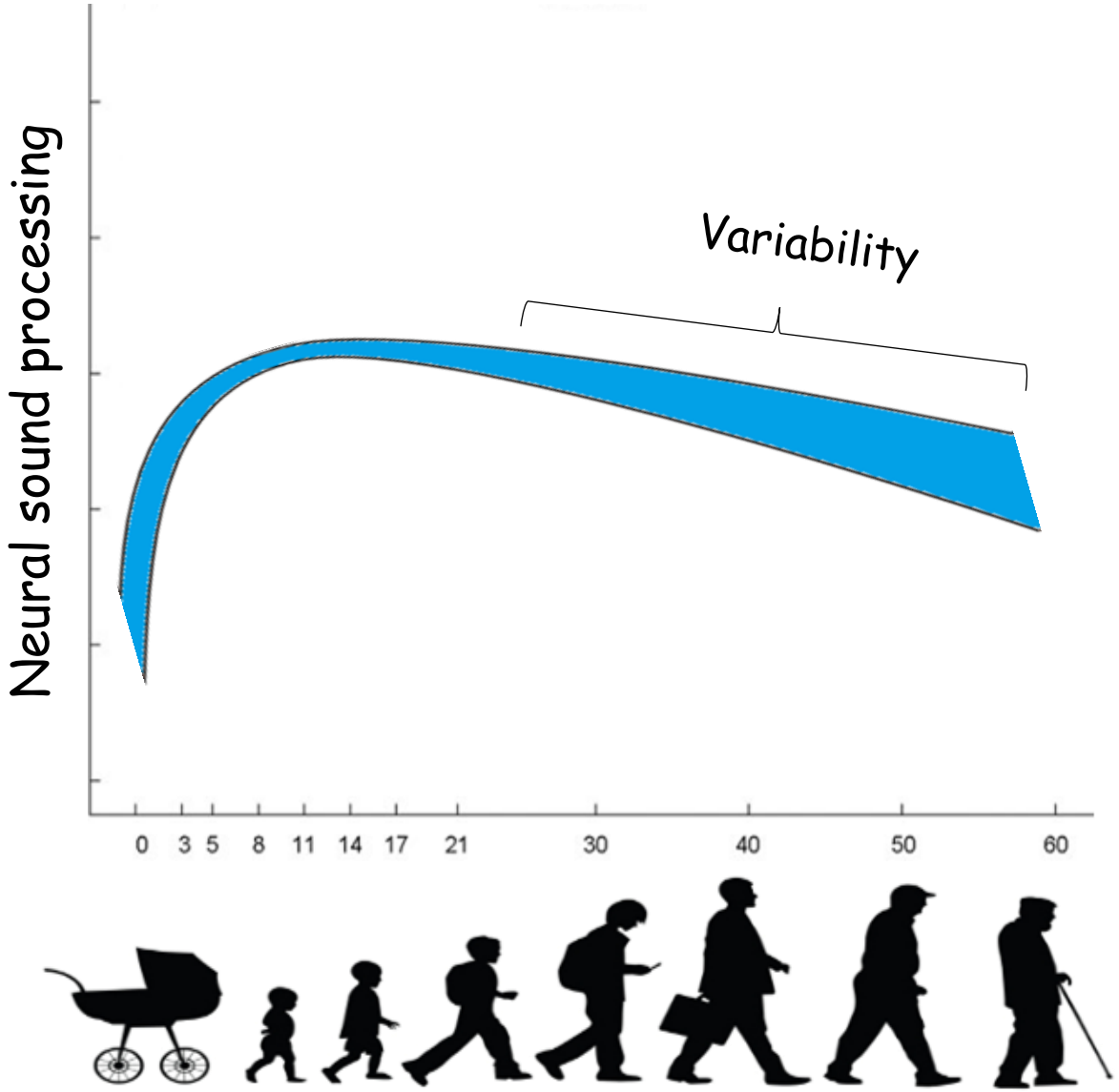


Biology



Anderson et al. *PNAS*, 2013
Anderson et al. *Front Syst Neurosci*, 2013
Caspary *Ear and Hearing*

Biological Aging is Individual



Skoe et al., *Cerebral Cortex*, 2015

Gray and Recanzone *Evolution of Nervous System* 2017

Summary

Nurture Eyes and Ears for healthy aging

Biology can inform training strategies, individualized care

Gaps

How does auditory aging begin?

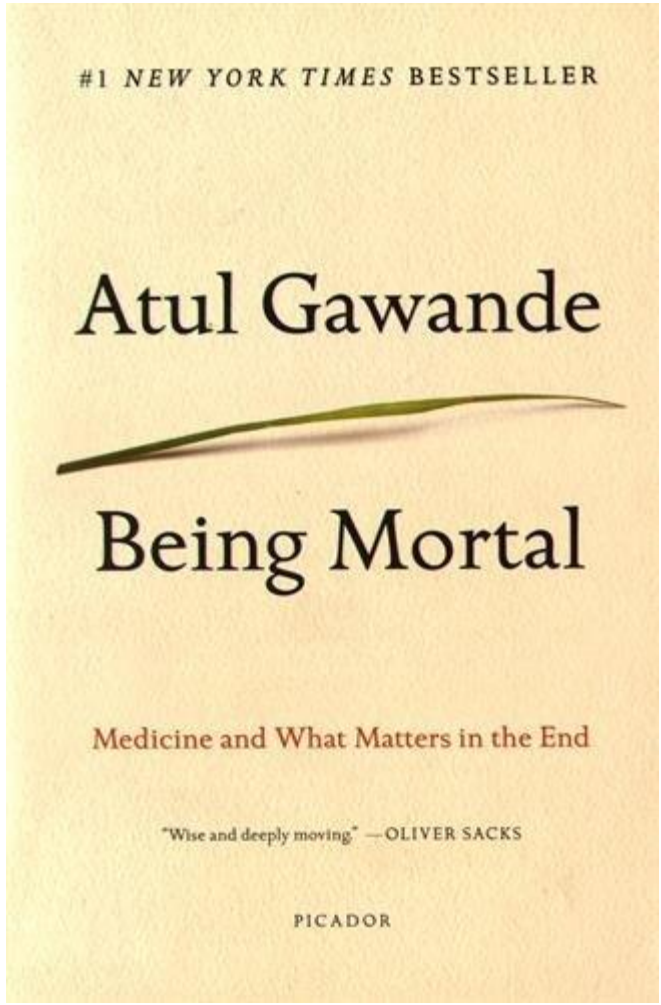
presbycusis?
hair cell damage?
synaptopathy?

central hearing loss?

combined effect of auditory and visual impairment?

What factors make an older adult successful at hearing in noise?

whole person care



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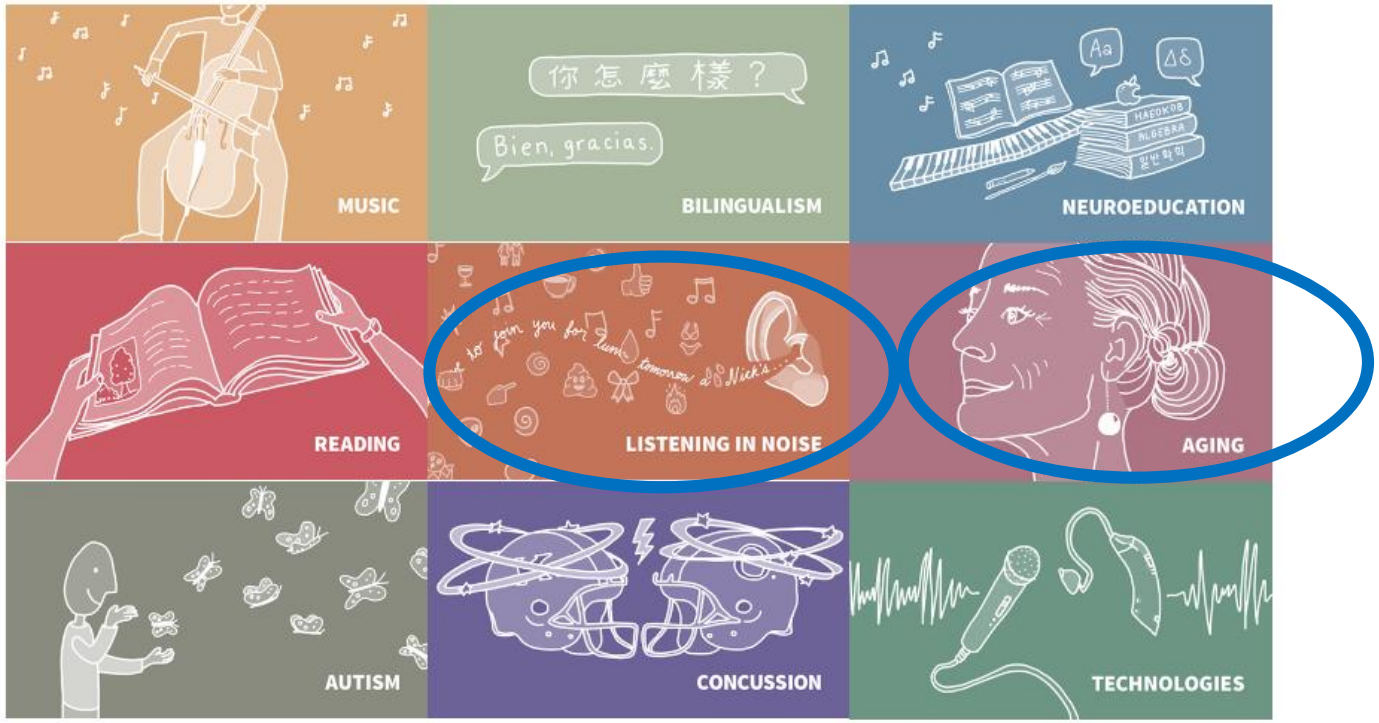
Auditory Neuroscience Laboratory



Demonstration
Our Biological Approach

NIH National Institutes of Health
NSF
NAMM Foundation
MED EL
THE DANA FOUNDATION