

THE IMPORTANCE OF WHITE MATTER TRACT INTEGRITY IN AGING SPEECH PERCEPTION: MOVING BEYOND THE AUDITORY PERIPHERY

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Introduction - Speech perception and aging

One of the most common complaints amongst elderly populations is related to difficulties perceiving speech in the presence of background noise. Traditionally this difficulty has been ascribed to the biological aging of the auditory periphery (Mazelova et al. 2003)

Yet research has shown that even when differences in hearing are controlled for (Bilodeau-Mercure et al, 2014; Wong et al, 2009) or when older and younger groups have equivalent hearing thresholds, elderly speech in noise difficulties still exist (Tun, 1998). This suggests that factors in addition to the decreasing sensitivity of the auditory periphery are contributing to the speech in noise difficulties.

The human brain undergoes numerous morphological changes as we age. Most notably from our mid-40's until the end of life there is a significant and consistent reduction in the amount/integrity of white matter tracts. Degeneration of this kind is known to result in slower or incomplete transmission of neural impulses and impaired cognitive functioning.

Methods

	YOUNGER (n=14)				OLDER (n = 15)			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Age	29y5m	10.49	19	46	71y11m	5.85	65	84
Handedness	83.78	18.27	50	100	96.24	8.87	68.42	100
Education	16y11m	2.34	13	21	16y5m	4.60	10	30
Depression	3.79	3.68	0 (zero)	12	2.53	3.07	0 (zero)	8
MOCA	28.57	1.09	27	30	27.47	1.68	25	30
Left PTA (dB)	3.57	8.29	-3	29	15.49	10.5	-2.33	43.33
Right PTA (dB)	5.38	9.83	-1.33	37.33	13.69	8.72	-3.33	32.33
Left DPOAE (dB)	14.95	6.23	1	23.67	4.7	3.01	0.33	11.22
Right DPOAE (dB)	14.47	5.16	1.44	22.67	5.2	3.79	-0.56	14.56
SRT (dB SNR)	26.81	8.87	15	52	40.6	7.96	30	55

Task:

- Two-alternate forced choice auditory discrimination

Stimuli:

- 48 simple syllables
- All syllables contained:
 - one of four vowels (/e/, /ə/, /ɛ/, /ø/) and
 - one of 12 consonants (/f/, /s/, /ʃ/, /v/, /z/, /ʒ/, /p/, /t/, /k/, /b/, /d/, /g/)

Intelligibility:

- High: no background noise
- Medium: SNR of +15dB
- Low: SNR of -5dB

Diffusion:

High Angular resolution (b=1500s/m²; 60 directions; 1.8mm³)

Structural:

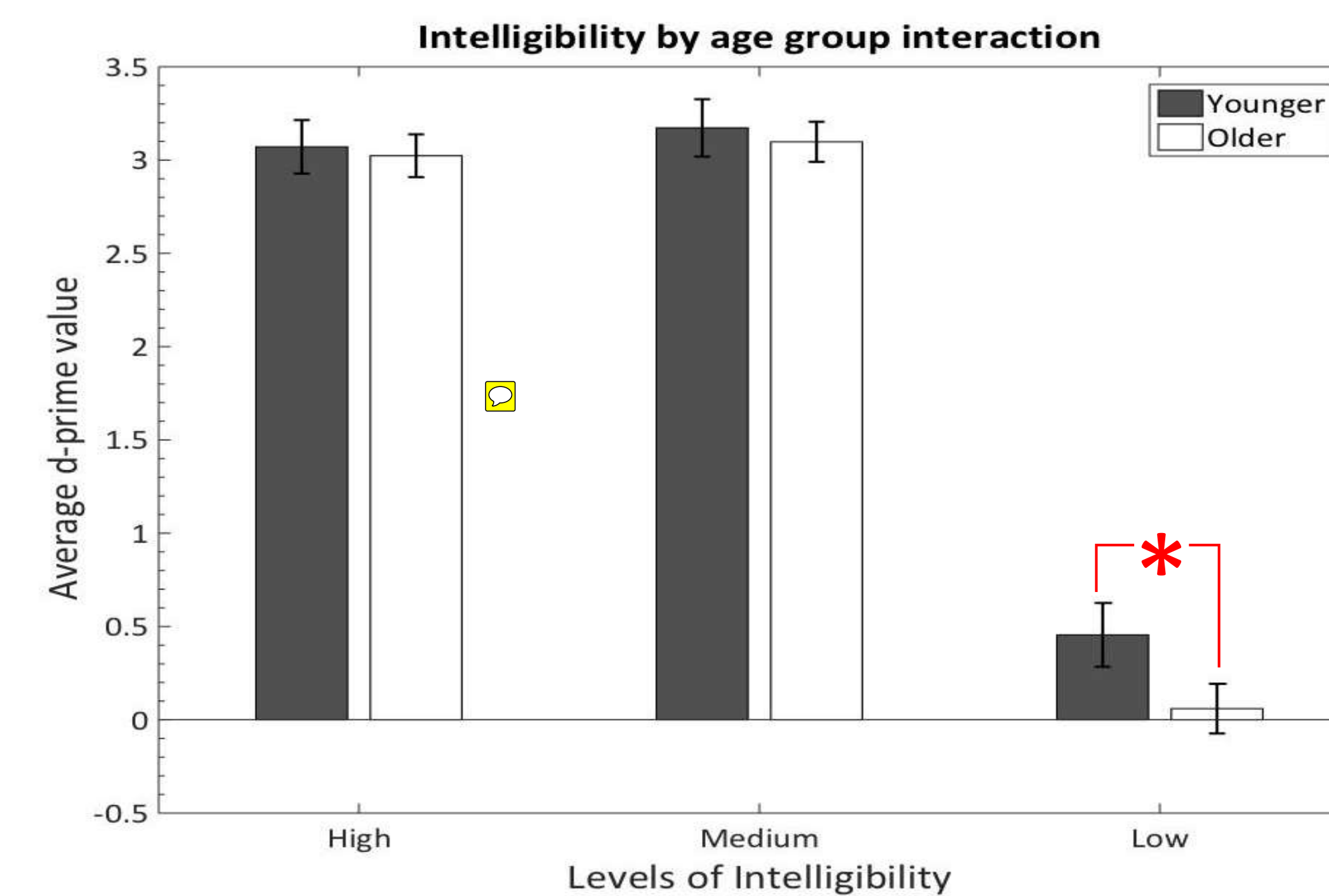
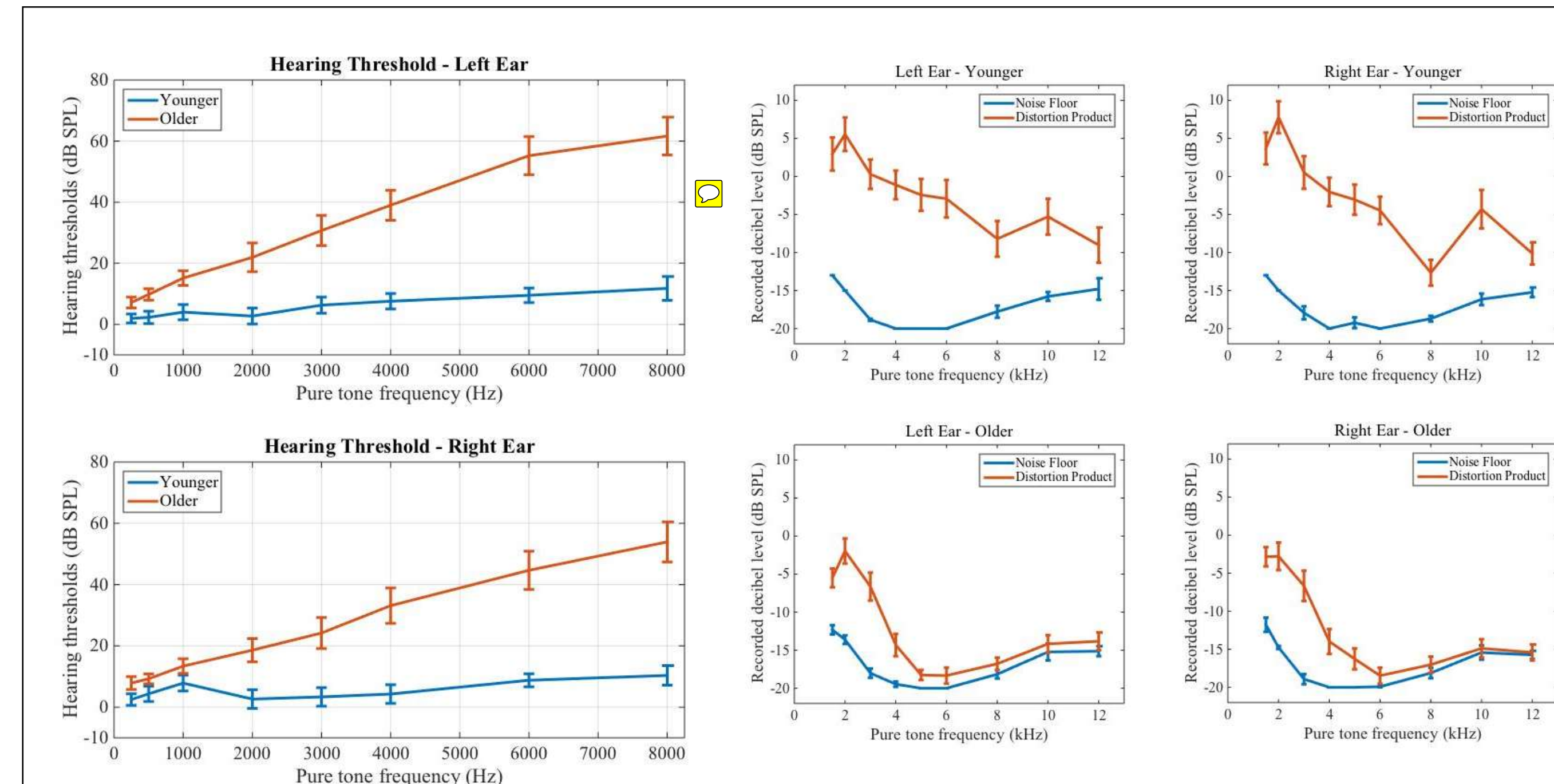
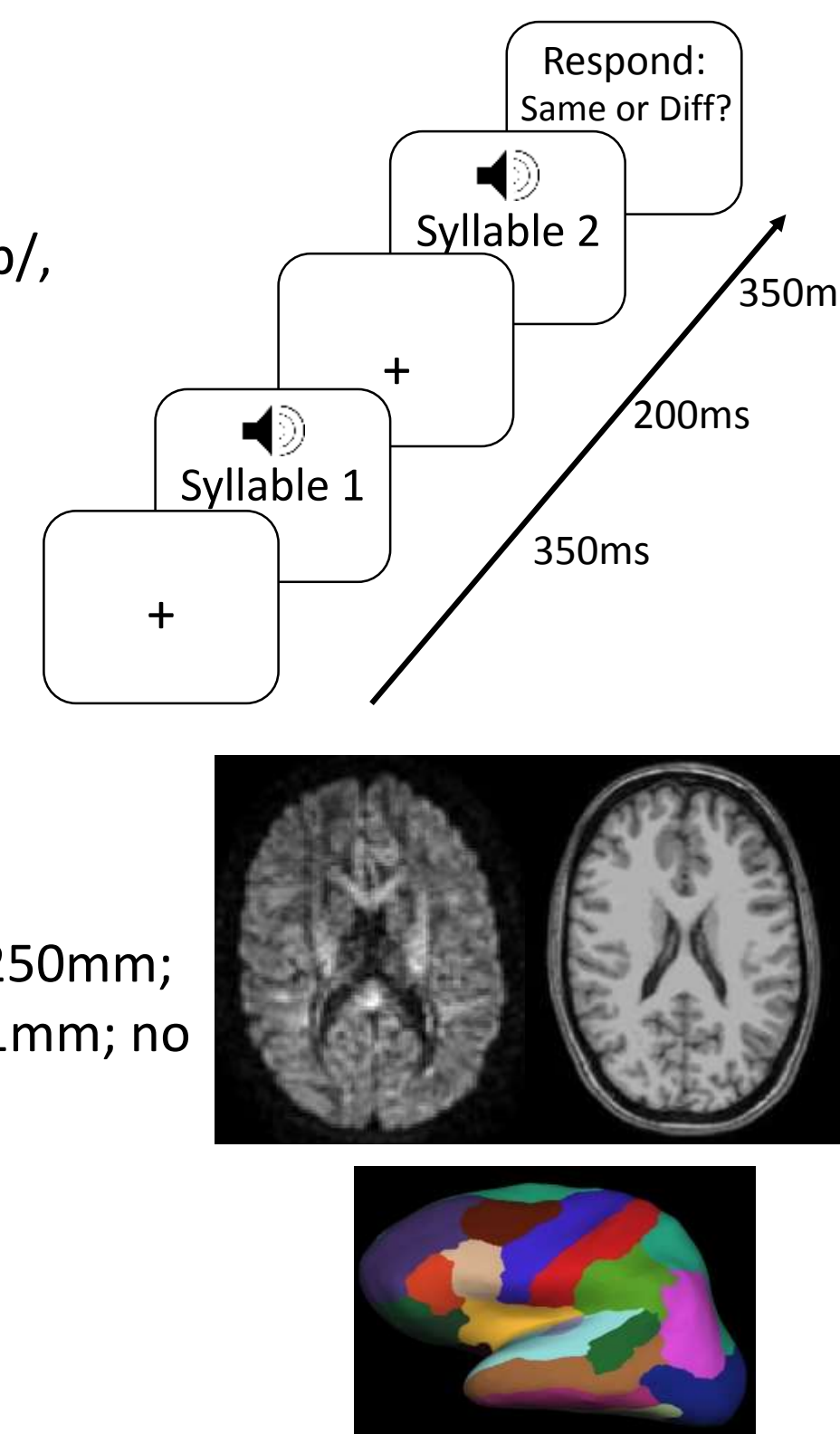
3D T1-weighted MPRAGE sequence (TR = 8.2ms; TE = 3.7ms; FoV = 250mm; flip angle = 8°; 256x256 matrix; 180 slices/volume; slice thickness = 1mm; no gap)

Tract Definition:

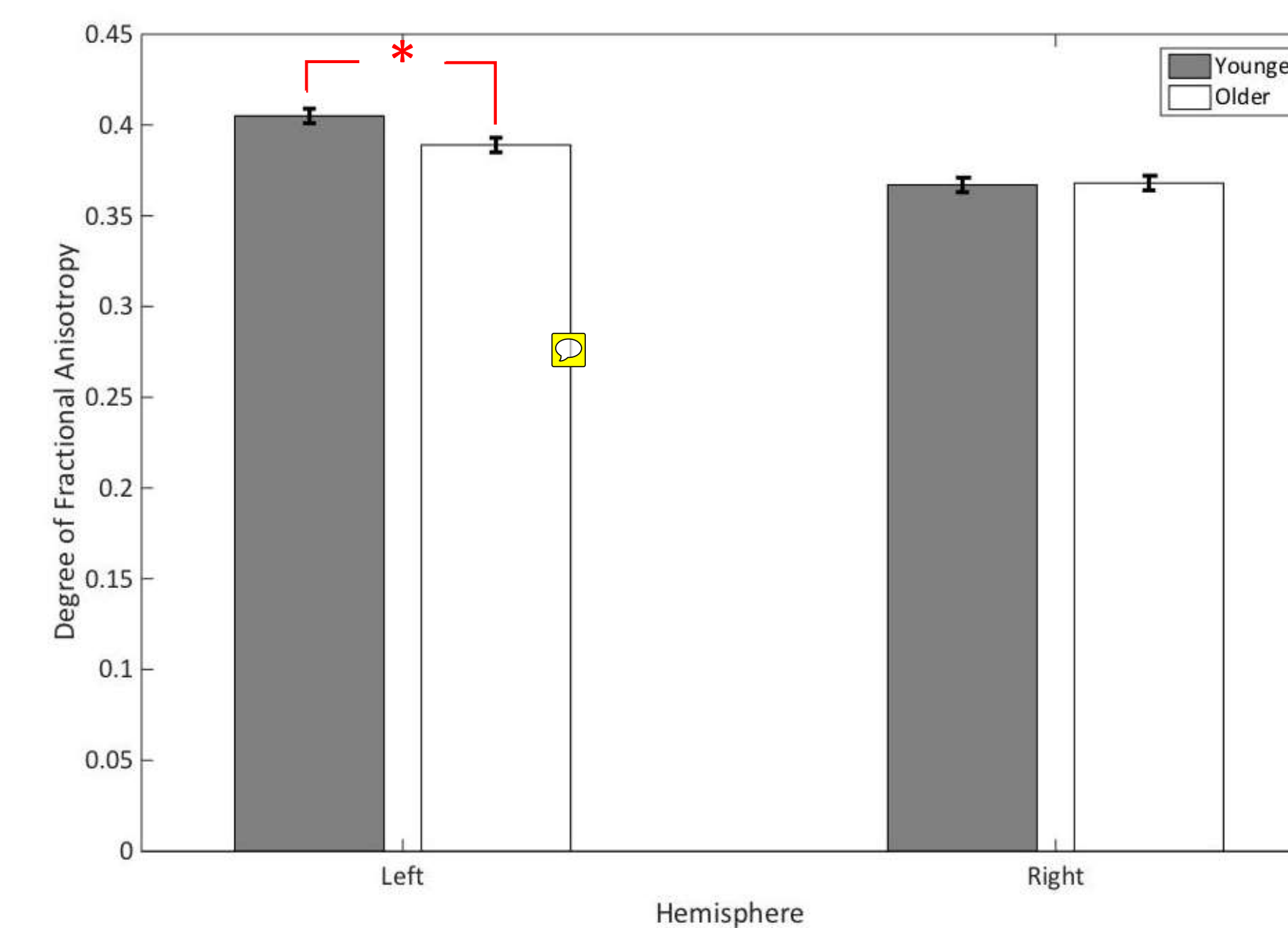
White Matter Query Language (Wasserman et al, 2013)

Cortical Parcellation:

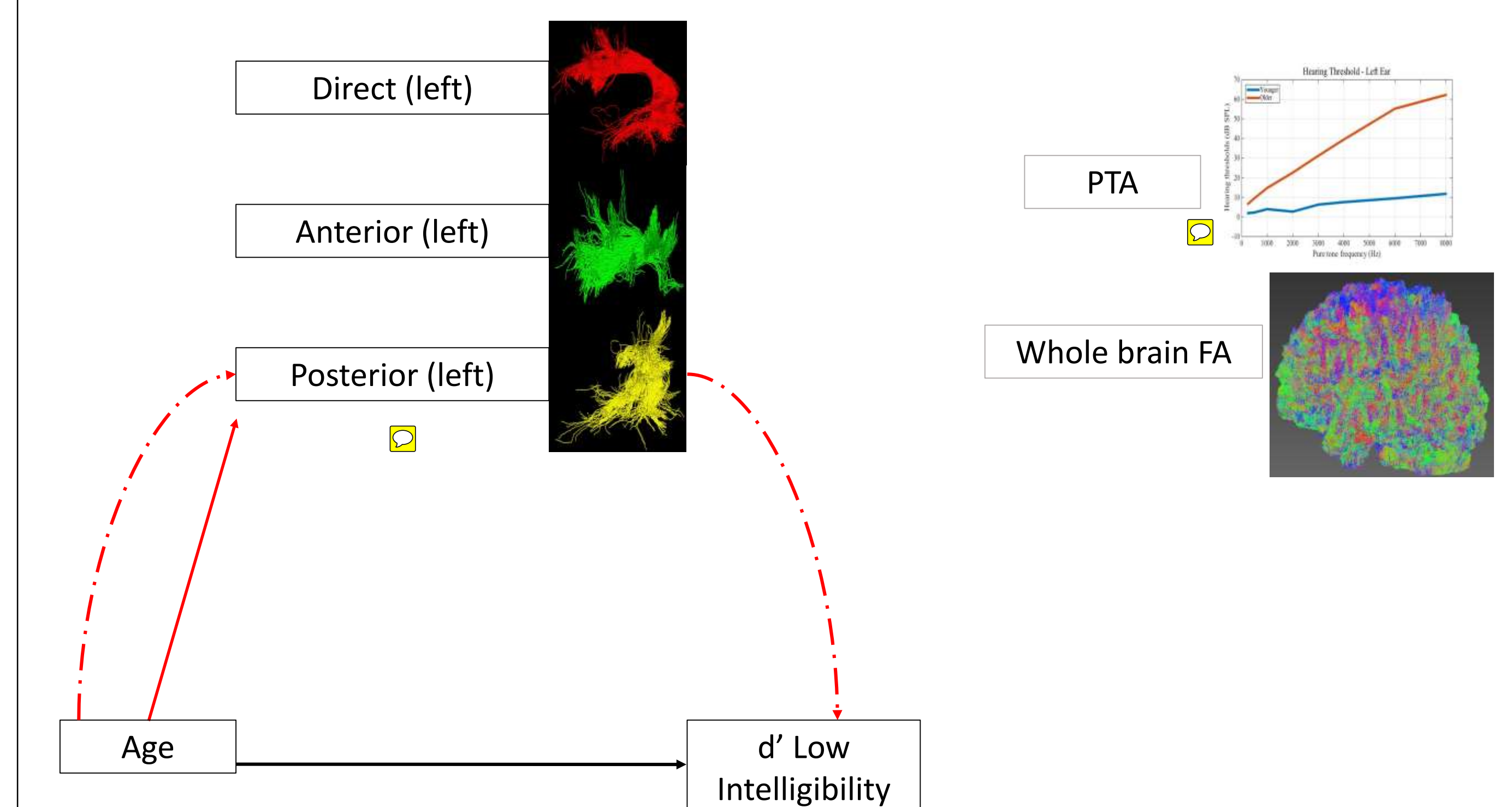
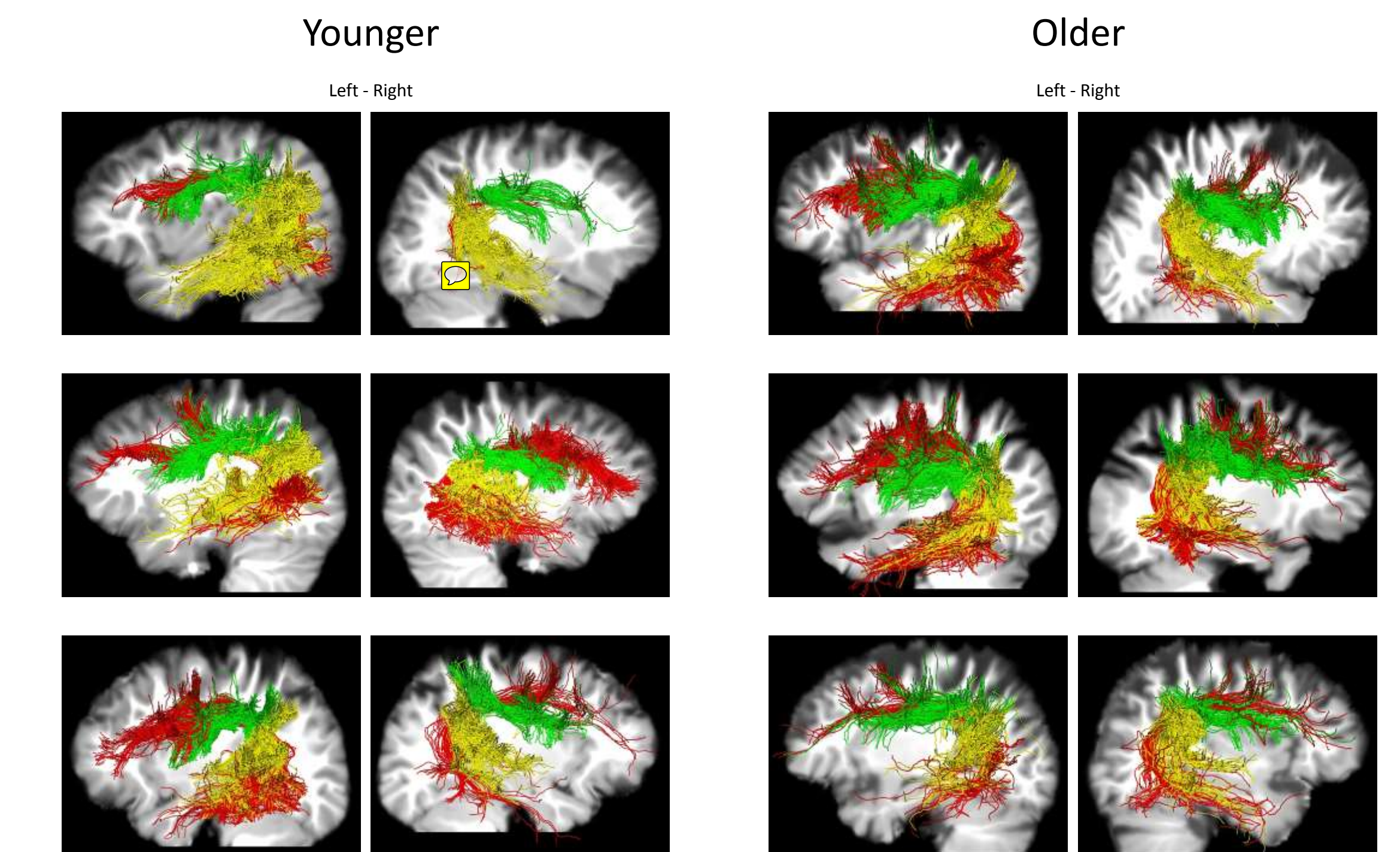
FreeSurfer Desikan-Killiany Atlas (DKT; 2006)



Intelligibility*Age Group: $F(1.46, 36.52)=4.04, p=0.038, \eta_p^2=0.14$
 High: $t(27)=0.26, p=0.4, d=0.101$ (one-tailed); Med: $t(27)=0.438, p=0.33, d=0.159$ (one-tailed); Low: $t(27)=1.839, p=0.039, d=0.67$ (one-tailed)



Hemisphere * Age Group: $F(1,26)=5.19, p=0.03, \eta_p^2=0.17$
 Left: $F(1,26)=6.11, p=0.02, \eta_p^2=0.19$; Right: $F(1,26)=0.014, p=0.91, \eta_p^2=0.001$



Age → FA posterior Arcuate: coeff. (a₃)=-0.006, SE=0.0003, p=0.037

Indirect effect: coeff. (a₃b₁)=-0.004, SE=0.003, CI=-0.146, -0.001

Conclusion

- Background noise significantly impairs elderly speech discrimination.
 - Even after controlling for hearing declines.
- Aging is associated with significant reductions in the integrity of white matter in the left hemisphere section of the arcuate fasciculus
- The integrity of the posterior segment of the arcuate fasciculus plays a significant mediating role between age and speech discrimination abilities in noise.

ACKNOWLEDGMENTS: