Effects of noise exposure and musical training on the neural encoding of sounds. What factors determine our ability to understand speech in noise?

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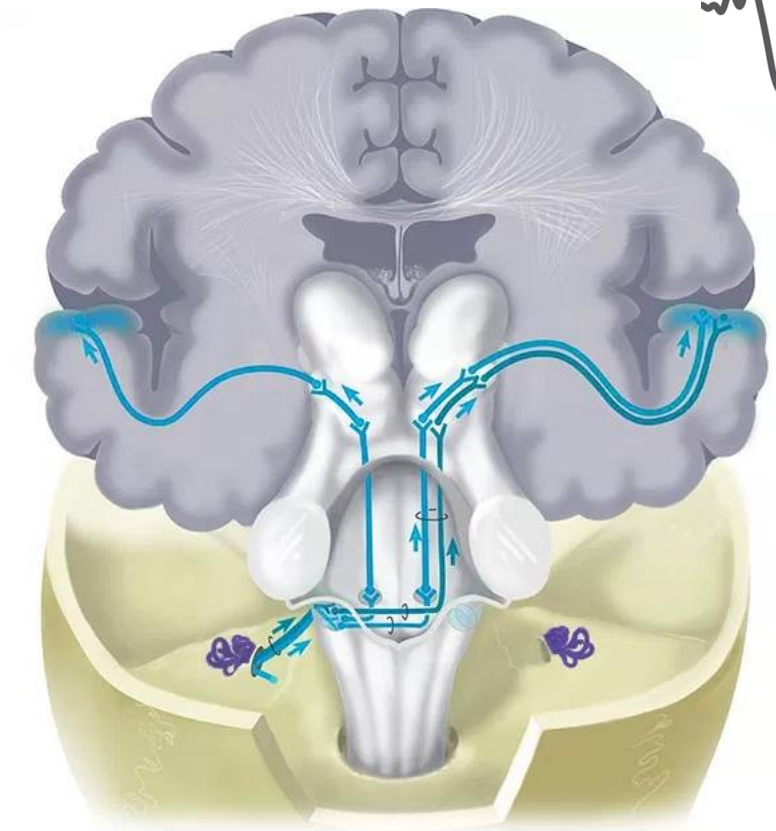
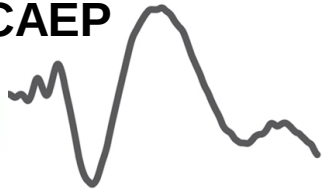
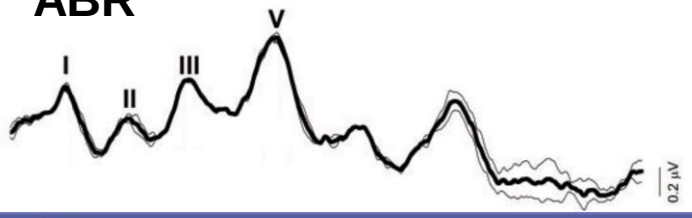
Australian Hearing Hub, 16/02/2017



CAEP

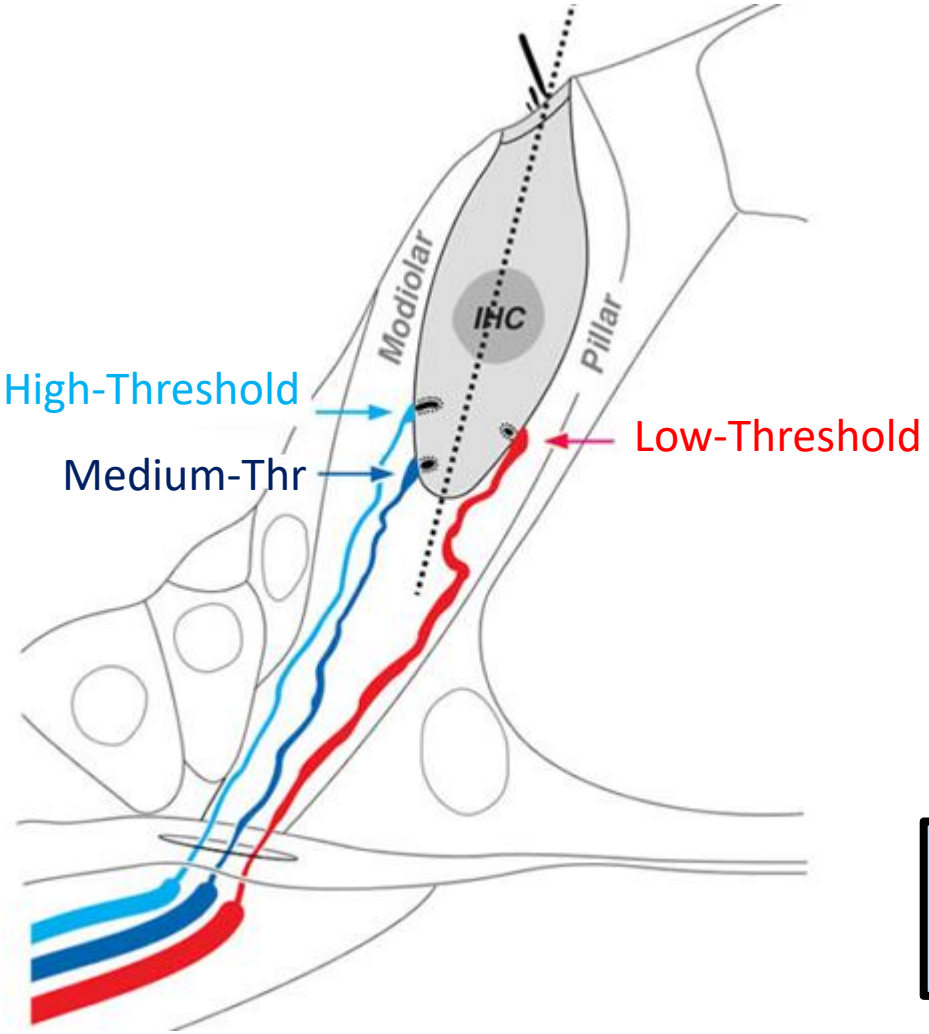


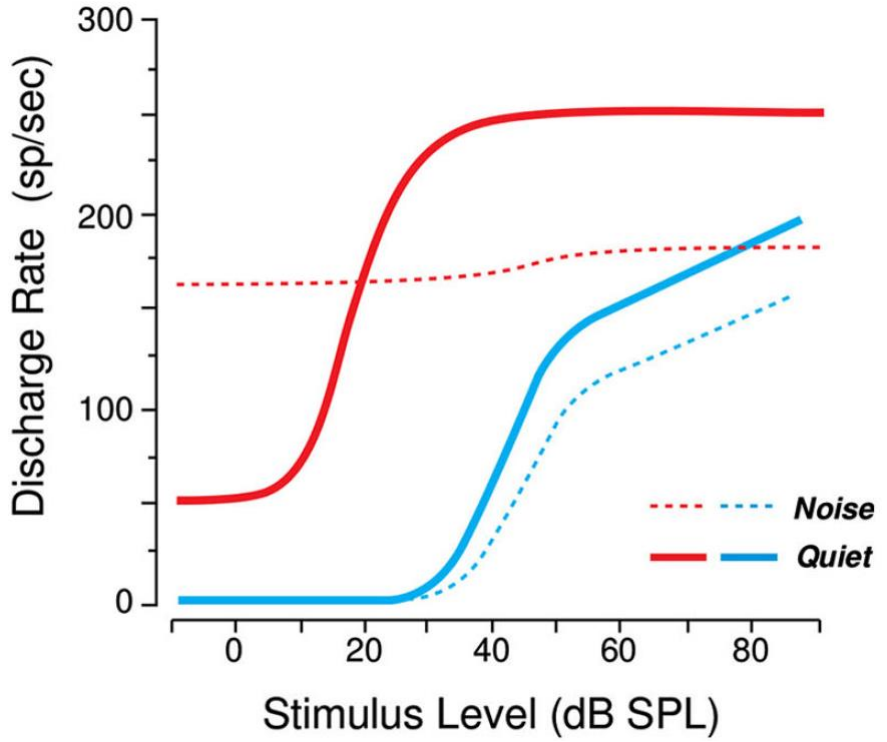
ABR



Noise exposure

Hidden hearing loss





HT fibres play an important role in speech perception in noise

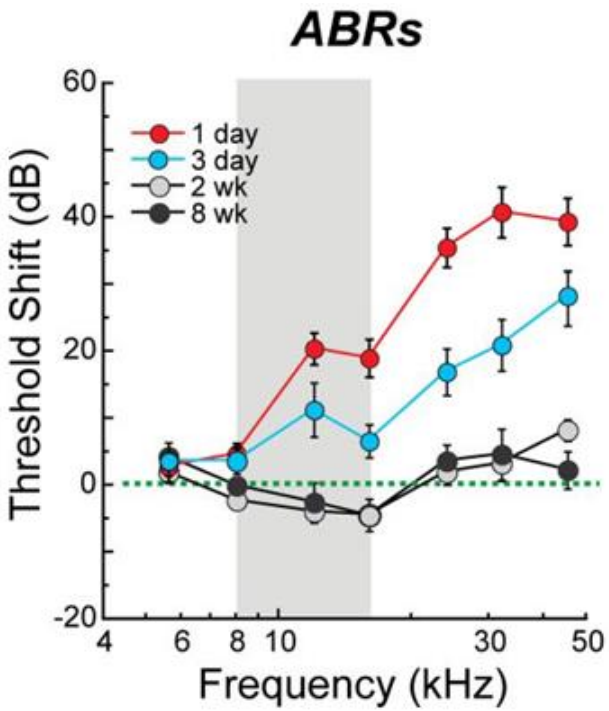
Behavioral/Systems/Cognitive

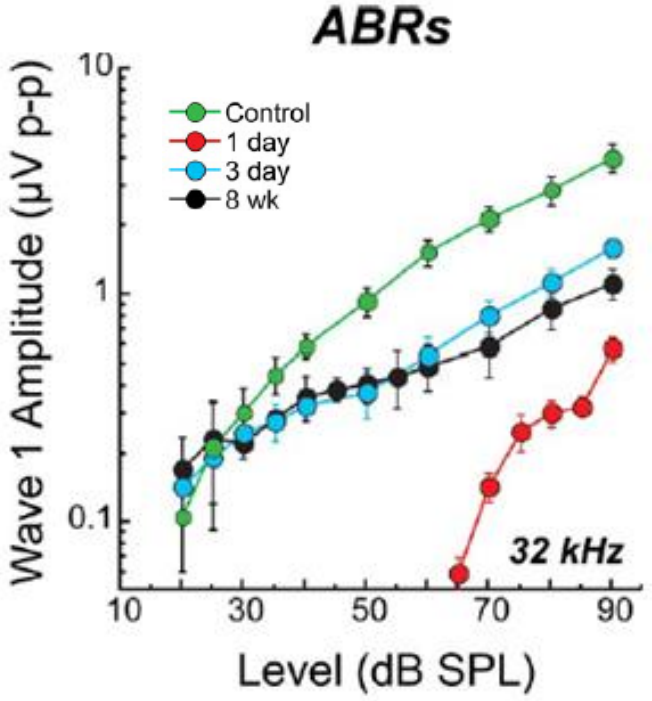
The Journal of Neuroscience, November 11, 2009 • 29(45):14077–14085 • 14077

Adding Insult to Injury: Cochlear Nerve Degeneration after "Temporary" Noise-Induced Hearing Loss

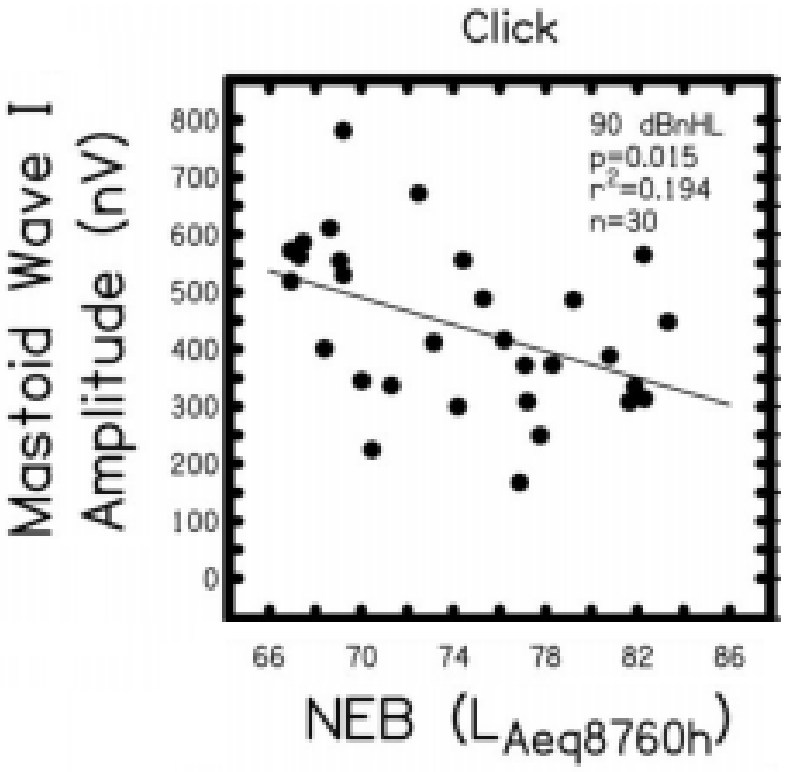
Sharon G. Kujawa[1,2,3,4] and M. Charles Liberman[1,2,4]

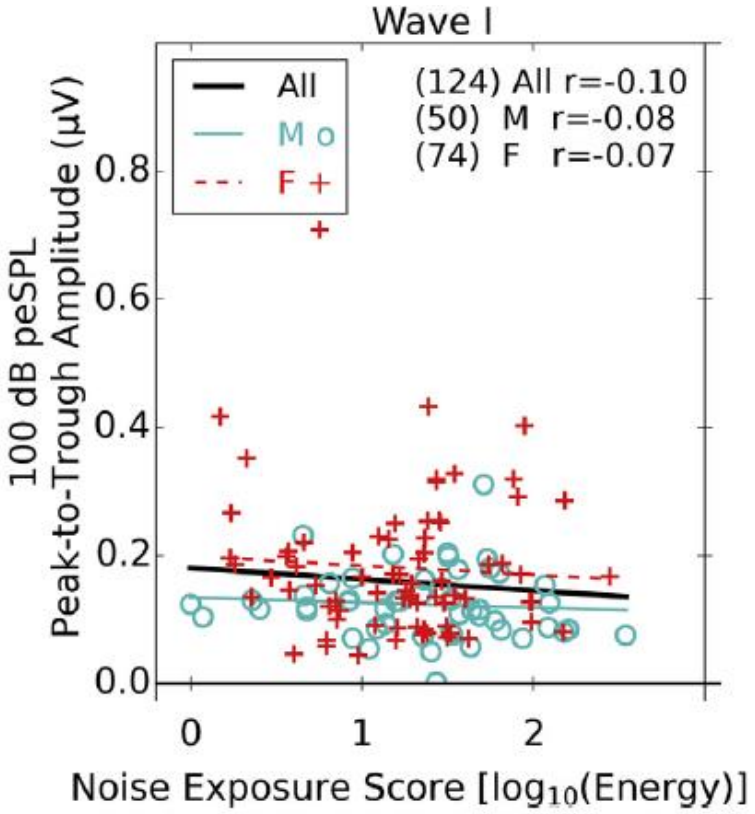
- Anaesthetized mice
- 8-16 kHz noise
- 2 h, 100 dB SPL





Noise-induced damage affects HT fibers





Ear Hear. 2015 ; 36(2): 172–184.

Auditory function in normal-hearing, noise-exposed human ears

Greta C. Stamper, Ph.D.[1] and **Tiffany A. Johnson, Ph.D.**[1]

[1]The University of Kansas Medical Center, Kansas City, 66160

Hearing Research

Effects of noise exposure on young adults with normal audiograms I: Electrophysiology

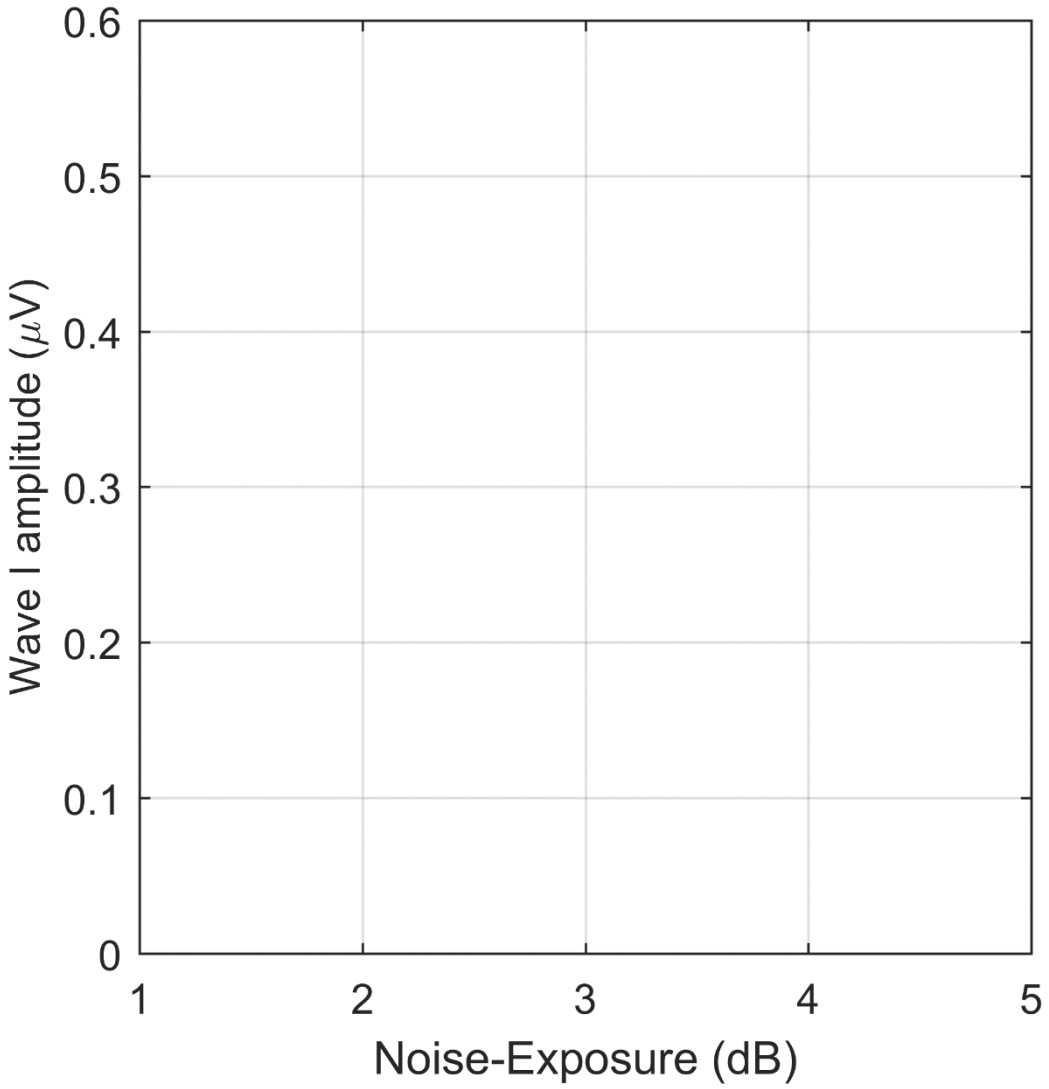
Garreth Prendergast [a, *], Hannah Guest [a], Kevin J. Munro [a, b], Karolina Kluk [a], Agnès Léger [a], Deborah A. Hall [c, d], Michael G. Heinz [e], Christopher J. Plack [a, f]

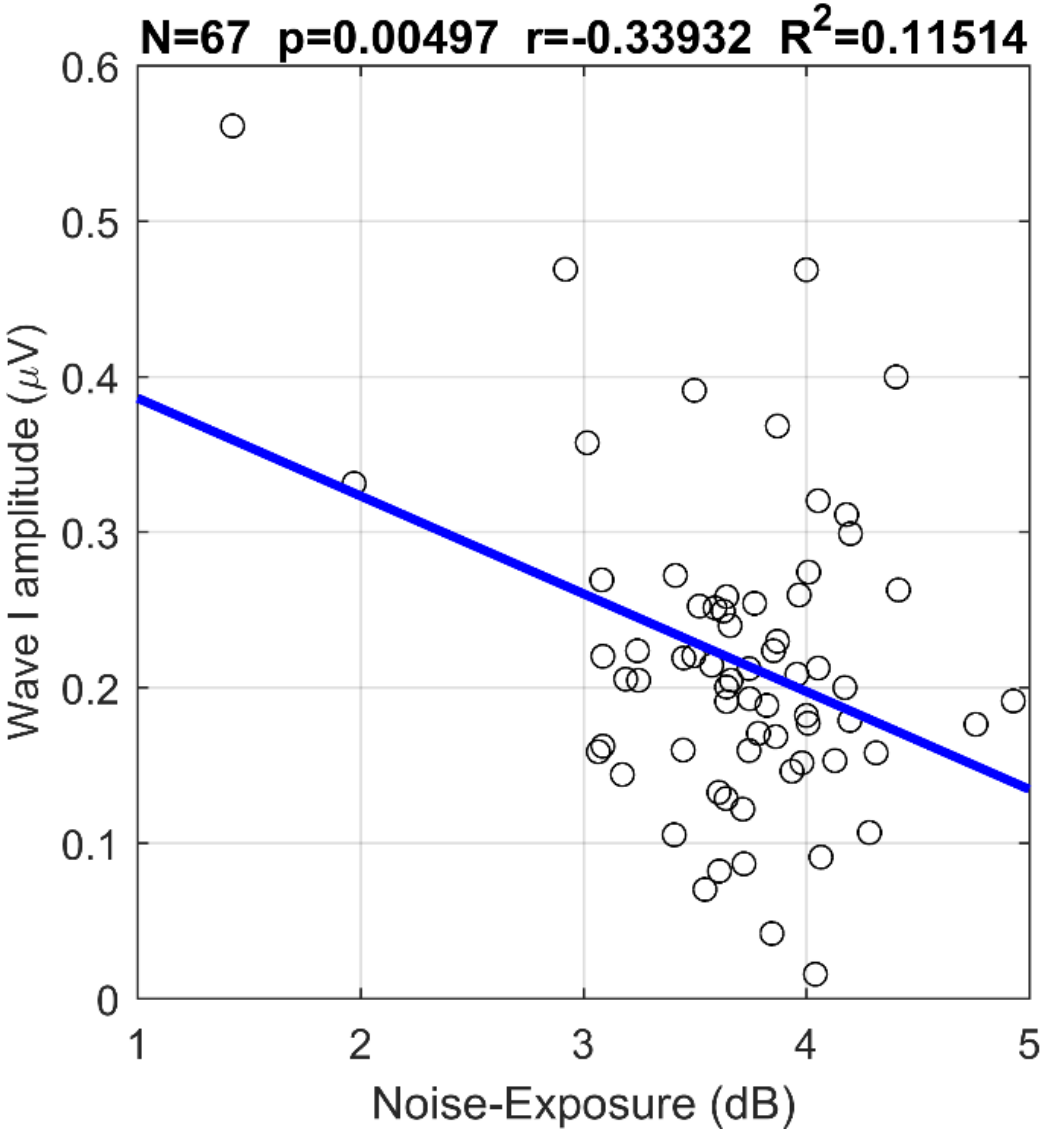
Hypothesis

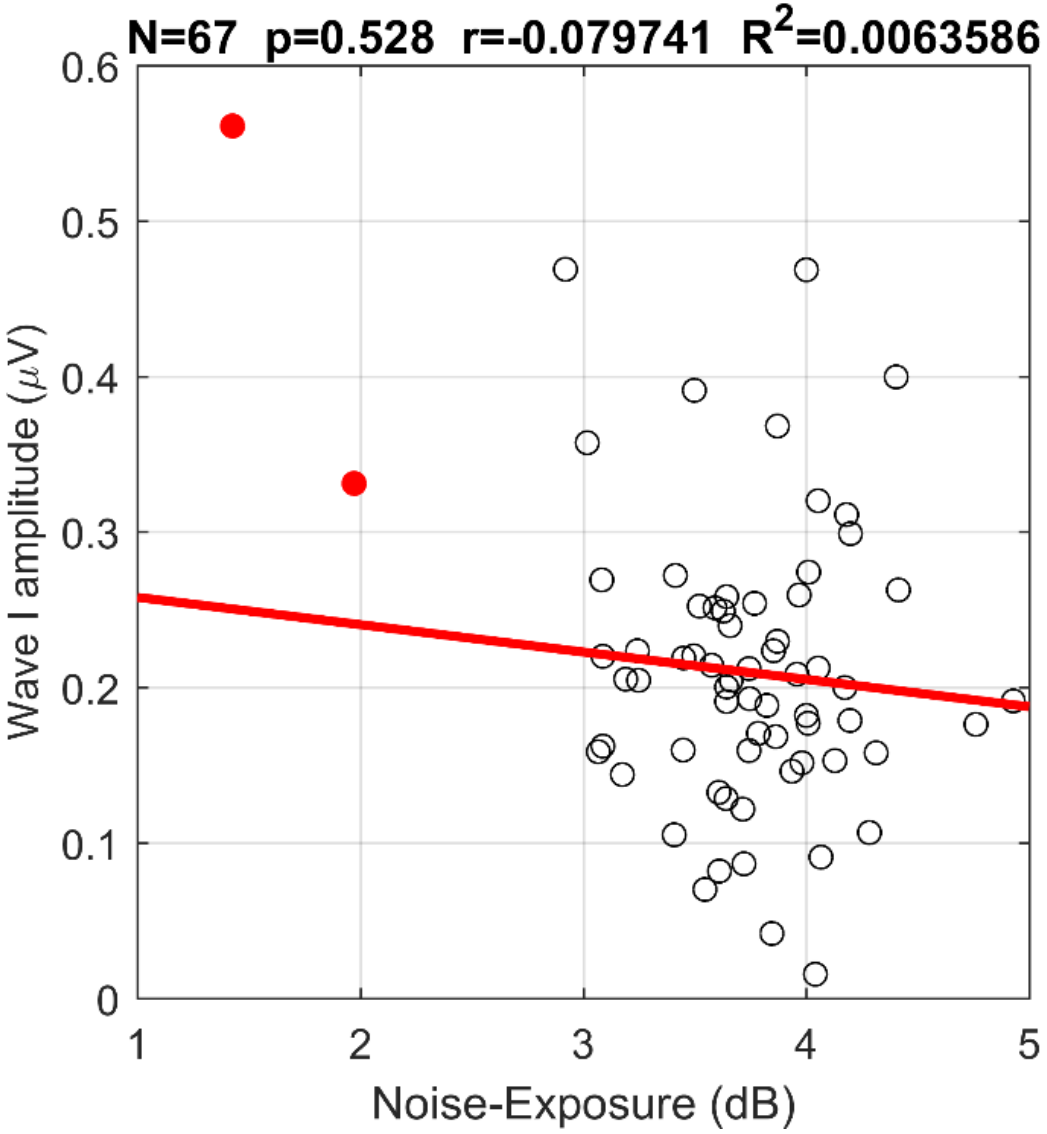
The amplitude of ABR wave I is modulated by noise-exposure

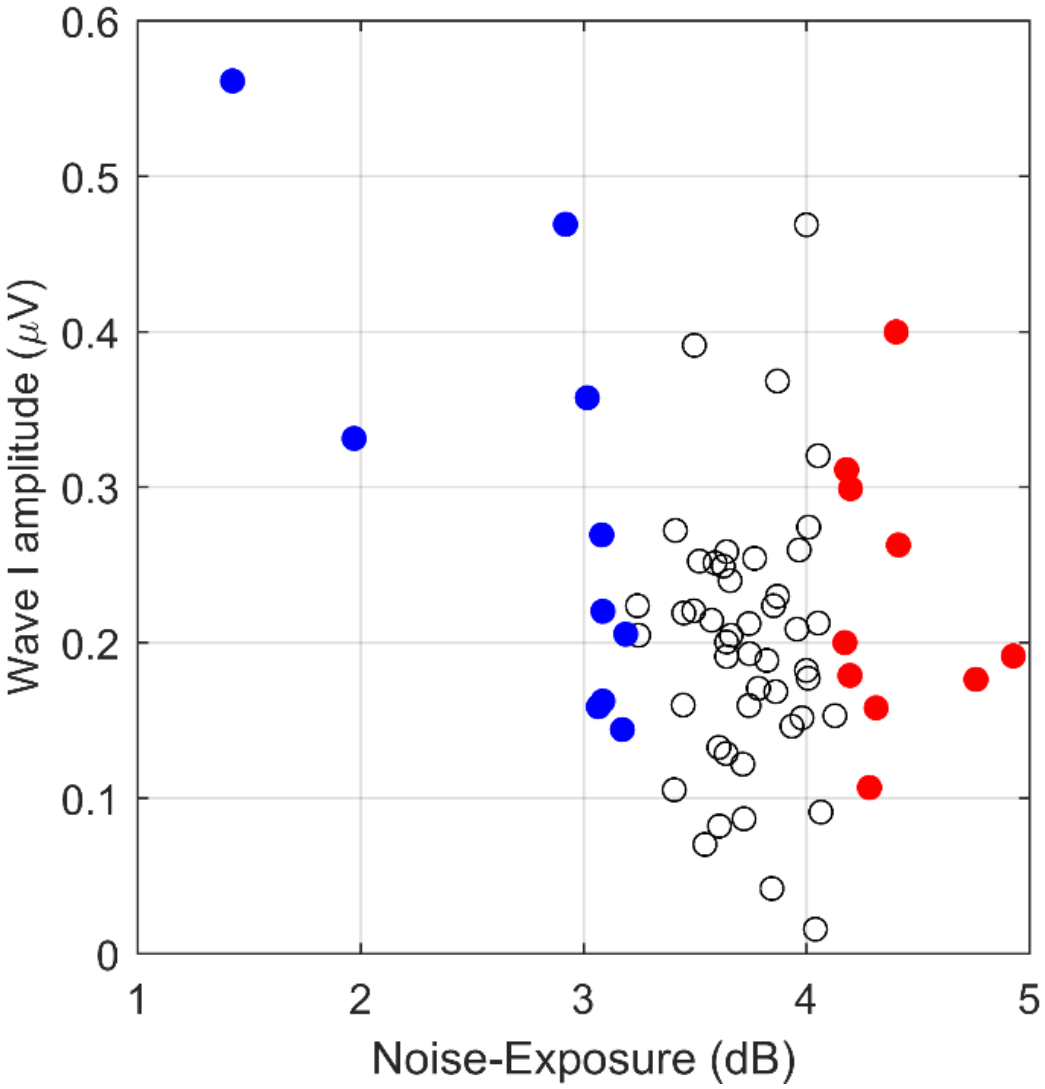
Methods

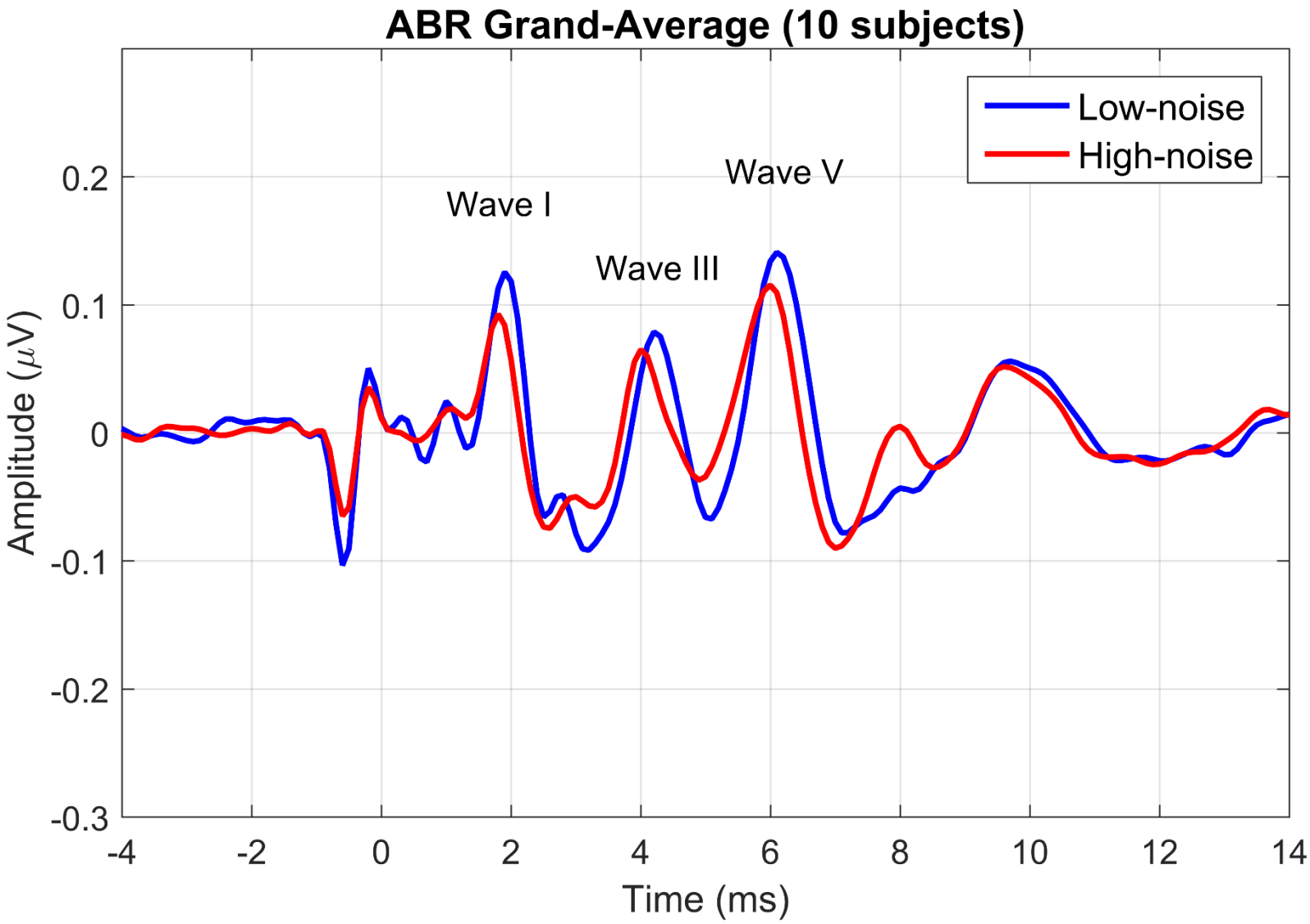
- 67 normal hearing subjects (35 males, 44.32 ± 6.43 yr)
- Lifetime **noise exposure** questionnaire
- **ABR** evoked by clicks
  - ✓ 75 dB HL
  - ✓ 39.1 Hz rate
  - ✓ 12,500 clicks
  - ✓ Fz-TIPtrode


0.6
0.5
0.4
0.3
0.2
0.1
0
Wave I amplitude (μV)
1
2
3
4
5
Noise-Exposure (dB)


N=67 p=0.00497 r=-0.33932 R2=0.11514
Wave I amplitude (μV)
0.6
0.5
0.4
0.3
0.2
0.1
0
1
2
3
4
5
Noise-Exposure (dB)


N=67 p=0.528 r=-0.079741 R2=0.0063586
Wave I amplitude (μV)
0.6
0.5
0.4
0.3
0.2
0.1
0
1
2
3
4
5
Noise-Exposure (dB)


0.6
0.5
0.4
0.3
0.2
0.1
0
Wave I amplitude (μV)
1
2
3
4
5
Noise-Exposure (dB)


ABR Grand-Average (10 subjects)
Low-noise
High-noise
Wave I
Wave III
Wave V
Amplitude (μV)
0.2
0.1
0
-0.1
-0.2
-0.3
-4
-2
0
2
4
6
8
10
12
14
Time (ms)

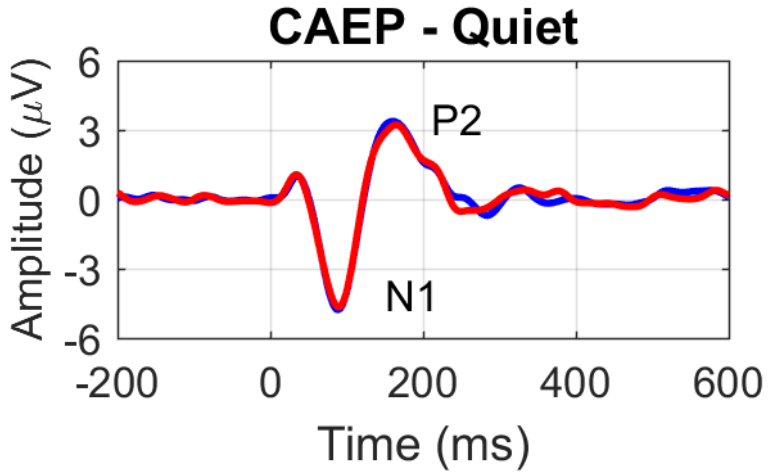
Musical training

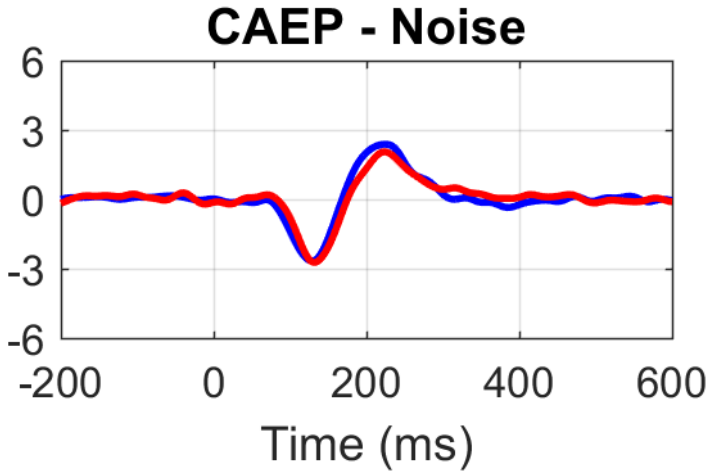
Hypothesis

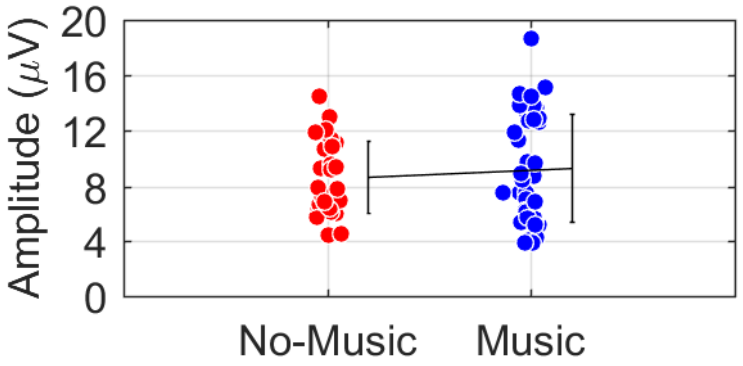
Cortical responses are enhanced in musicians, especially in challenging scenarios

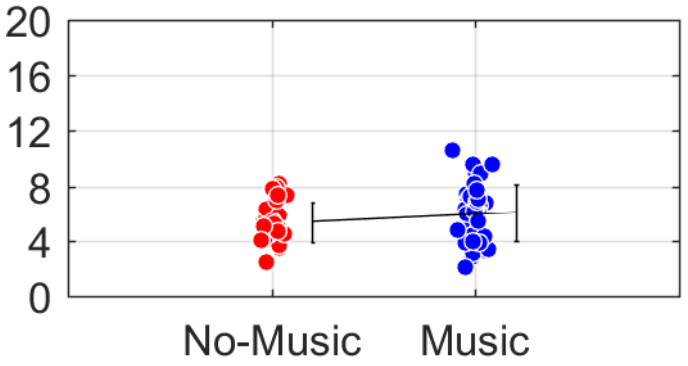
Methods

- Index of **musical training** – MUSE questionnaire
  - Musicians: lot of training & professionals [29 subjects]
  - Non-musicians: no training & little training [38 subjects]
- **CAEP**
  - ✓ 130 ms /da/ @ 75 dB SPL
  - ✓ 0.66 Hz rate (ISI 1.52 s)
  - ✓ 250 stimuli
  - ✓ SNR: Quiet & 0 dB
  - ✓ Cz - [M1&M2]
- **IRN**
  - ✓ 75 dB SPL
  - ✓ 0.90 Hz rate (ISI 1.10 s)
  - ✓ 250 stimuli
  - ✓ 4 it [weak] & 64 it [strong]
  - ✓ Cz - [M1&M2]
- Analysis: Linear-Mixed Effects Model



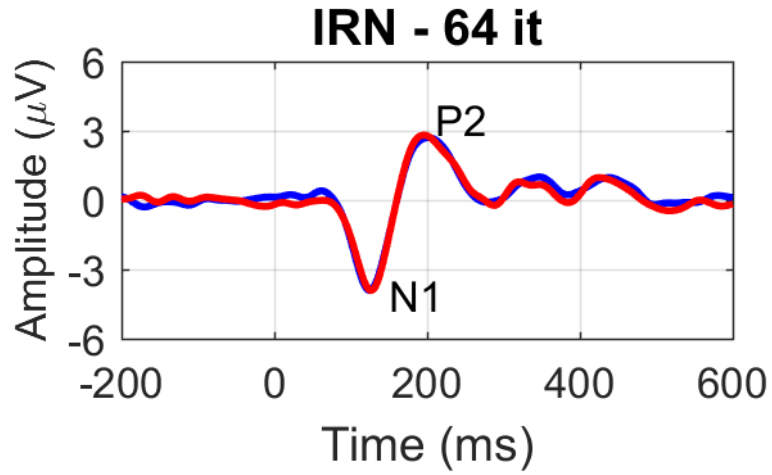


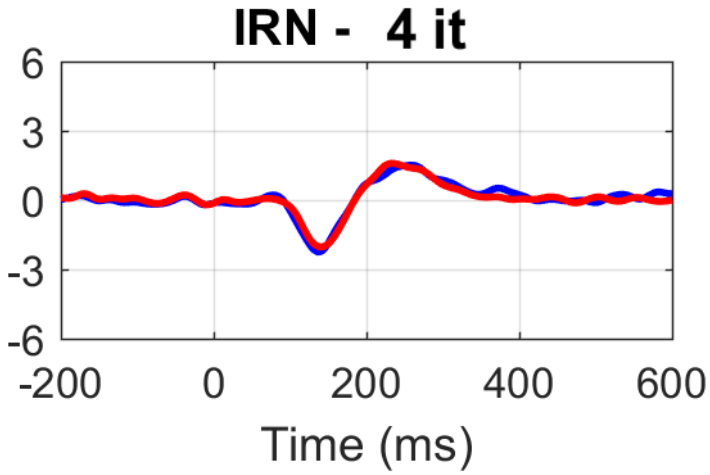


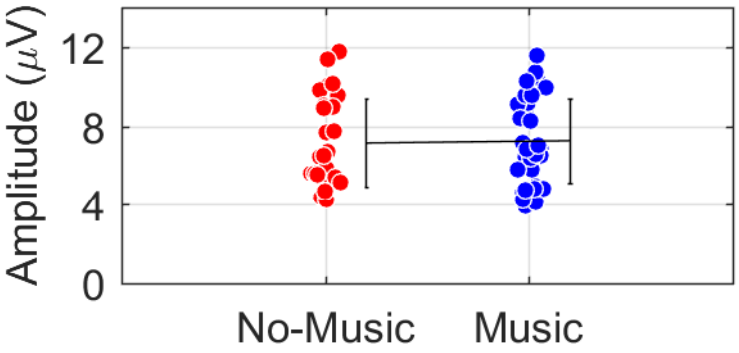


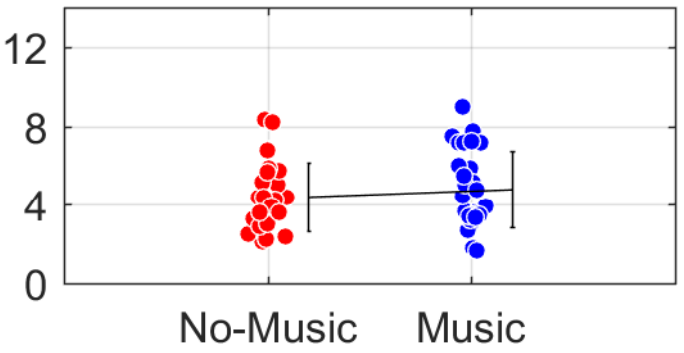
	EFFECT-SIZE	P-VALUE
AGE (Slope)	**0.19 µV/yr**	**0.005**
MALE	**-1.81 µV**	**0.03**
MUSICIANS	+0.98 µV	0.268

	EFFECT-SIZE	P-VALUE
AGE (Slope)	**0.13 µV/yr**	**0.0004**
MALE	-0.37 µV	0.41
MUSICIANS	**+1.14 µV**	**0.018**









	EFFECT-SIZE	P-VALUE
AGE (Slope)	**0.11 µV/yr**	**0.017**
MALE	+0.71 µV	0.21
MUSICIANS	+0.88 µV	0.15

	EFFECT-SIZE	P-VALUE
AGE (Slope)	**0.10 µV/yr**	**0.025**
MALE	**+1.30 µV**	**0.011**
MUSICIANS	**+1.25 µV**	**0.012**

Cognitive factors

Subjects

- 122 subjects: 63 female, 30 to 57 years (45.04 ± 6.36)

Online survey

- Age
- Ototoxicity
- Self-reported Speech-in-Noise performance [SSQ-12]
- Lifetime Noise exposure (workplace + leisure)
- Music training [MUSE]

Audiometry

- Low frequencies [LF]
- High frequencies [HF]
- Extended high frequencies [EHF]
- Medial-olivocochlear reflex [MOCR]

Speech in Noise

- Listening in Spatialized Noise High-Cue [LiSN-S]
- NAL-Dynamic Comprehension Test [NAL-DCT]

Cognitive measures

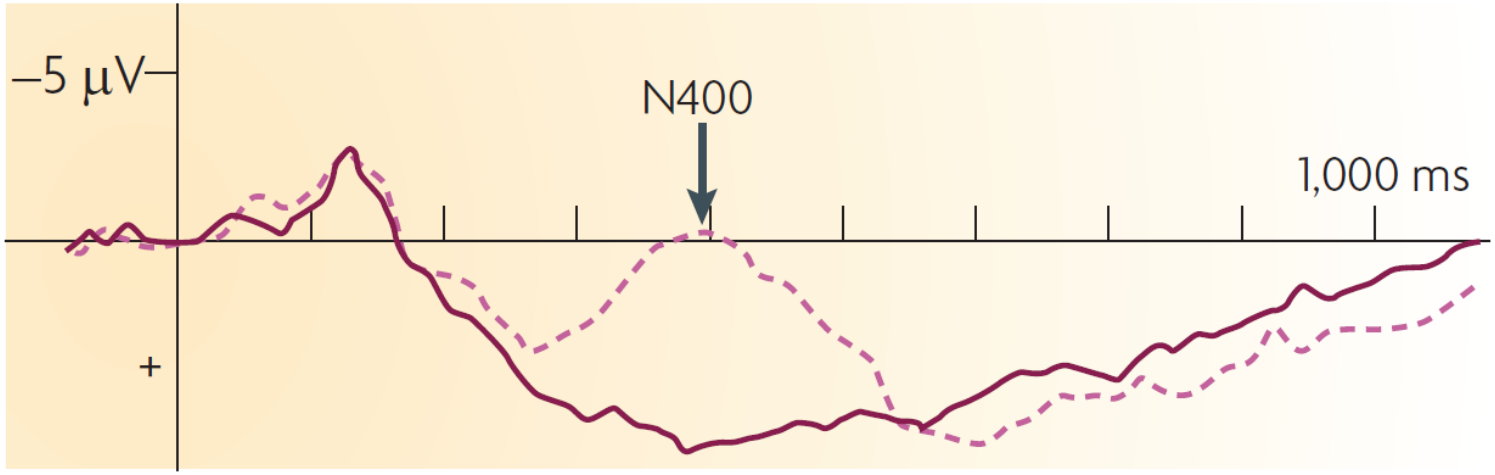
- Test of Everyday Attention [TEA]
- Working memory [RST]
- Text Reception Threshold [TRT] (visual task)

	SSQ	LiSN-S	NAL-DCT
Age	**-0.19**	**0.32**	**-0.30**
Ototoxicity	-0.14	**0.18**	-0.02
Music training	0.14	-0.06	0.07
Low-Frequency	-0.01	**0.27**	-0.20
High-Frequency	-0.18	**0.33**	-0.15
Extended High Freq	**-0.21**	**0.38**	**-0.37**
MOCR	**0.29**	0.07	-0.05
Attention [TEA]	0.07	**-0.20**	**0.23**
Working Memory [RST]	**0.20**	**-0.24**	**0.40**
Noise exposure	-0.10	0.01	0.05
TRT (visual task)	-0.03	0.15	**-0.47**

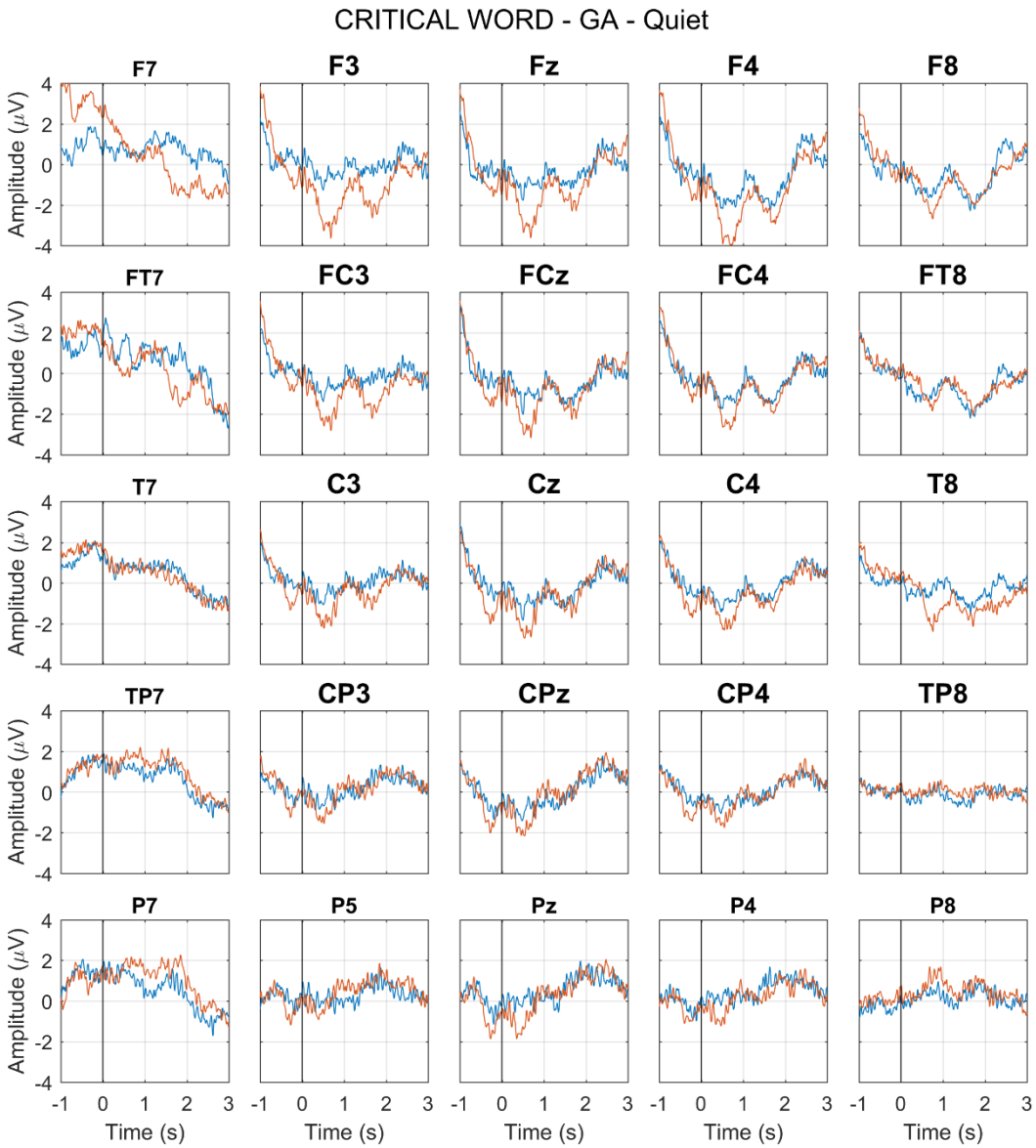
N400

[Congruent] The mother helps the children cross the road

[Incongruent] The mother helps the **cocktails** cross the road



N400


CRITICAL WORD - GA - Quiet
F7
F3
Fz
F4
F8
FT7
FC3
FCz
FC4
FT8
T7
C3
Cz
C4
T8
TP7
CP3
CPz
CP4
TP8
P7
P5
Pz
P4
P8
Amplitude (μV)
Time (s)

Take-home messages

1. Our data do not show concluding results on the effects of noise exposure in the peripheral encoding of sounds

2. Musicians present stronger cortical auditory evoked potentials in compelling scenarios

3. Working memory & attention are relevant cognitive factors in speech in noise performance

4. EHF is a potential indicator of early diagnosis of communication deficits