

Blast Exposure and TBI in the Veteran Population: Effects on Central Auditory Processing

Melissa A. Papesh, AuD PhD

Blast Exposure & TBI among Veterans

- From 2000 to 2016: **361,092** military personnel diagnosed with TBI¹
 - **82.3%** classified as **mild**
 - **22%** of all combat casualties resulting from TBI
- Many more have been exposed to high-intensity blast waves²
 - Even without TBI diagnosis, is sufficient to cause **premature brain aging**, white matter damage, and **chronic** symptoms³



¹ Defense and Veterans Brain Injury Center, 2017

²Institute of Medicine Report, 2013

³Trotter et al. (2015) Military blast exposure, ageing and white matter integrity

Common **hearing-related complaints** of blast-exposed Veterans:



- Hearing in noise
- Following rapid speech
- Understanding spoken instructions
- Following long conversations
- Tinnitus
- Hyperacusis

**Normal
Hearing??**

Case Study

- Male Veteran, age 52 at first visit
 - Referred to **Auditory Processing Disorder** clinic by general audiology clinic
- Auditory Complaints:
 - Difficulty hearing in noise & in presence of multiple talkers
 - Difficulty on the telephone
 - Difficulty paying attention to people speaking
 - Confusion of similar sounding words
 - Talks louder than normal
 - Needs TV louder than normal

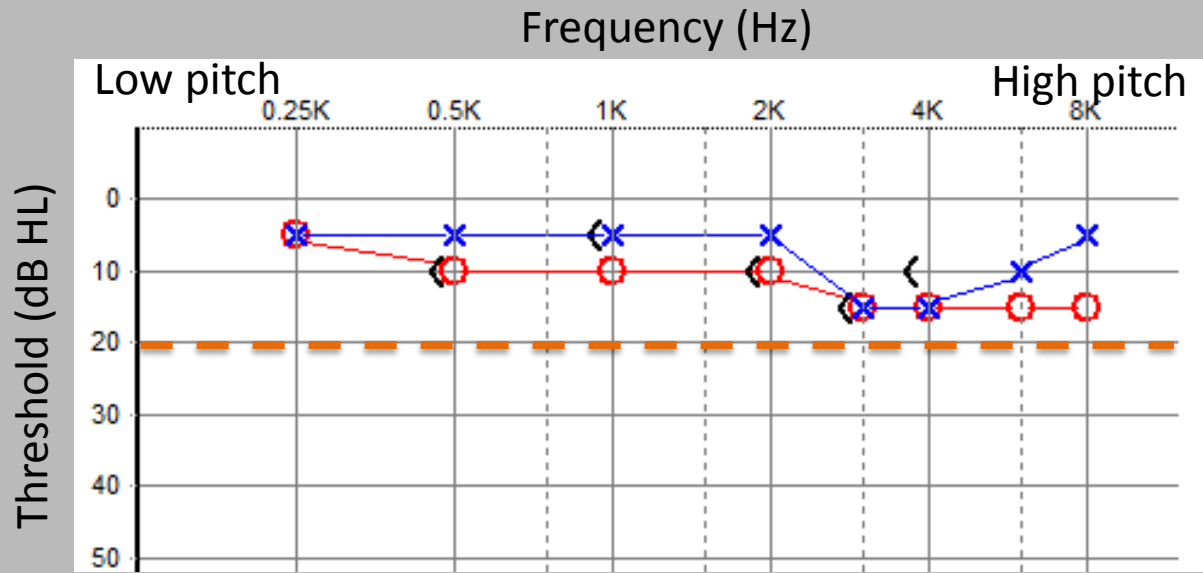
Medical History

- **Diagnosed with TBI** stemming from blast exposure from IED in 2008
 - 2 additional blast exposures as well
- Previously undergone Cognitive Rehabilitation treatment in Polytrauma/SLP for cognitive difficulties
- Additional medical diagnoses including:
 - PTSD
 - Obstructive Sleep Apnea
 - Chronic Headaches
 - Diabetes Mellitus, Type-2
 - Colitis
 - Obesity
 - Nerve compression of arm leading to weakness and numbness
 - Chronic back pain
 - Chronic knee pain
 - Hyperlipidemia
 - Coronary heart disease



Routine Audiometry

- Normal pure tone thresholds:



- Normal middle ear and tympanic membrane function
- Normal acoustic reflexes
- Normal inner ear function (DPOAEs present from 750 – 8000 Hz)
- Excellent speech recognition in quiet

APD Test Measures

- SCAN-A (all subtests)
 - Filtered Words
 - Auditory Figure Ground
 - Competing Words
 - Competing Sentences

} **All Normal**
- Temporal Processing: Gaps-in-Noise
 - Right ear
 - Left ear

} Thresholds of 8 to 10 ms in each ear = **Abnormal**
- Temporal Pattern Recognition: Pitch Pattern Test
 - Right Ear → 52% Correct = **Abnormal**
 - Left Ear → 80% Correct = **Abnormal**

APD Test Measures cont.

- Speech Understanding in Noise Tests:
 - Words-in-Noise (WIN)
 - QuickSIN

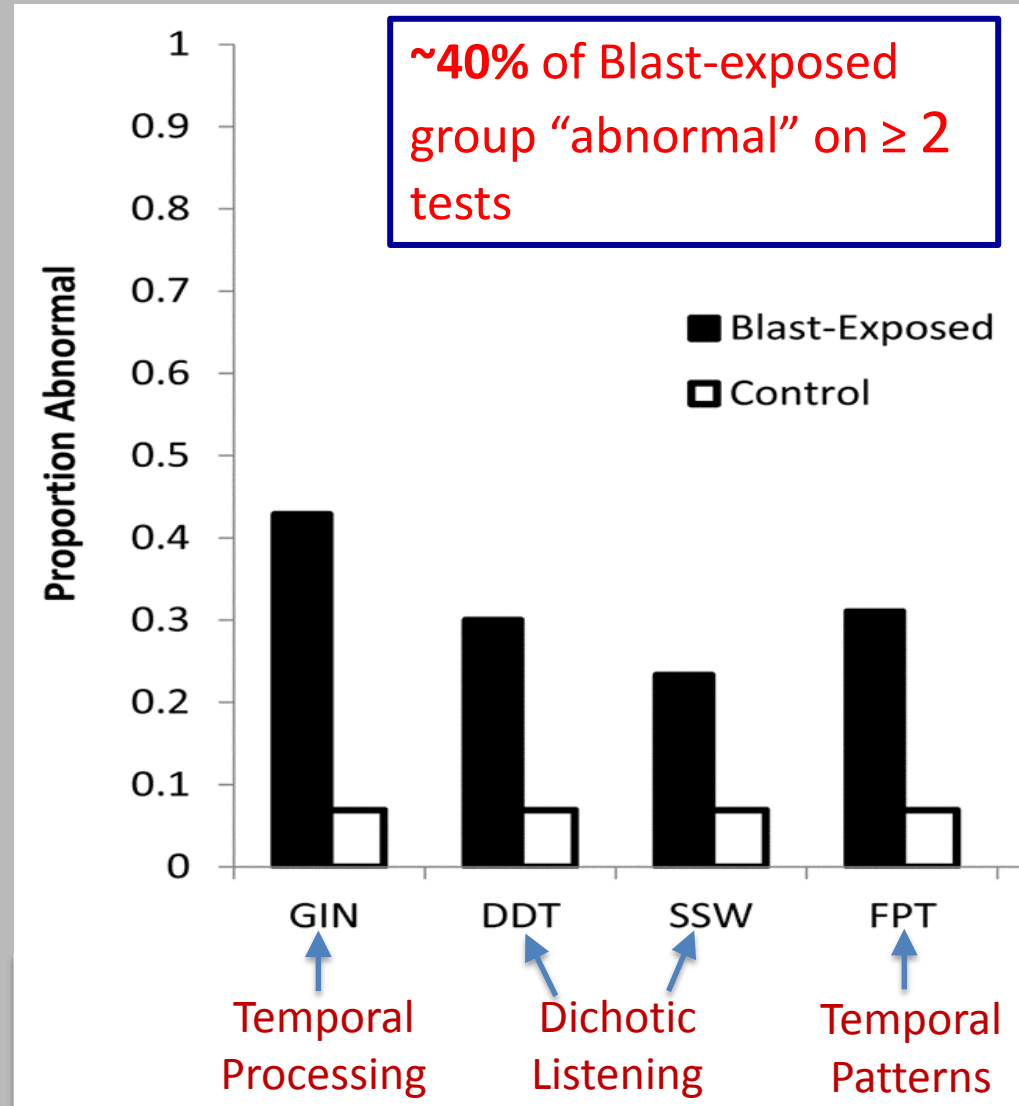
} Normal Performance
- Dichotic Listening Tests Digits
 - Dichotic Digits Test
 - Staggered Spondaic Words Test

} Normal Performance

Research on Chronic Effects of blast exposure

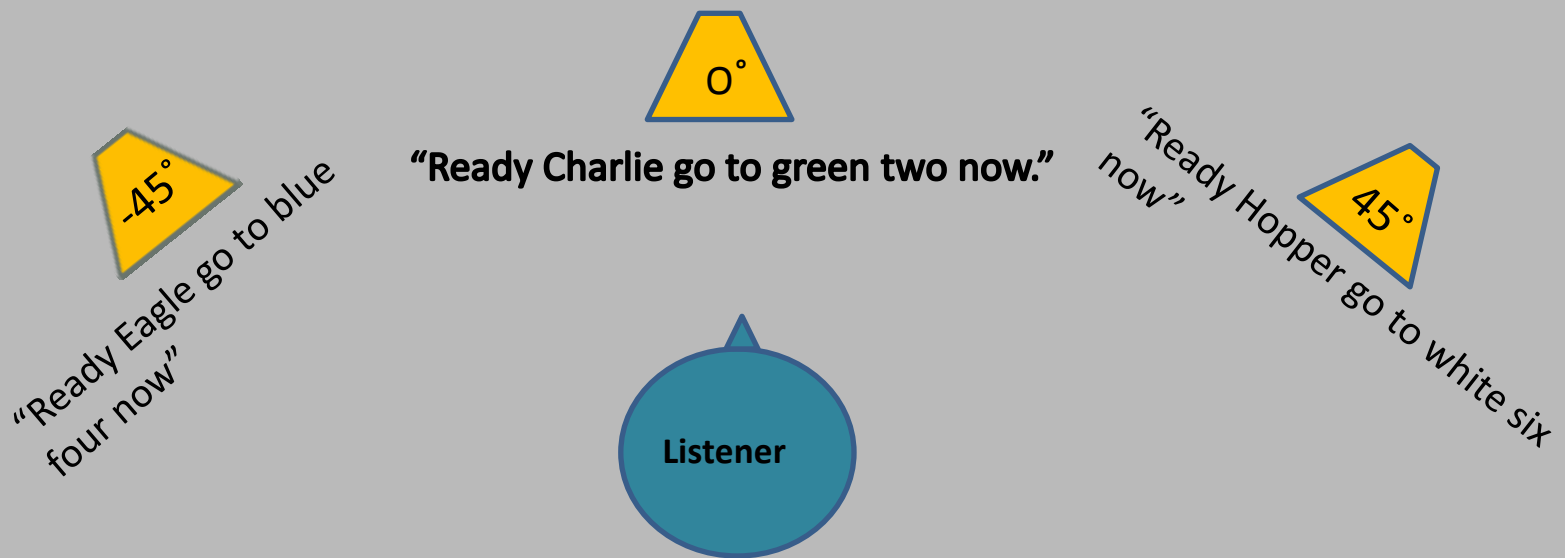
Participant Stats:

- Blast-exposed within the past 10 years (n=30)
- Normal or near normal hearing thresholds
- Average age of 37 (range: 25 – 64)
- All had excellent speech understanding in quiet
- N = 29 age- and hearing-matched controls



APD Test Measures cont.

- **Spatial Release from Masking – Speech**
 - How much benefit does the listener gain from having spatial separation between target voices and distractions?

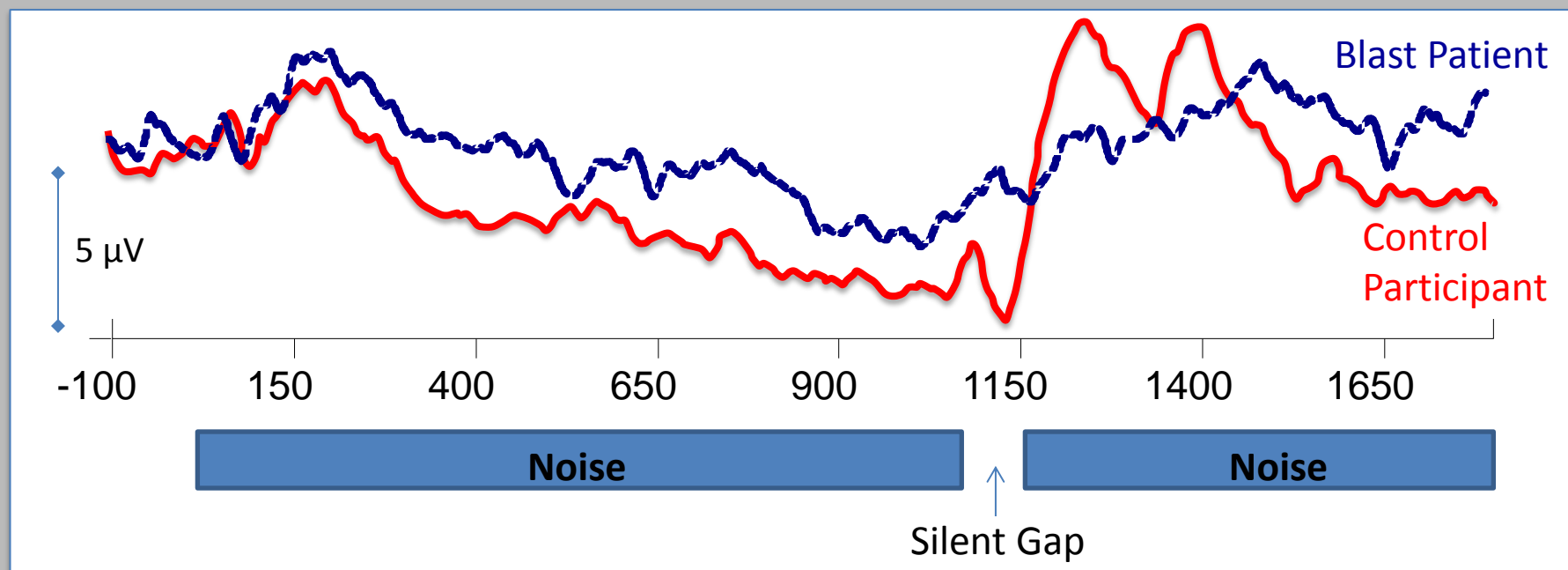


- Control listeners achieve an average spatial release of **~10 dB** (SD: 2.6 dB)

Case Study Patient: **3 dB** Spatial Release

Electrophysiological Data

- Cortical Gaps-in-Noise paradigm corroborated behavioral results:

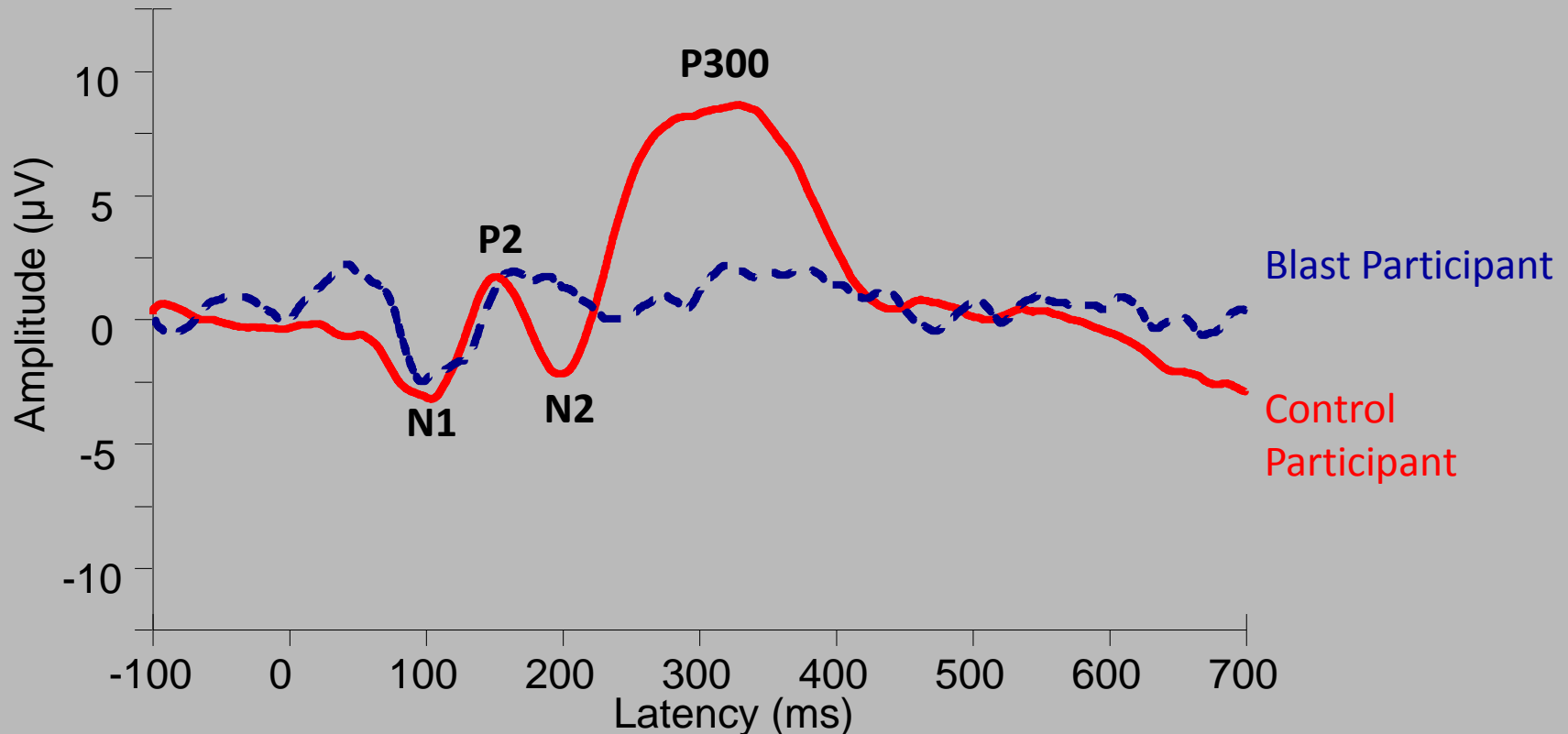


- Cortical detection of ITD cues corroborated behavioral SRM results

Electrophysiology Data cont.

P300 oddball paradigm

- 500 Hz “standard” tone (80% of trials)
- 1000 Hz “rare” tone (20% of trials)



Clinical Impressions & Recommendations

- Impressions:
 - Temporal processing impairment
 - Likely contributes to perceived difficulty with speech understanding in noise:
 - Minimal benefit from spatial separation of from sound sources
 - “Smearing” of sounds over time
- Recommendations:
 - Low-amplification hearing aids with directional microphones & FM system
 - Counseling re: environmental modifications and communication strategies to improve SNR

Follow-Up

- Data Logging indicates average hearing aid use of **8 hours per day**
- He overall finds the hearing aids to be "**perfect.**" He stated that the hearing aids have made a huge, positive difference in a his daily life.
- Reports that he is **less fatigued** by the end of the day, because it is easier to hear.
- He also reported a significant improvement in his ability to understand in **background noise** and on the **telephone**.
- Family has also noticed a great improvement.
- 2 years later, Veteran is still wearing HAs regularly

What interventions are most effective?

Research by **Gabrielle Saunders, Terry Chisolm, and Paula Myers**

Participants (n = 86):

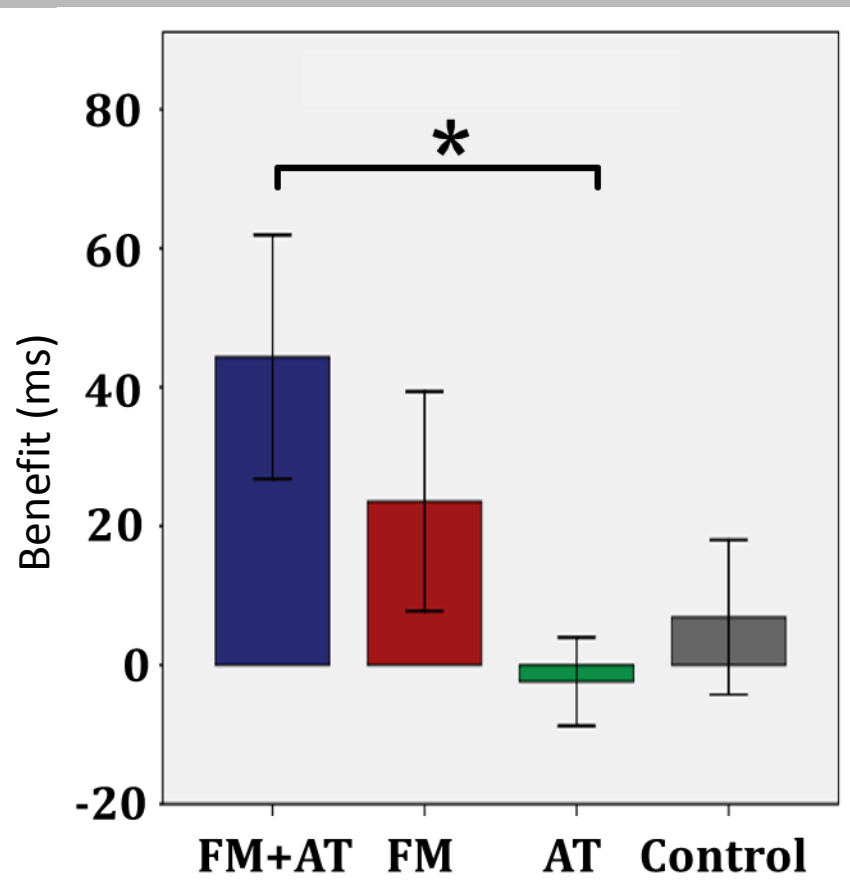
- OEF/OIF Veterans
- Normal or near normal hearing thresholds
- Blast exposure incurred during deployment (since 2001)

Interventions (4 groups):

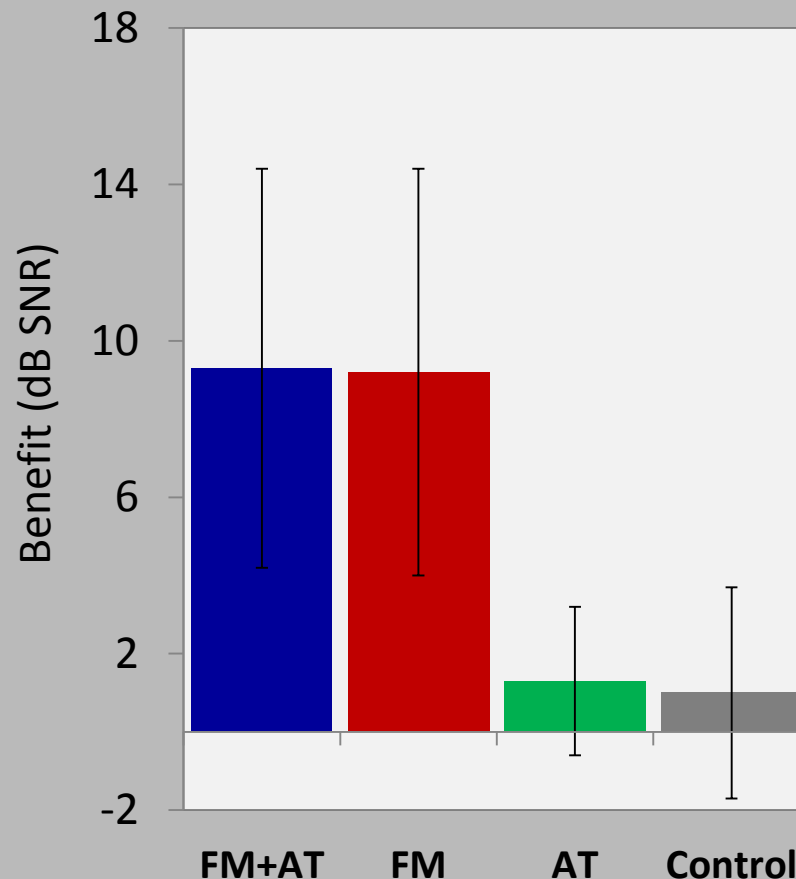
- FM System
- Auditory Training (Posit Brain Fitness program)
- FM System + Auditory training
- Counseling only

Intervention Results

Gap Detection



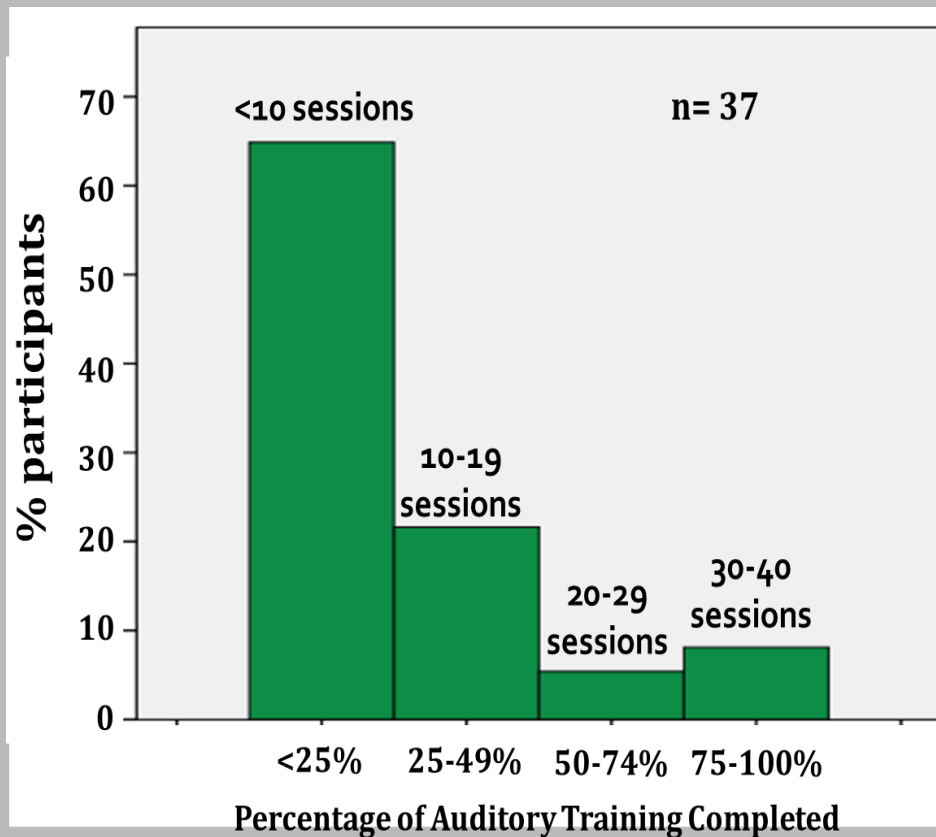
Hearing in Noise Test



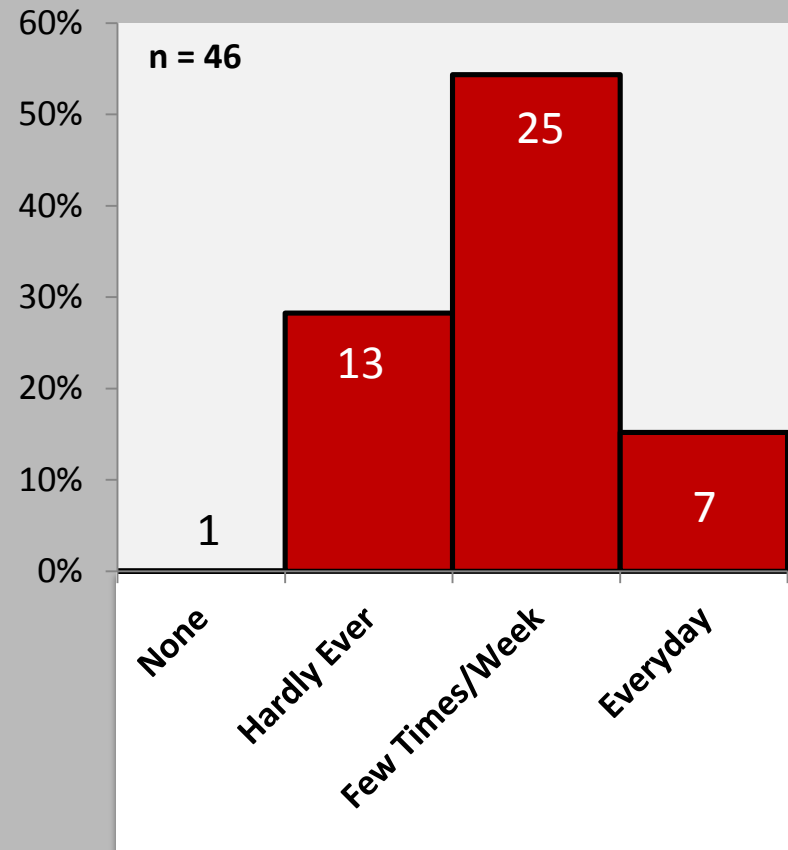
Generally, the greatest improvements were found for the FM and the FM+AT groups with minimal change in the AT group

Compliance with Intervention

Auditory Training



FM System



Many thanks to our **Veterans** and to all those that made this work happen!!!



- **Frederick J. Gallun, PhD** – principal investigator
 - **Robert L. Folmer, PhD** - principal investigator
 - **Curtis J. Billings, PhD** – principal investigator
 - **Gabrielle Saunders, PhD** - principal investigator
 - **Paula Myers, PhD** - principal investigator
 - **Terry Chisolm, PhD** - principal investigator
 - **Lauren Dillard, BS** – Mentored T-35 student
 - **Heather Belding, BS** – Research Assistant
 - **Michele Hutter, MS** – Research Audiologist
- **Melissa T. Frederick, AuD** – Research Audiologist
 - **Michelle Arnold, AuD** – Research Audiologist
 - **Shienpei Silverman, MS** – Research Assistant
 - **VA Portland Healthcare System**

