

NASA Audiology Summer Internship

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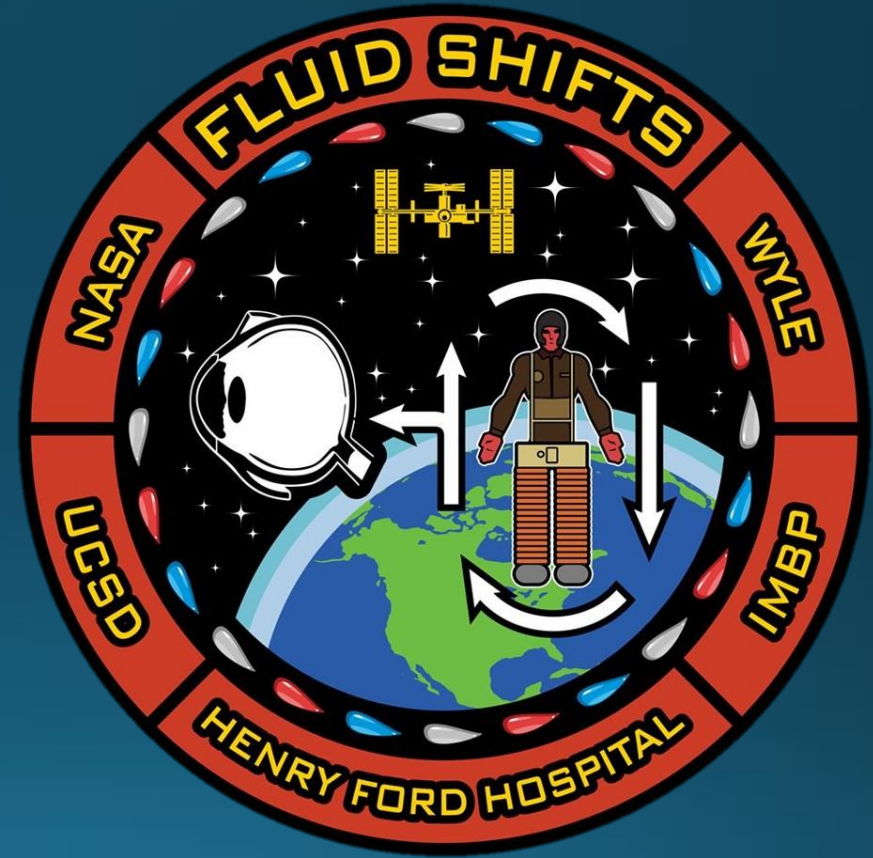
Title:

Assessing the Utility of Otoacoustic Emissions
for Monitoring Intracranial Pressure in
Microgravity through Analog Observations



Presentation Overview

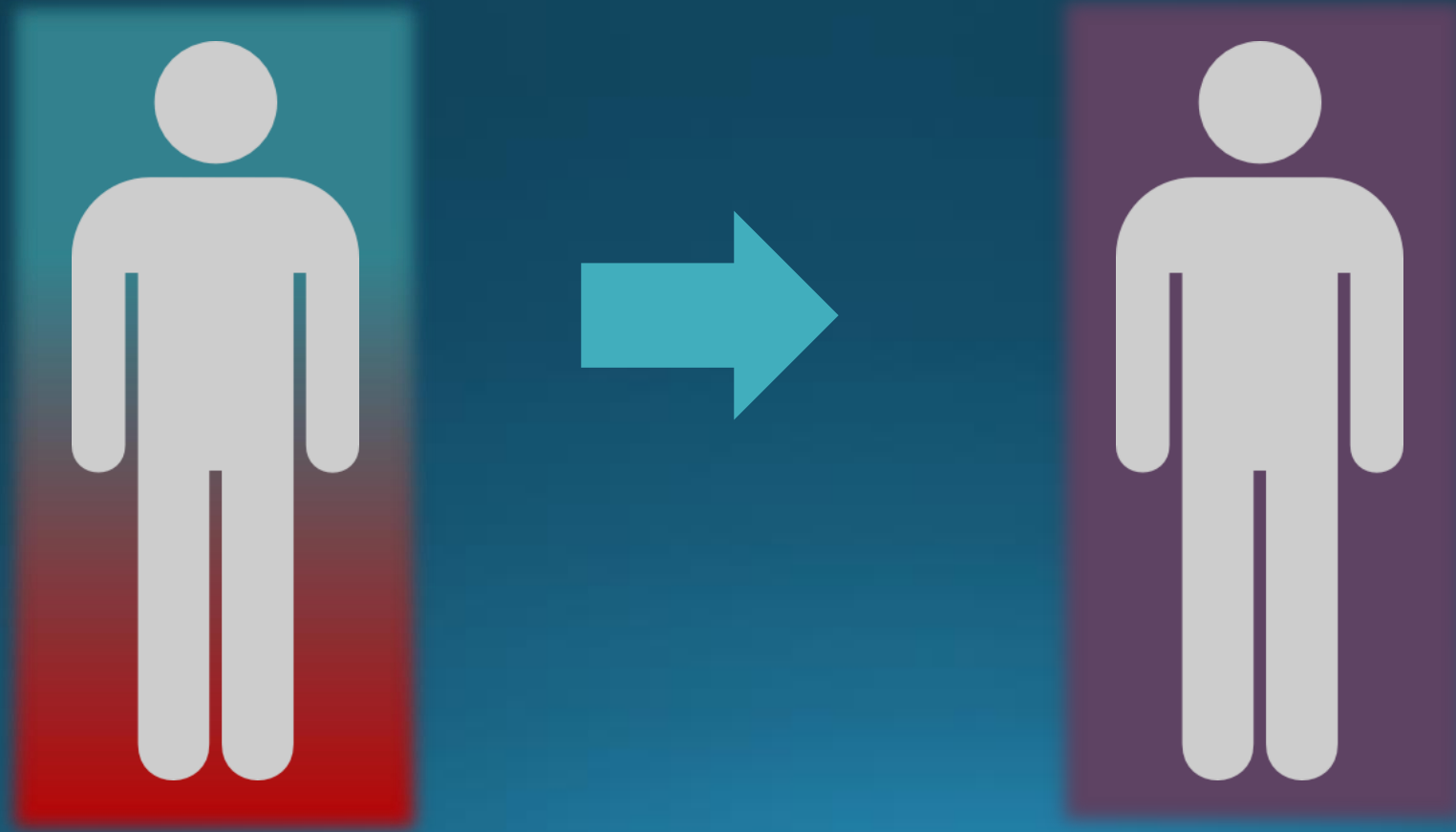
- Fluid Shifts Project
- Project Contributions
- Impact & Personal Growth



Fluid Shifts

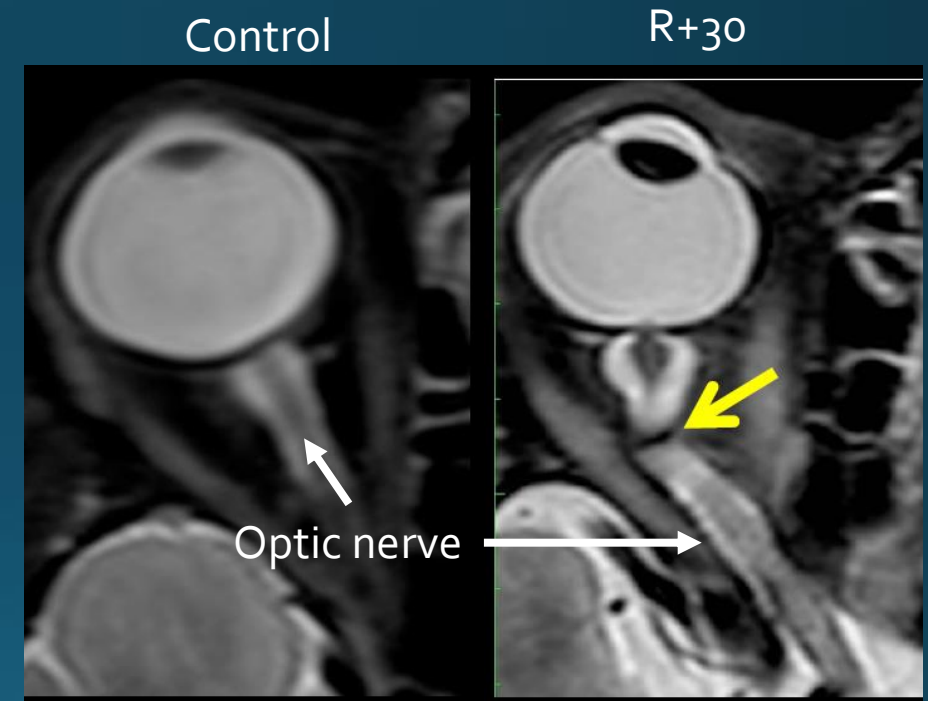
On Earth: higher fluid pressure in lower extremities

In microgravity: fluid pressure more equally distributed throughout body



Intracranial Pressure (ICP)

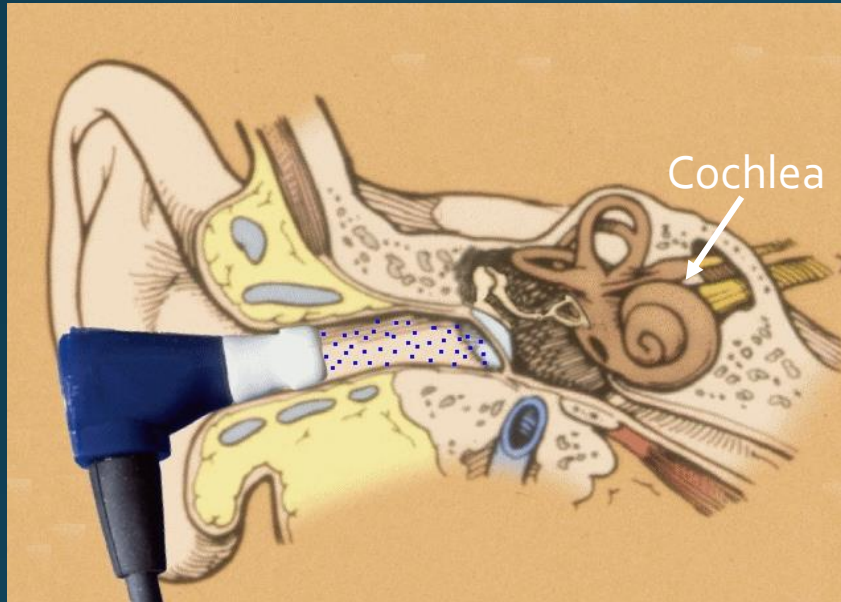
- Hypothesis: upward shift of fluids leads to
 - increase in volume of fluids in skull
 - increased ICP
- Crew health and performance problems associated with elevated ICP:
 - Headache
 - Feeling of fullness
 - Decreased visual acuity during and after spaceflight
 - *Visual Impairment and Intracranial Pressure (VIIP)*



humanresearchroadmap.nasa.gov/Evidence/reports/VIIP.pdf



Otoacoustic Emissions (OAEs)

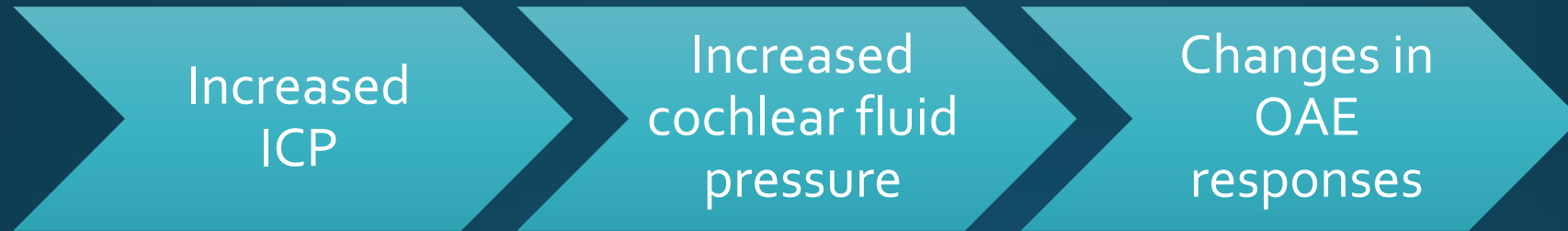


- Acoustic signal produced by movement of hair cells within the cochlea
- Typically recorded in response to sound stimuli



Outer hair cell vibrating in response to sound – generator of OAEs

Otoacoustic Emissions (OAEs)



- Potential non-invasive monitoring of ICP
- Quick and easy to administer



Analogues to Spaceflight

- OAEs are one of several potential non-invasive ICP monitoring tools being assessed in NASA's Fluid Shift Study
- Analog studies have included the use of
 - Head-down tilt studies
 - Lower-body negative pressure (Chibis pants)



Internship Project Contributions

- OAE Processor Handbook for future researchers
- Analysis of analog subject OAE data
- Experiment to characterize confounding variables seen in OAEs acquired from crewmembers on International Space Station (ISS)



Handbook for Future Researchers

- Concise resource for future interns and researchers, which will contribute to their analyses of subsequent data collected on ISS
- OAE Processor Handbook covers:
 - Brief overview of project and relevant literature
 - Extracting and formatting data from OAE measurement instrument
 - Implementing indexed files in analytical program
 - Interpreting results



Analog Subject Data

Transient-evoked otoacoustic emissions (TEOAEs) were recorded from 8 subjects in seated, supine, and 15-degree head-down tilt conditions



Seated



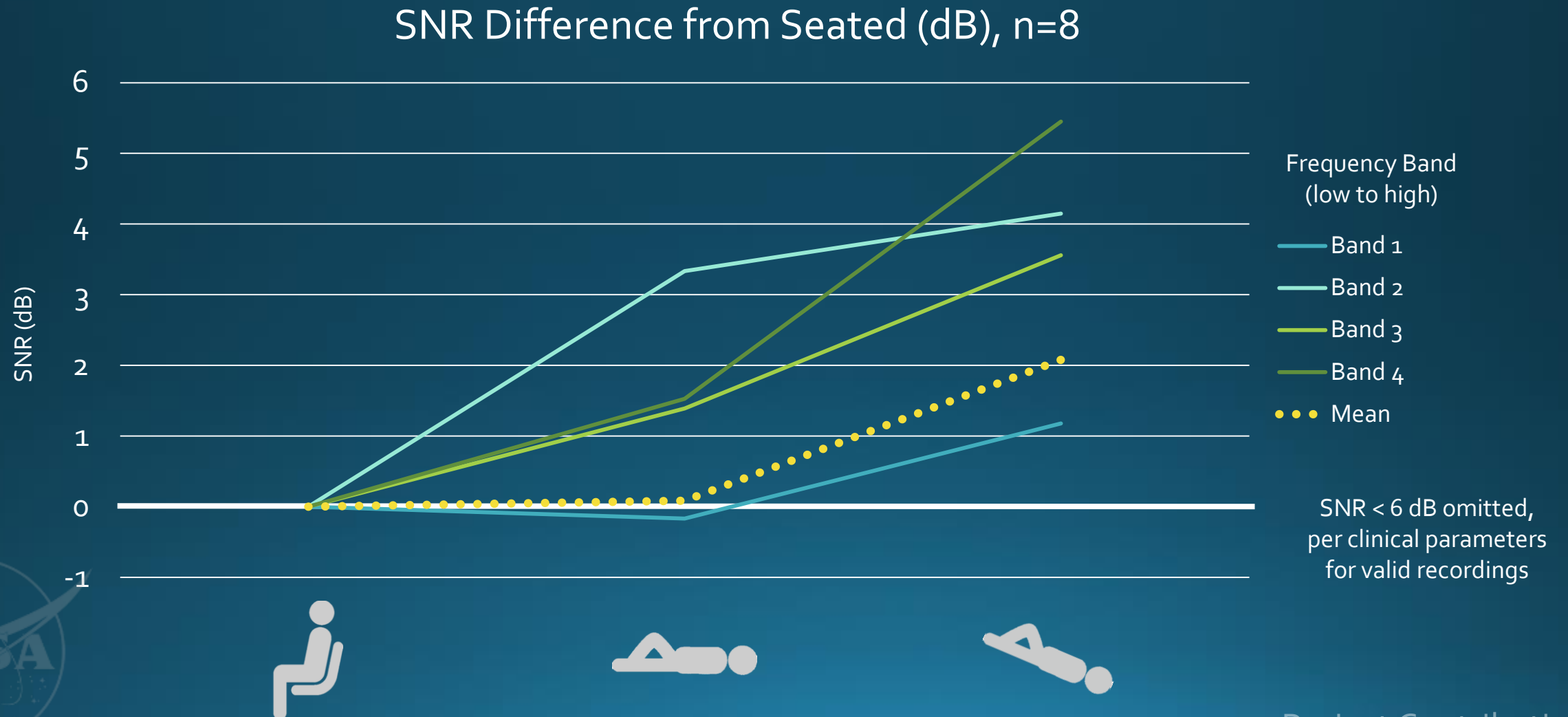
Supine



15-degree head-down tilt

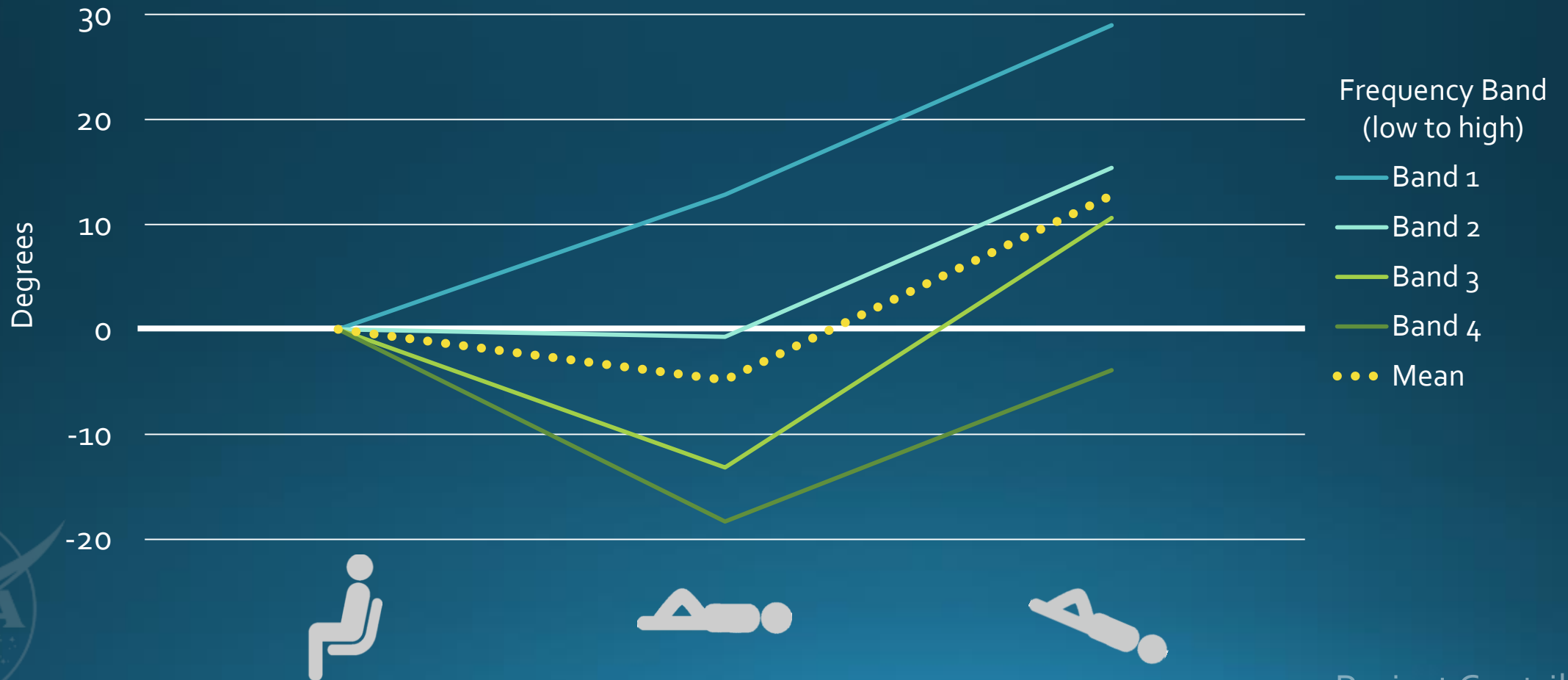


Analog Subject Data



Analog Subject Data

Phase Difference from Seated (Degrees), n=8



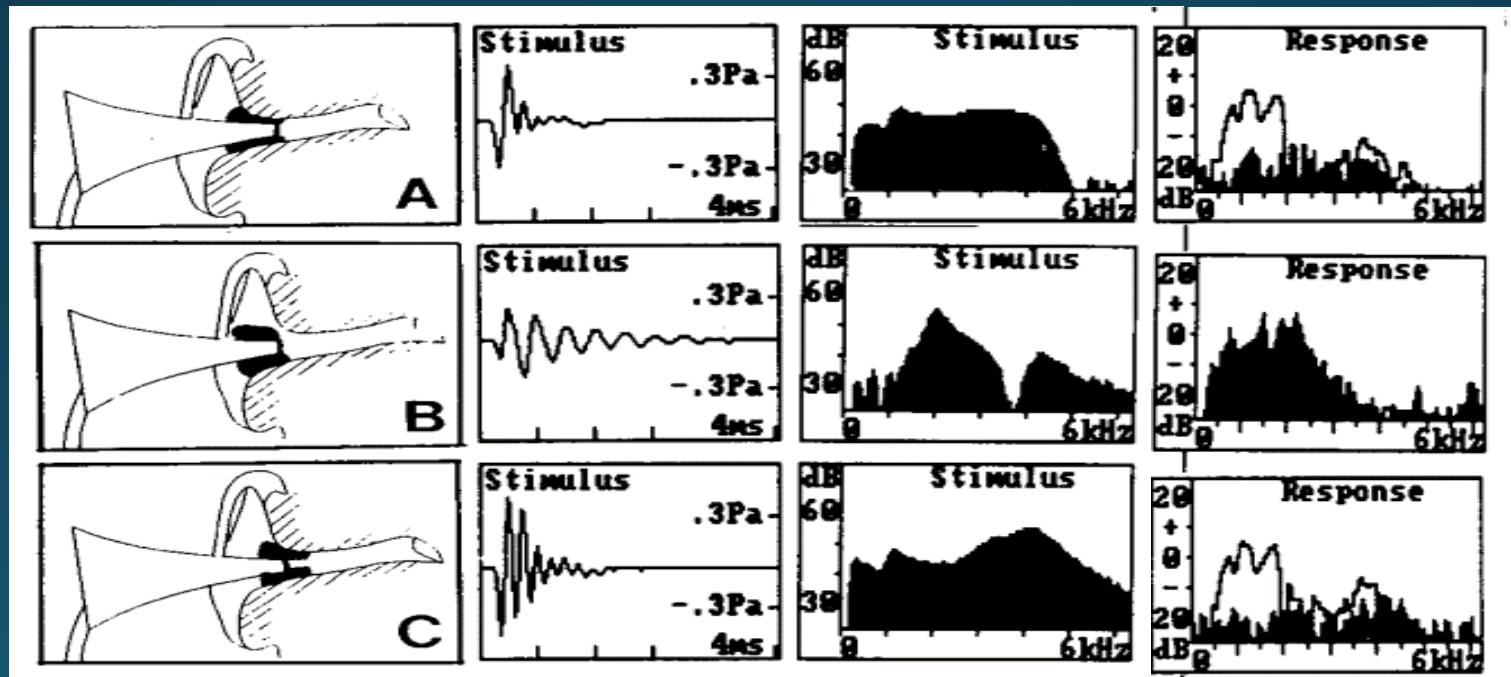
Confounding Variables Experiment

- Conclusions about OAE data obtained from crewmembers on ISS are confounded due to the small sample size and possible influence of extraneous factors
 - Characteristics of OAE probe insertion
 - Middle ear pressure
 - 6-degree HDT condition



OAE Probe Insertion

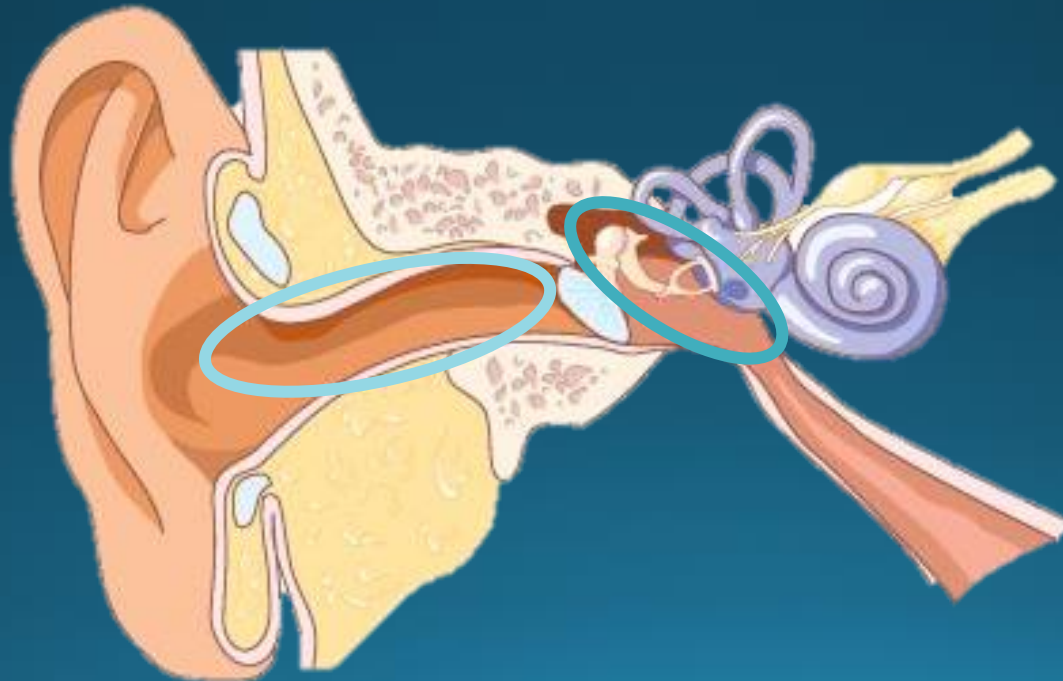
- Slightest variations in OAE probe orientation, depth, and fit can alter magnitude and phase characteristics of stimulus and response



Kemp, Ryan, & Bray (1990)

Middle Ear Pressure

- OAE stimulus and response must both traverse middle ear cavity
- Pressure mismatches between external and middle ear affect propagation of signal

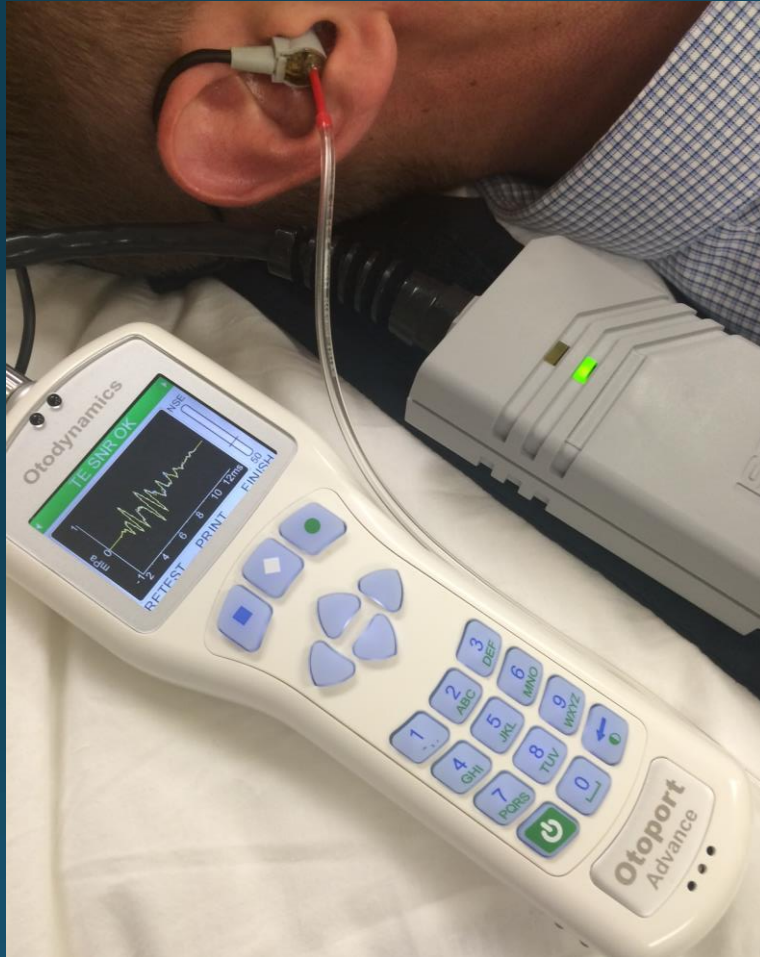


6-Degree Head-Down Tilt Condition

- Established as standardized baseline condition for simulating effects of microgravity (joint US/Soviet study, 1979)



Experimental Protocol



- 7 analog subjects
- Test conditions:
 - *Iterations with/without probe re-insertion between tests*
 - *Air pressure induced in external canal to match middle ear pressure*
 - *Four different postures*
- 24 total TEOAE recordings per subject
- ~2.5 hours per subject



Confounding Variables Experiment

- Findings

...to be determined! Analysis will continue through Fall 2016.



Skill Enhancement at NASA Internship

Technical

- OAE parameter establishment
- OAE results interpretation
- Stata statistical analysis program

Soft Skills

- Research design
- Statistical methods
- Technical writing

Experiences

- Hearing conservation program
- SLSSI events and lectures



Impact of NASA Internship

- Takeaway lessons
 - Applications for audiology are widespread and in unexpected places
 - Very necessary to critically evaluate scientific literature based on **how** researchers draw their conclusions
- Organizational lessons learned
 - Characterizing ICP/VIIP crucial for maintaining crewmember health and performance for long-duration spaceflight and well-being upon return
 - “The work we are doing today will one day put a human on Mars”



Recommendations for Future Interns

- NASA is a very collaborative community. Reach out!
- Explore topics beyond their field through SLSSI lectures and events.
- Pursue lofty goals! The quality of their experience is determined by the effort you put into it.



Acknowledgments

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 - Medical Clinic Staff



You are cordially invited to the

Summer Intern Award Ceremony

**Come see how interns at The Johnson Space Center
have impacted NASA's mission!
Forward this invite to others across JSC!**

Date: Wednesday, August 10

Time: 3:00pm – 4:00pm (CT)

Location: Teague Auditorium

**Following the event, be sure to stay for the milk and
cookie mixer from 4:00-4:30pm.**



References

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