NASA Audiology Summer Internship

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Mentor: Richard Danielson, Ph.D.
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

Fluid Shifts Project
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)
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

Increased ICP → Increased cochlear fluid pressure → Changes in OAE responses

CSF = cerebrospinal fluid
Analogs 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.
Analog Subject Data

SNR Difference from Seated (dB), n=8

Frequency Band (low to high)
- Band 1
- Band 2
- Band 3
- Band 4
- Mean

SNR < 6 dB omitted, per clinical parameters for valid recordings
Analog Subject Data

Phase Difference from Seated (Degrees), n=8

Degrees

Frequency Band (low to high)
Band 1
Band 2
Band 3
Band 4
Mean

Project Contributions
Confoundning 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
Confoundling Variables Experiment

- Findings

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

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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.
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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


