EXIT PRESENTATION

Maintaining Balance

Erin Heap Oklahoma Space Grant Consortium Intern Summer 2010

SOUTHERN NAZARENE UNIVERSITY

Agenda

Agenda

- Personal Background
- Project 1
  - Experiment- Stochastic Resonance
- Project 2
  - Pilot Study
- Experiences at JSC

Personal Background

Born in **Harlingen, Texas**

Raised in **Maryland**, outside DC

Southern Nazarene University
Bethany, OK

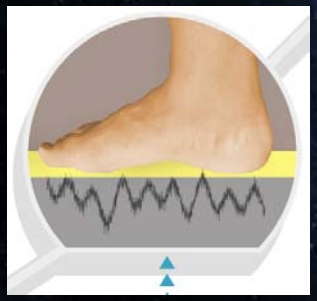
NASA JSC
Intern thru OK Space Grant in Neurosciences Lab!

Research Work
1-2 years. Maybe at the JSC?

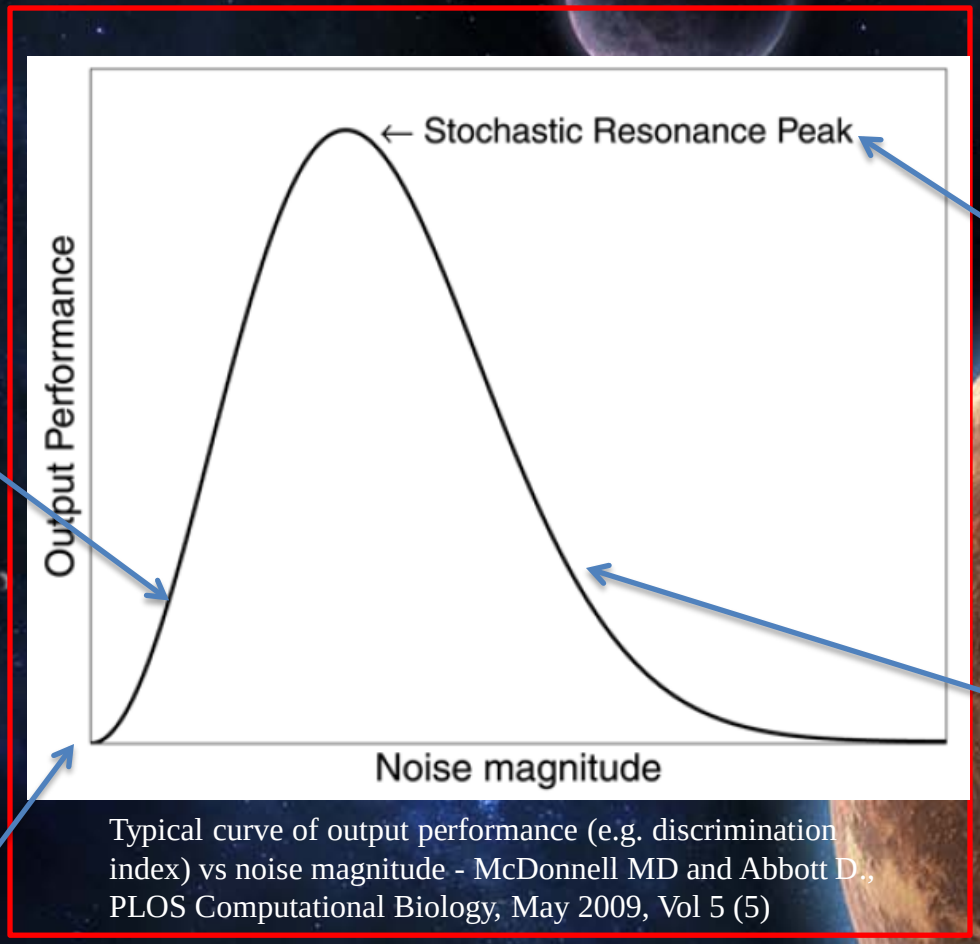
Medical School
☺

Project 1- Stochastic Resonance (SR)

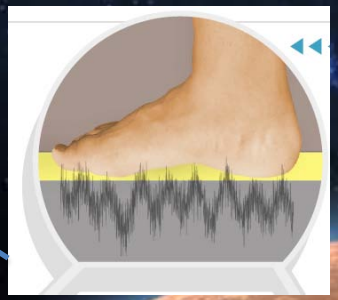
Stochastic resonance is a phenomenon in which the response of a non-linear system to a weak input signal is optimized by the presence of a particular non-zero level of noise.



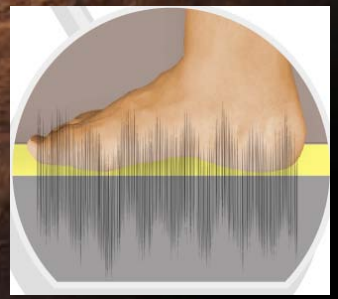
2. Some Sensation



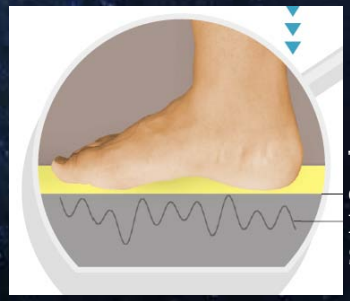
Typical curve of output performance (e.g. discrimination index) vs noise magnitude - McDonnell MD and Abbott D., PLOS Computational Biology, May 2009, Vol 5 (5)



3. Peak Sensation



4. Decreased Sensation



Threshold of sensation Mechanical Signal

1. No Sensation

Harry J, Niemi JB, Priplata AA, Collins JJ, IEEE Spectrum, April 2005.

Project 1

Goal:

- To develop a countermeasure based on the principle of stochastic resonance for sensorimotor disturbances experienced after long duration space flight.
- ***We hypothesize that enabling the detection of time-critical relevant imperceptible sensory signals will play a crucial role in improving strategic responses while performing functional tasks during crewmembers' re-adaptation to Earth G.***

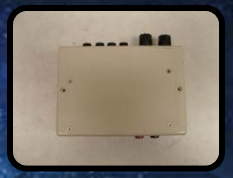
Research Question:

- What is the optimal amplitude of electrical stimulus to the vestibular organs that will enhance balance performance?

SR Procedure

- 16 healthy subjects with no known neurological condition gave informed consent
- Two sessions per subject
- Subject's stood on 10 cm medium density foam, arms crossed and eyes closed for each trial.
- Each session 21 trials
  - Three blocks of 7 stimulation trials for 0 to ± 700 μA levels, randomized
- Each trial lasted 44 seconds: 22 seconds baseline and 22 seconds of stimulation

Stochastic Resonance

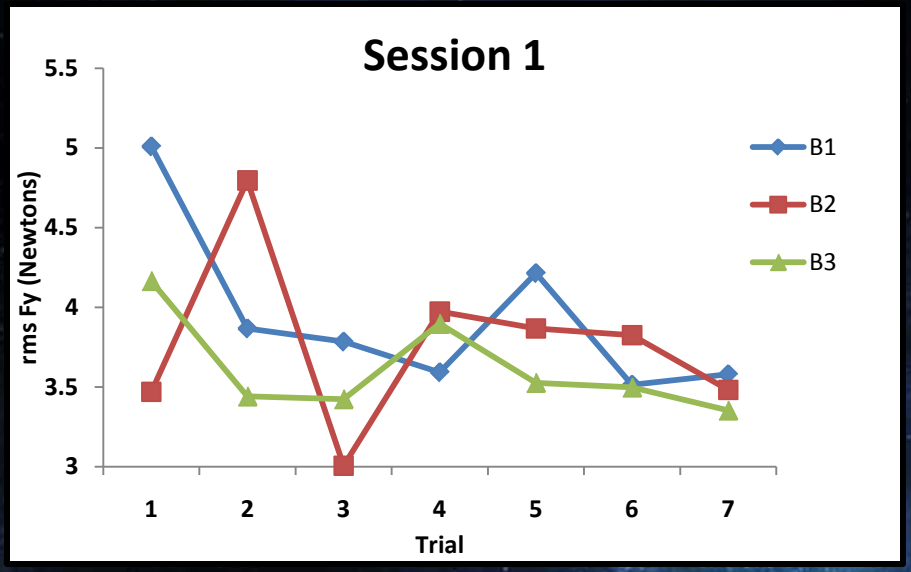


- Postural sway measured using a Kistler force platform and inertial motion sensors (Xsens) attached to head and torso segments.
- 42 total Variables calculated, 6 of interest, focused on rms Fy and COP PL
- Subject's overall rating of the difficulty of the trial recorded on a scale 1-5

Focus

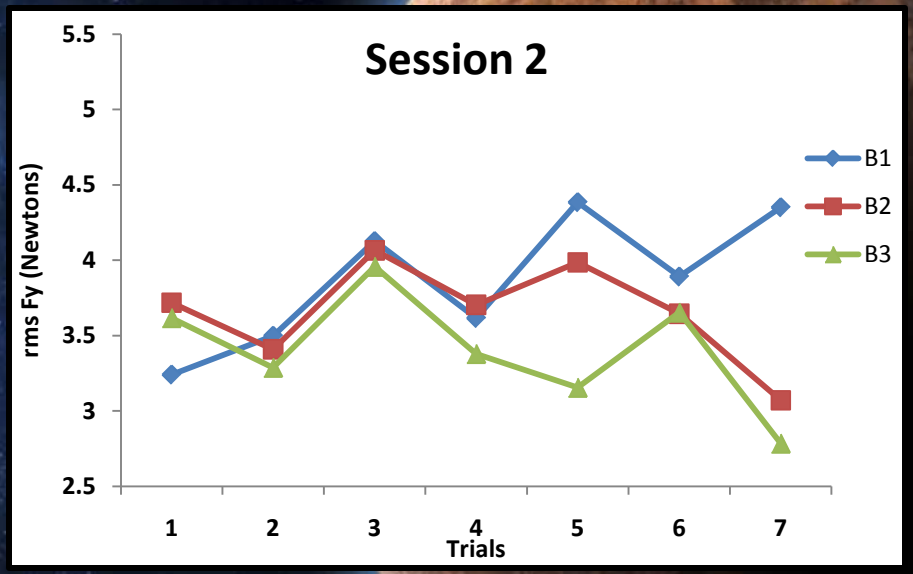
- Specific Question:
  - **Do subjects have a tendency to improve performance within and/or across the two sessions while standing on unstable surface?**
- Average and Standard Deviation for the baseline period across 7 trials per block for each of 6 variables.
- A 3*2 Repeated Measures Analysis of Variance with factors: Session (two levels) and Blocks (3 levels)

SR Results



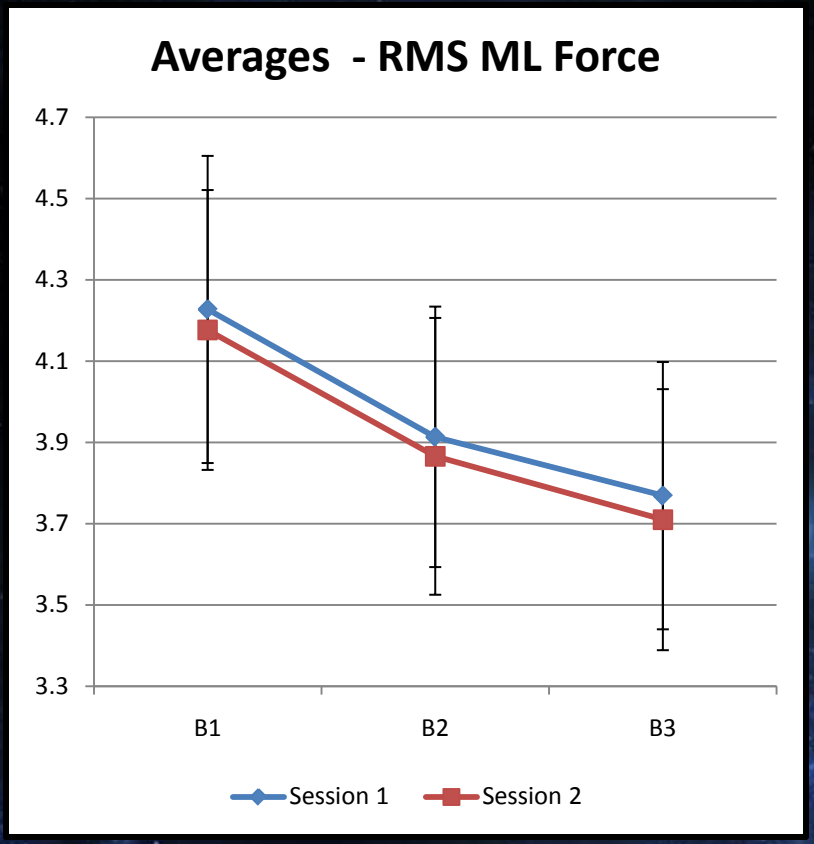
Subject 18 rms Fy

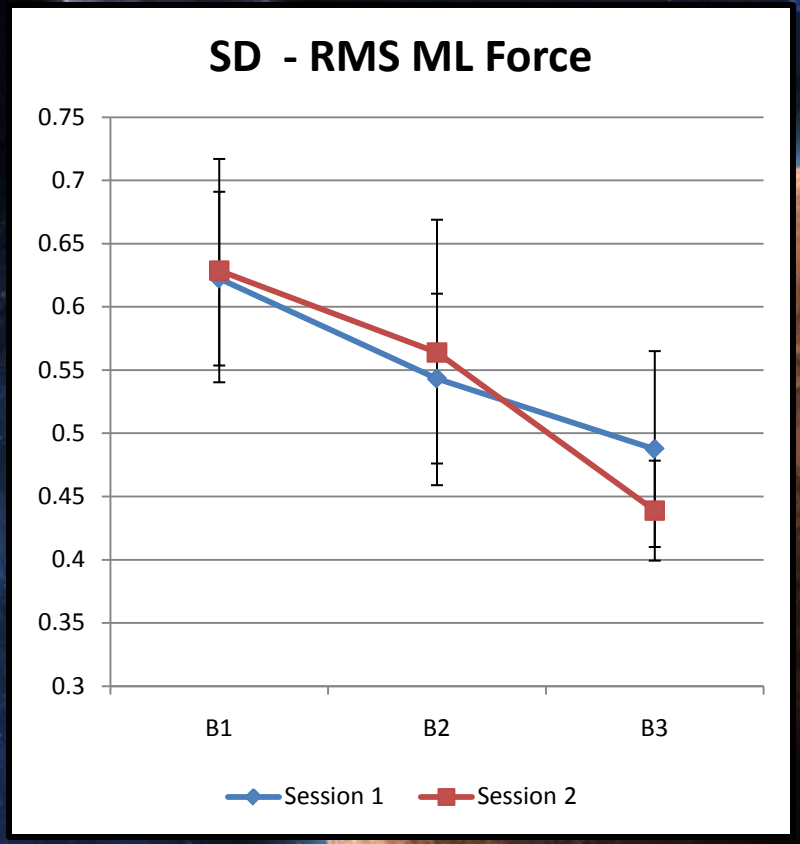
- Intra session learning was most evident in the rms Fy and COP PL variables



SR Results

Error Bars= SEM





RMANOVA : Block significant ($p<0.05$) and Sessions are not significantly different

SR Discussion

- Data shows that learning occurs within but not between sessions.
- Subjects improved the most in the third block.
- Statistically, the third block was different from the first and second.

Pilot Study

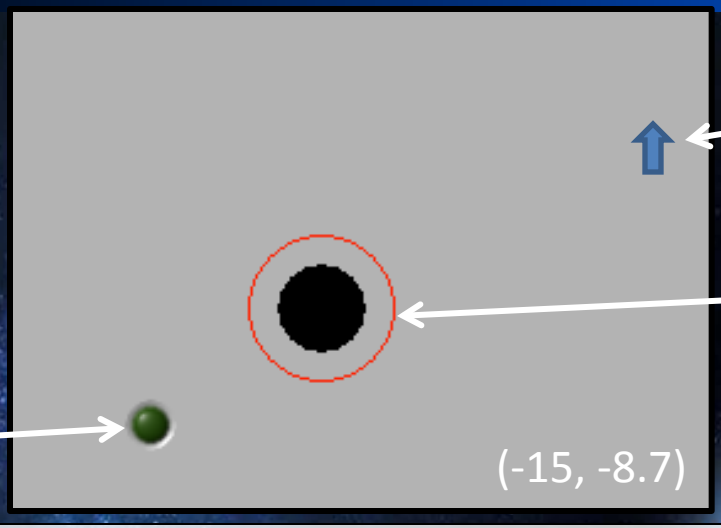
- **How will adaptation to a novel functional task be affected by postural disturbance?**
- Postural disturbance
  - Sitting (familiarization)
  - Standing on ground
  - Standing on unstable surface
- Two types of feedback

Pilot Design

Procedure

- 5 subjects with no known neurological conditions
- Target displayed for 1 second
- Subject instructed to begin pointing motion after hearing a tone presented one second later
- 75 random presentations of a target on screen in three presentation blocks:
    1. no translation (baseline, 13 trials)
    2. with translation (adaptation, 49 trials)
    3. no translation (after effects, 13 trials)
- Two surfaces:
    1. Stable
    2. Unstable

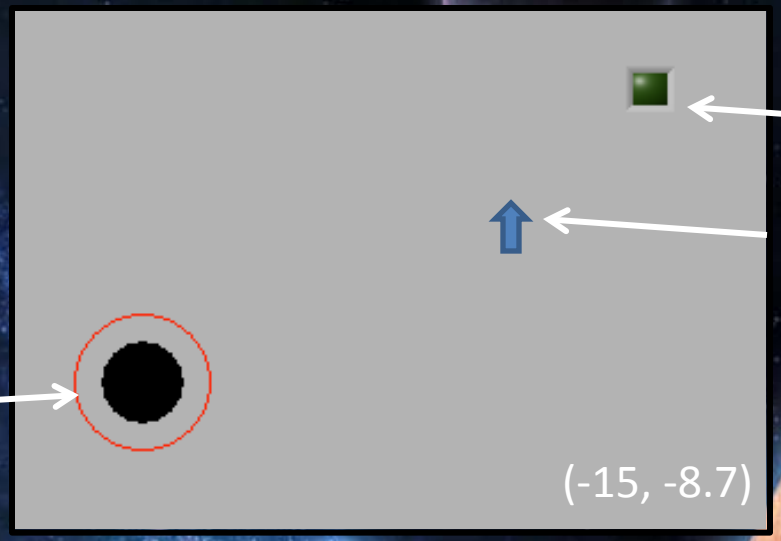
Pilot Design



Feedback 1

- The original target and a green dot will be displayed on the screen for a second, as feedback.
- The green dot is the translated location of subject's touch computed by the program.
- The goal is to get the green dot to the center of the target as quickly and accurately as possible. Subject's adjust touch location on screen on each subsequent trial.
- Quadrant and magnitude of translation altered for standing on stable and unstable surface.

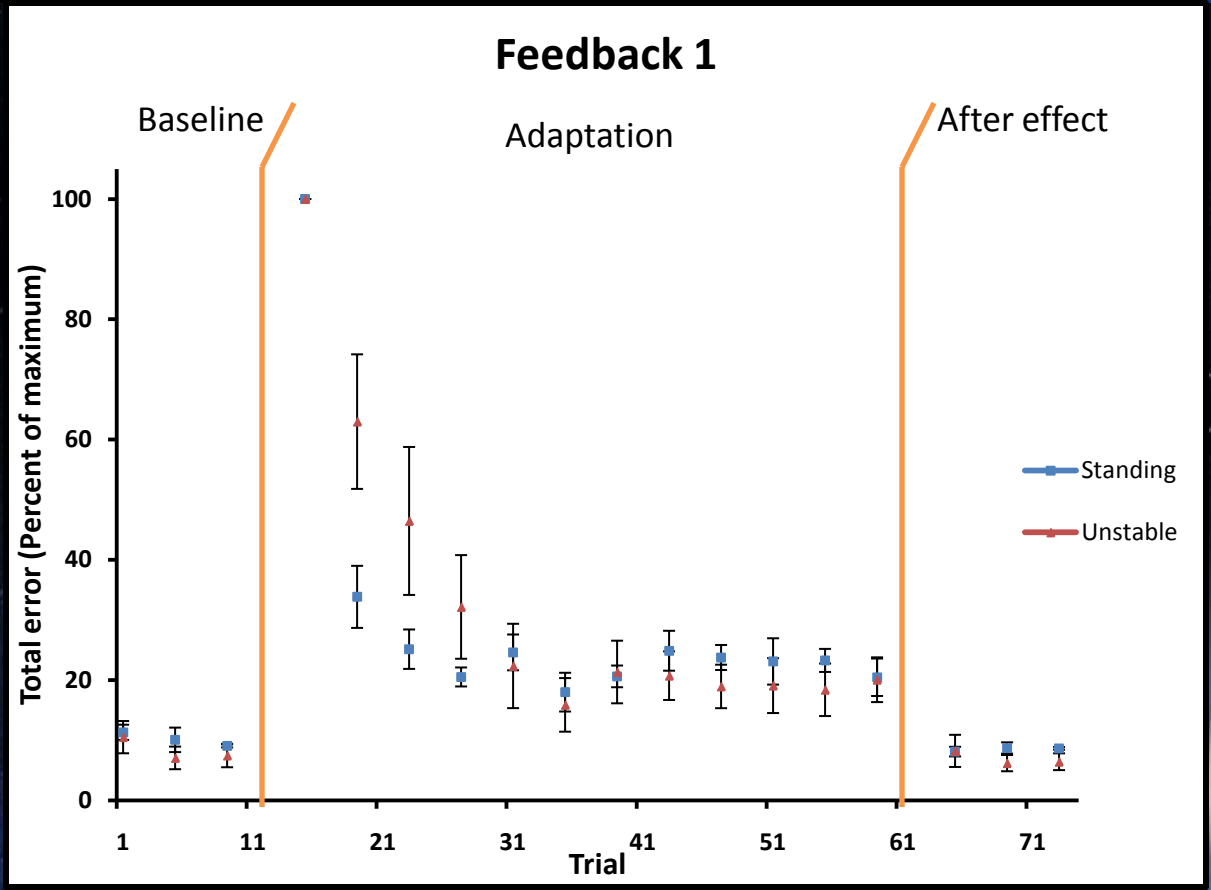
Pilot Design

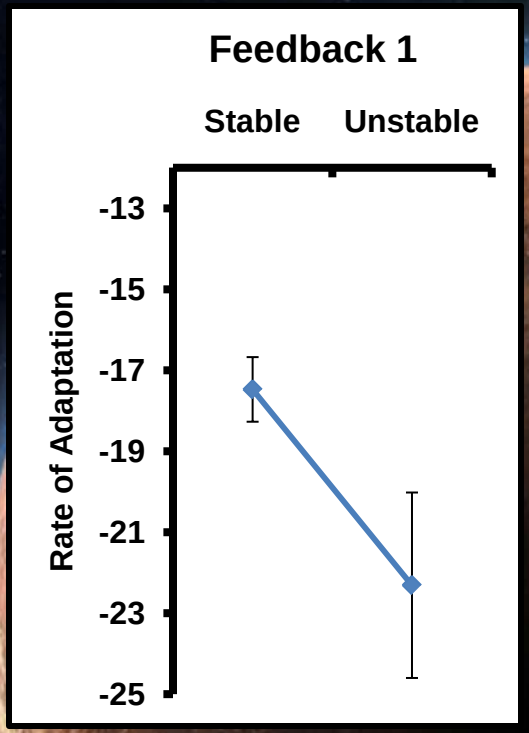


Feedback 2

- The original target and a green square will be displayed on the screen for a second, as feedback.
- The green square is the location of where subject should touch relative to target presented.
- The goal is to get the green square to overlap touch location as quickly and accurately as possible. Subject's adjust touch location on screen on each subsequent trial.
- Quadrant and magnitude of translation altered for standing on stable and unstable surface.

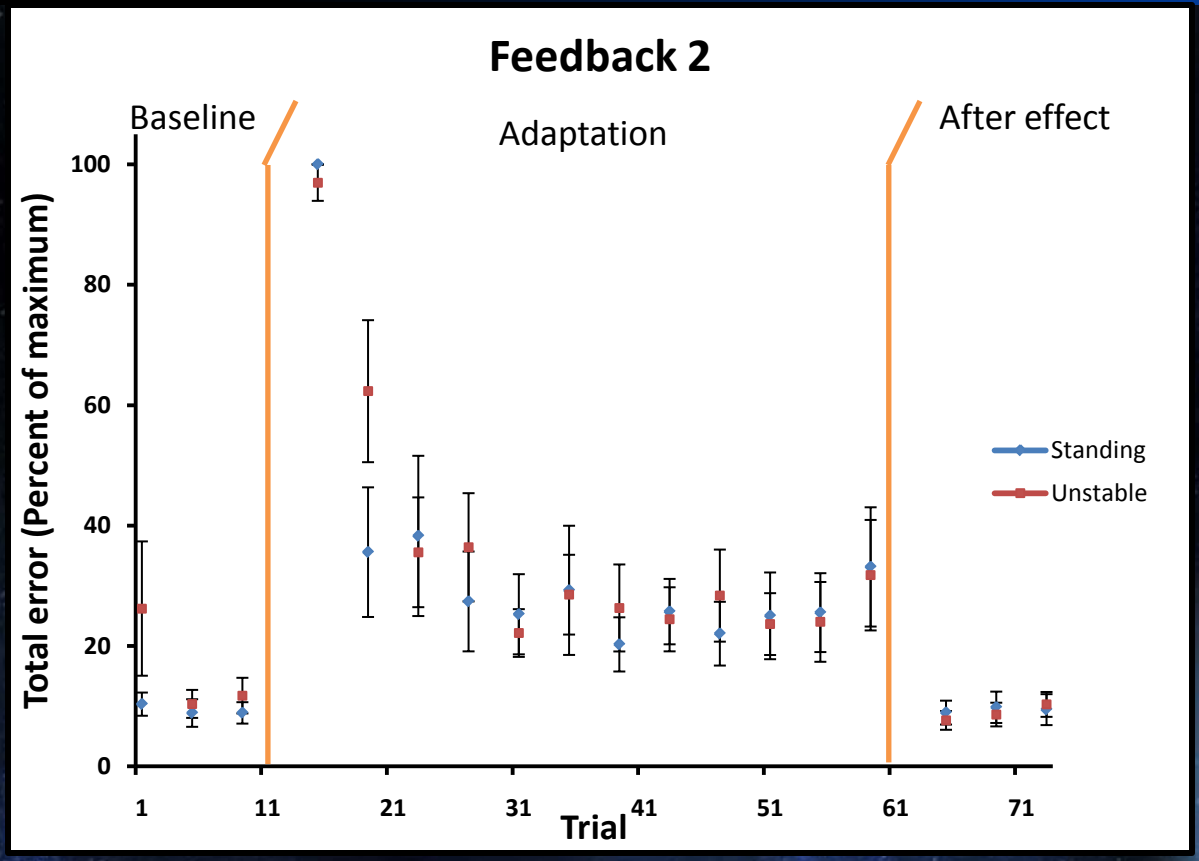
Pilot Results

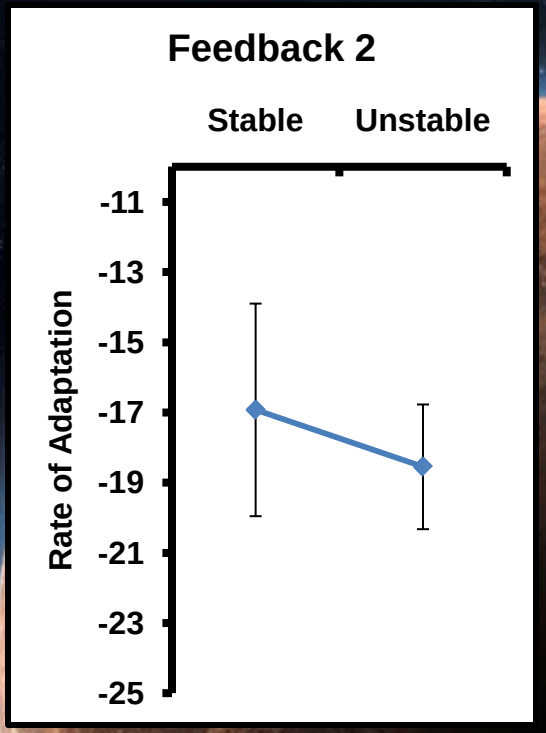




- Feedback 1 Results
  - Subjects showed adaptation curve for both postures, difference between adaptation rates while standing on the two surfaces.

Pilot Results





- Feedback 2 Results
  - Subjects showed adaptation curve for both postures, no difference in adaptation rates between postures

Pilot Discussion

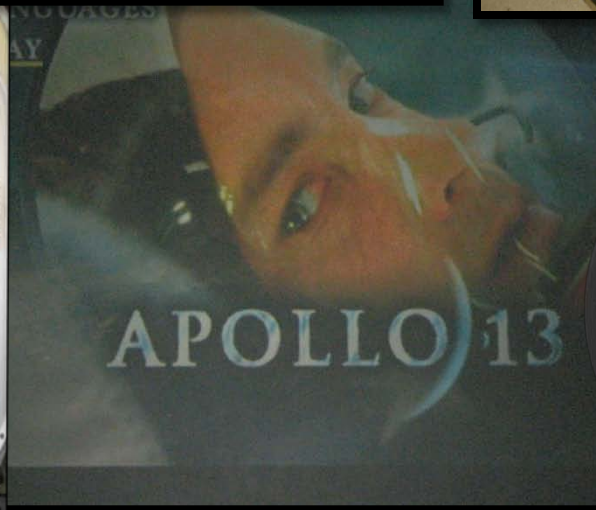
Limitations of the Pilot Study –

- No difference in the rate of adaptation between postures in Feedback 2 because of outlier data
- Did not show after effects in third block because subjects were conditioned to expect no translation

Pilot Discussion

- Subjects showed adaptation to a pointing task during standing on both stable and unstable surfaces
- Rate of adaptation was slower while standing on the unstable surface

Experiences at the JSC



Acknowledgments

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- Oklahoma Space Grant Consortium
- JSC
- NASA


Thank You
To graduation and beyond!