Orientt AR

OrienttAR:

Neurotech and AR for the Space Age

Using LiDAR and EEG to improve localization and orientation in microgravity environments

Alex Higuera

- **Summary**
- Introduction
- Justifications
- Foundations
- Application
- Conclusion & References

BIOLOGICAL ADAPTATION IN SPACE WITH ORIENTT AR

- Space travel requires a certain period of physical adjustment to microgravity environments.
- Once in orbit or beyond, astronauts experience disorientation due to their weightlessness and a lack of gravitational reference [1]
- With periods of disorientation lasting upwards of two weeks[2], this and related ailments affect performance in space
- NASA pays $172,600 / day per astronaut[3], so the costs of unproductivity adds up quickly
- Current solutions are either mechanically obtrusive or physiologically unfavorable
- Combining lightweight devices with a large data storage capacity can provide a compact alternative for eliminating disorientation and related symptoms in space

OrienttAR is a mobile solution using biofeedback and augmented reality

- LiDAR: infrared technology that provides a 3D mapping of space inside the a space vehicle like the ISS, which lines or grids can be visually projected onto
- EEG and EMG Biofeedback
  - Use an individual's brain waves as a baseline for comparison between gravity vs non-gravity environments
  - EEG and EMG real-time readings while in space can be used to compare signal periods at baseline on earth
  - The neural signal baseline will include variable orientations on earth
- Integrate EEG biofeedback with an Augmented Reality (AR) app that serves as a visual aid for orientation
- Perform visual tasks using the AR app that track progress

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THE PROBLEM

Astronauts experience disorientation due to their weightlessness and a lack of gravitational reference [4]

- Induces "space motion sickness" in a similar manner to car sickness
  - Currently, astronauts use antihistamines, anticholinergics, and antimuscarinics to counterbalance these symptoms, which can have physiological side effects [5] [6]
- May interfere with spatial perceptions during critical tasks
- Impedes productivity, up to 2 weeks[7]

THE SOLUTION

A biofeedback device that uses LiDAR and EEG to improve localization and orientation in microgravity environments.

- Use an individual's brain waves as a baseline for comparison between gravity vs non-gravity environments
- Integrate EEG biofeedback with an Augmented Reality (AR) app that serves as a visual aid for orientation
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PHYSIOLOGICAL BENEFITS

- Measurable improvements in orientation
- A lower incidence of space sickness, its symptoms and its consequences
- A reduction in physiological and psychological stressors

PROJECT JUSTIFICATIONS

- Studies and applications already combine EEG and AR [8]
- EEG devices are best used for measuring focus/concentration, and earth pilots already use focus techniques to re-orient themselves[9]
- EEG devices are already used in space[10]
  - However, existing EEG technology is heavy and bulky - a disadvantage when space and cargo on the ISS is at a premium

TECHNICAL JUSTIFICATIONS

- Bluetooth's frequency was built to minimize interference in the 2.4GHz band
- Bluetooth it's near field communication and the ISS has little environmental noise[11]
- Collecting individual EEG signals can provide a baseline for comparison
- EEG data can be successfully collected from consumer-grade devices[12]
  - Similar quality to the gold-standards in medicine
  - More cost-effective and efficient
  - Much lighter and portable
  - ideal for space travel

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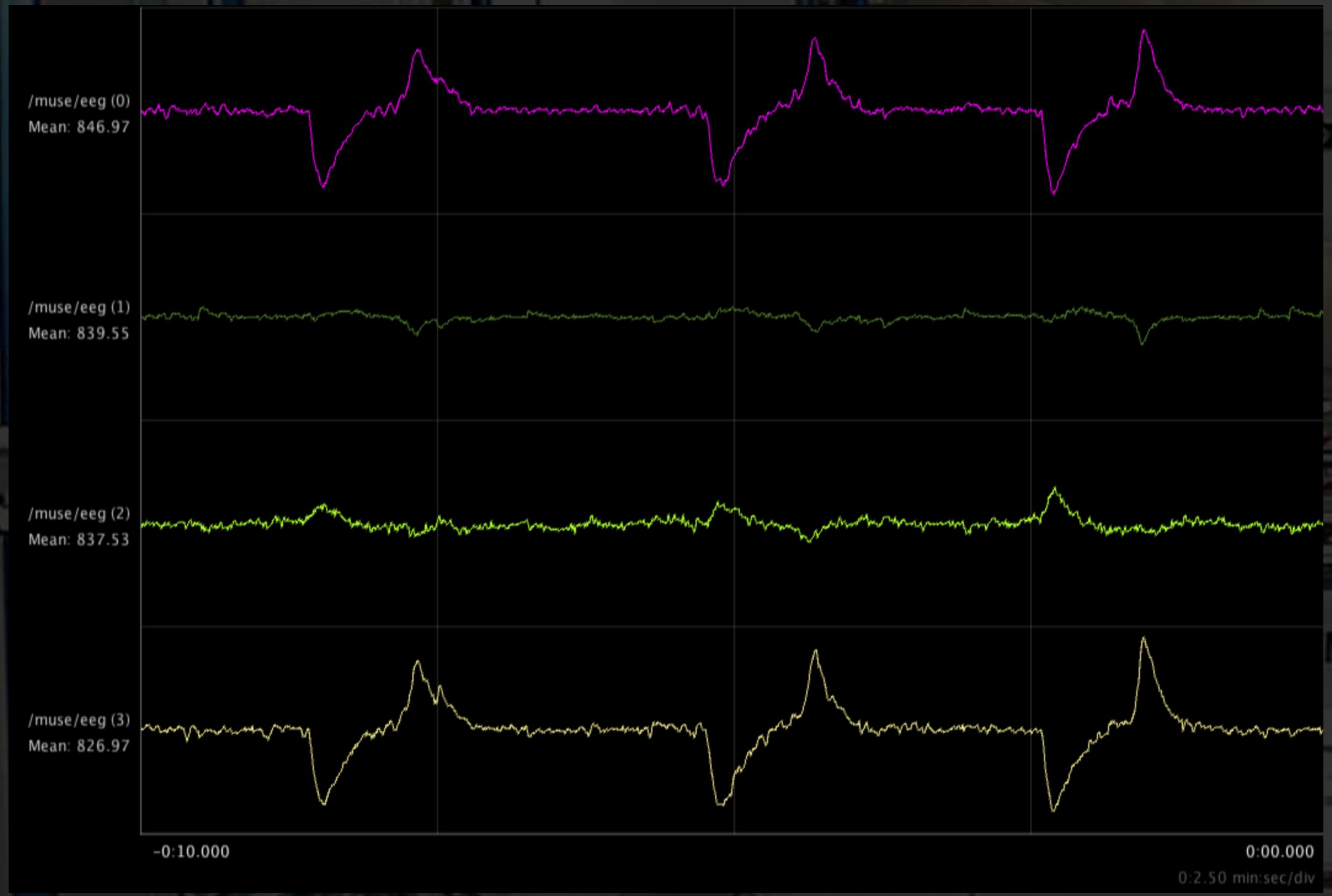
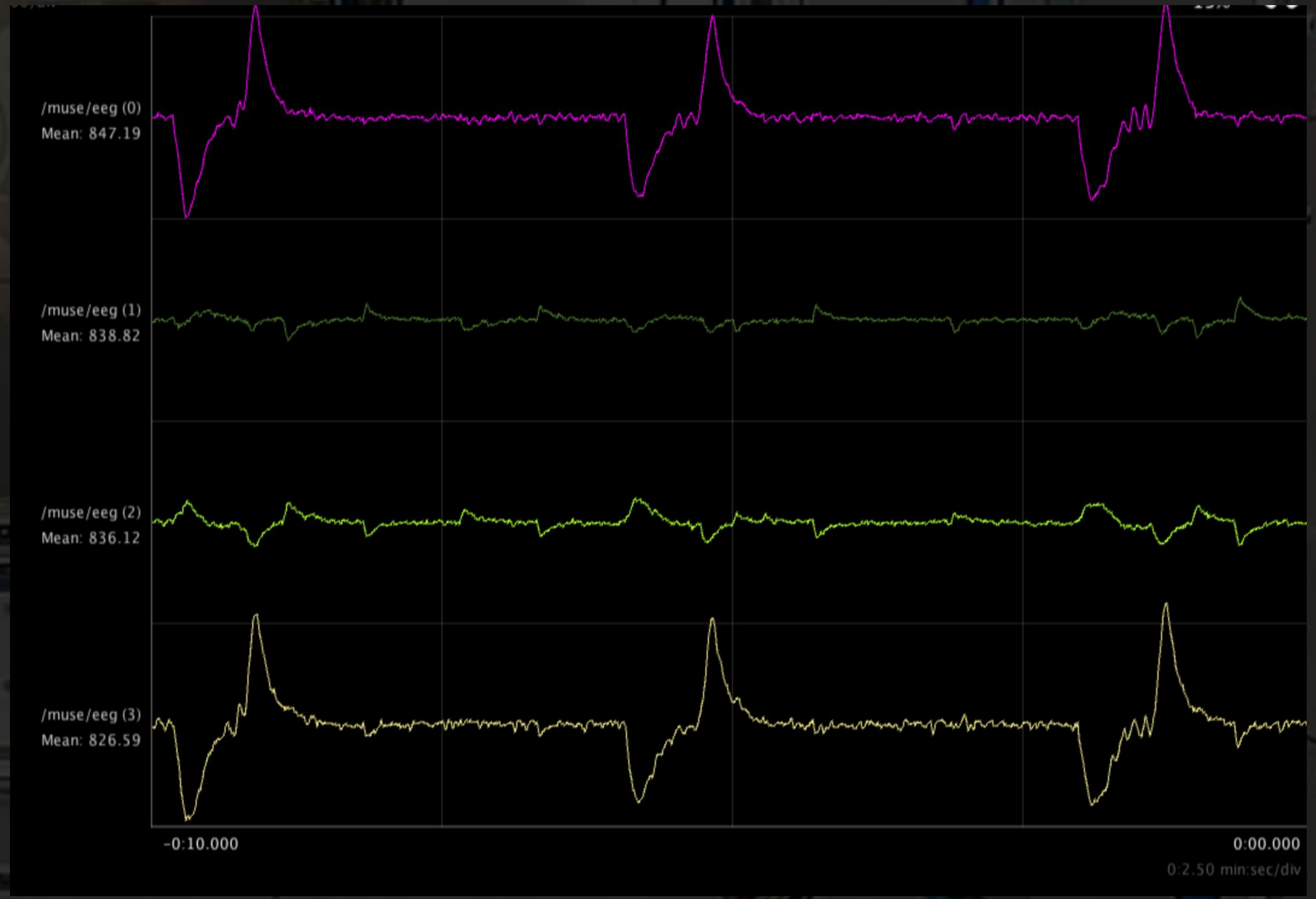
An individual's brain waves can be used as a baseline for comparison between gravity vs non-gravity environments

Sitting VS laying down (90 degree difference):

Sitting:



Laying down:



Source: MuseLab, raw EEG

- Signal differences between degrees of orientation can be comparatively measured
- Multiple trials are required to reach a reliable baseline

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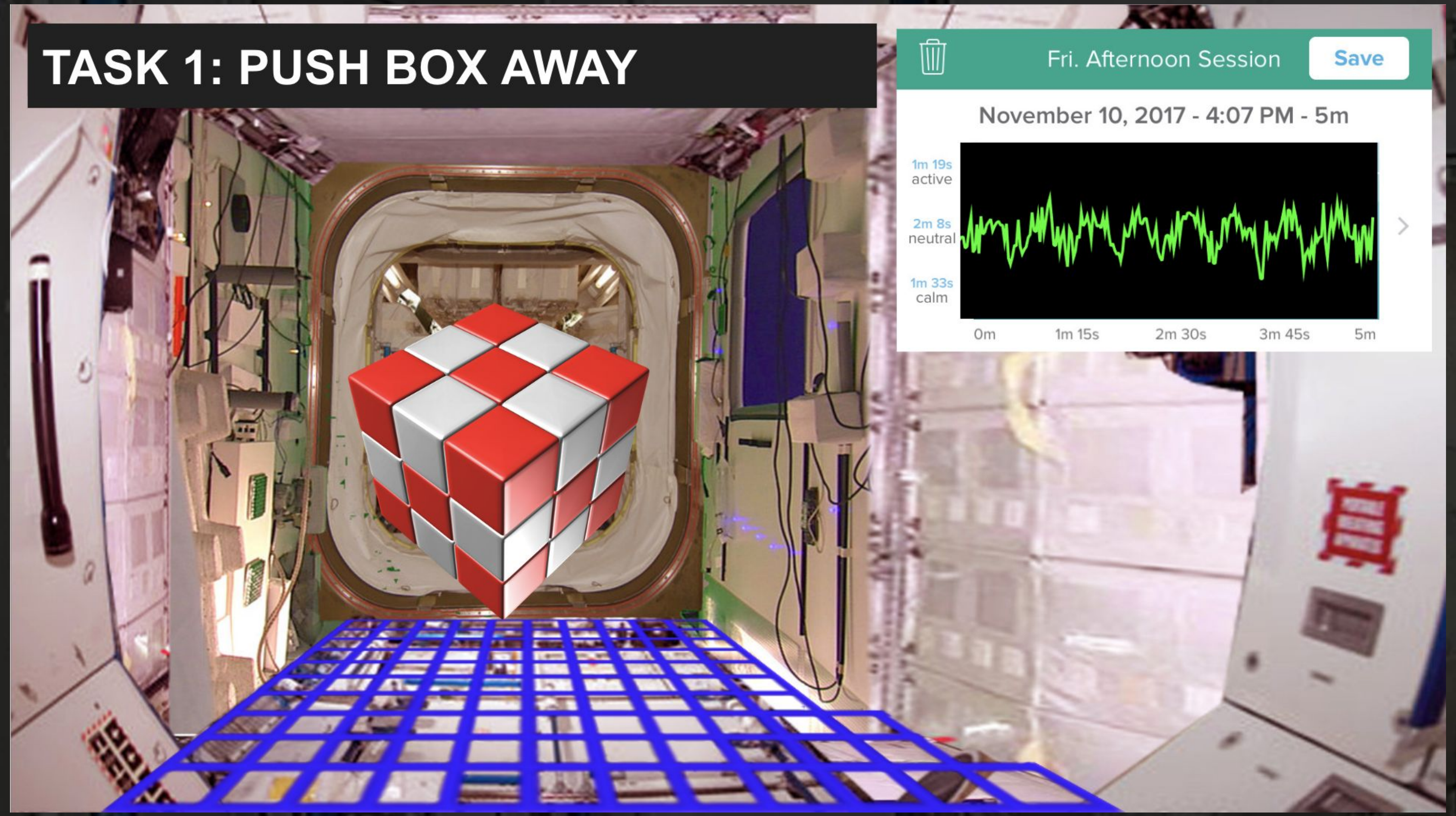

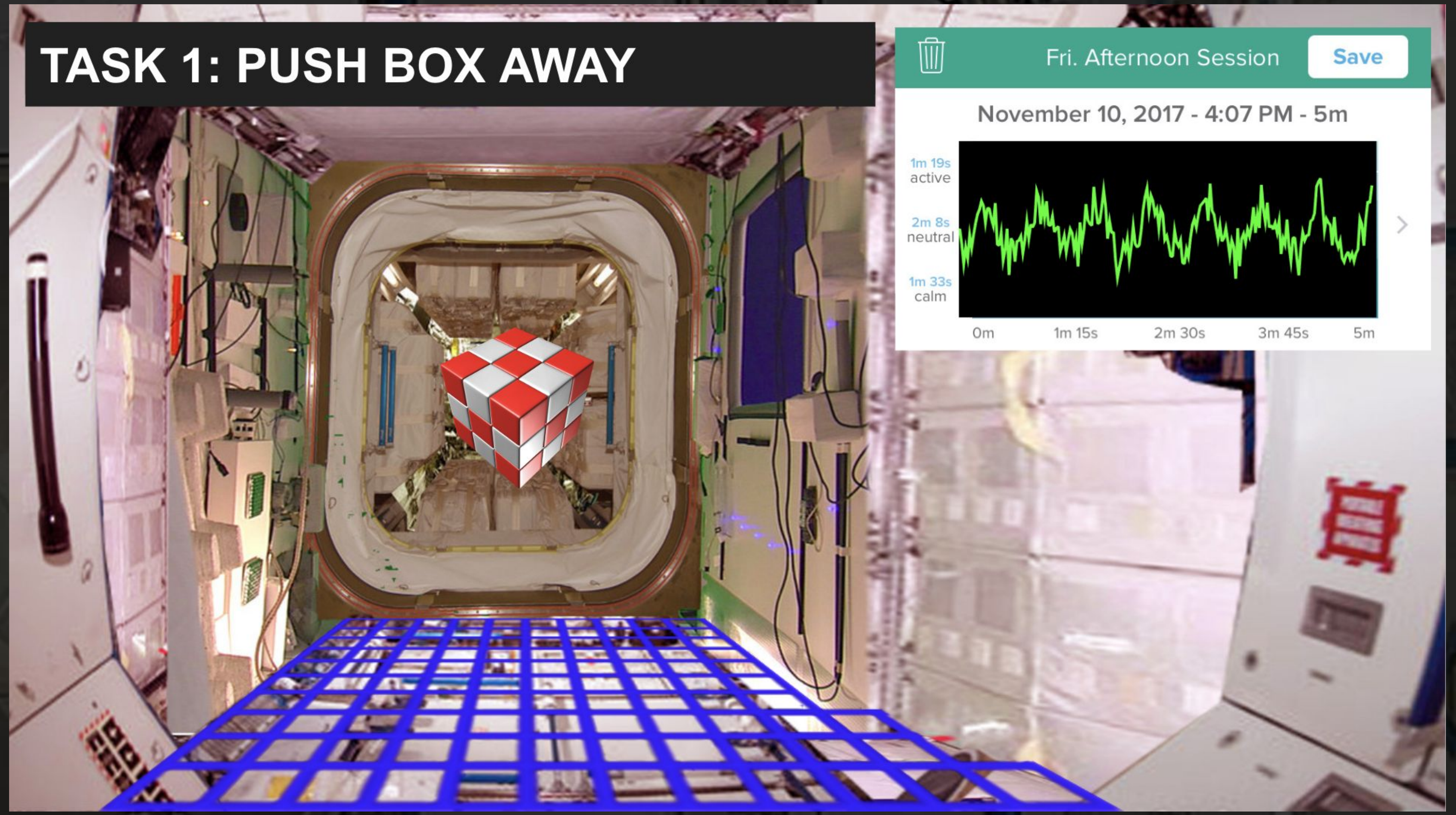

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USING AR AND EEG TO TRAIN THE BRAIN

- With a superimposed grid, you can focus on an object (i.e., a box) in your line of sight
- When brainwaves match that of previous states of stable orientation and localization, the box moves
- See real-time brainwaves to help with awareness of feedback

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CONCLUSION

Biofeedback and AR applications like OrienttAR can help alleviate adverse physiological conditions encountered while traveling in space. It provides a low cost and lightweight solution to space motion sickness. More research is needed to determine its efficacy.

REFERENCES

[1] Oman, Charles M. "Space Motion Sickness and Vestibular Experiments in Spacelab." SAE Transactions, vol. 91, 1982, pp. 2839–2859. JSTOR, www.jstor.org/stable/44644291.
[2] Dr. Sheyna Gifford, former Chief Medical Officer at NASA
[3] Jones, Erick. Quality Management for Organizations Using Lean Six Sigma Techniques. 2014
[4] Oman, Charles M. "Space Motion Sickness and Vestibular Experiments in Spacelab." SAE Transactions, vol. 91, 1982, pp. 2839–2859. JSTOR, www.jstor.org/stable/44644291.
[5] Dr. Sheyna Gifford, former Chief Medical Officer at NASA
[6] Gray SL, Anderson ML, Dublin S, et al. Cumulative Use of Strong Anticholinergics and Incident Dementia: A Prospective Cohort Study. JAMA Intern Med. 2015;175(3):401–407. doi:10.1001/jamainternmed.2014.7663
[7] Dr. Sheyna Gifford, former Chief Medical Officer at NASA
[8] J. Mercier-Ganady, F. Lotte, E. Loup-Escande, M. Marchal, A. Lécuyer, "The mind-mirror: See your brain in action in your head using eeg and augmented reality", Virtual Reality (VR) 2014 iEEE, pp. 33-38, 2014.
[9] Ingrid Centurion, Pilot and Chief Marketing Officer at Lunar Station Corp
[10] Effect of Gravitational Context on EEG Dynamics: A Study of Spatial Cognition, Novelty Processing and Sensorimotor Integration (Neurospat) - 09.26.18
[11] Miller, Robert. NASA Bluetooth Wireless Communications. 2007.
[12] Ratti E, Waninger S, Berka C, Ruffini G, Verma A. Comparison of Medical and Consumer Wireless EEG Systems for Use in Clinical Trials. *Front Hum Neurosci.* 2017;11:398. Published 2017 Aug 3. doi:10.3389/fnhum.2017.00398

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