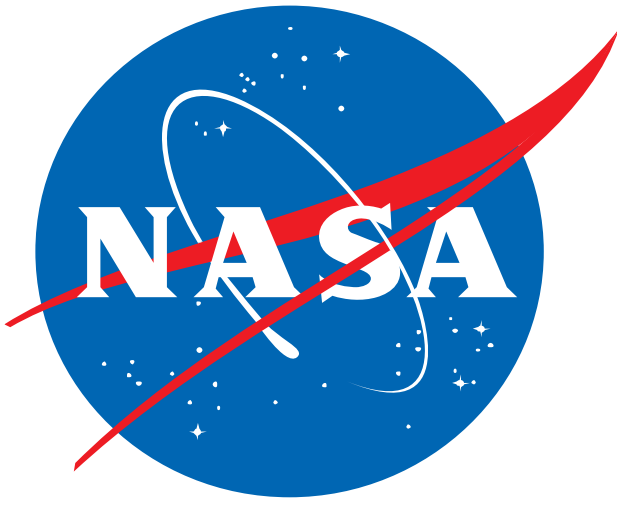


# Communication Delays in Cislunar Space: A Lab Study Examining Human System Integration Architecture (HSIA) and Team Risk Concerns

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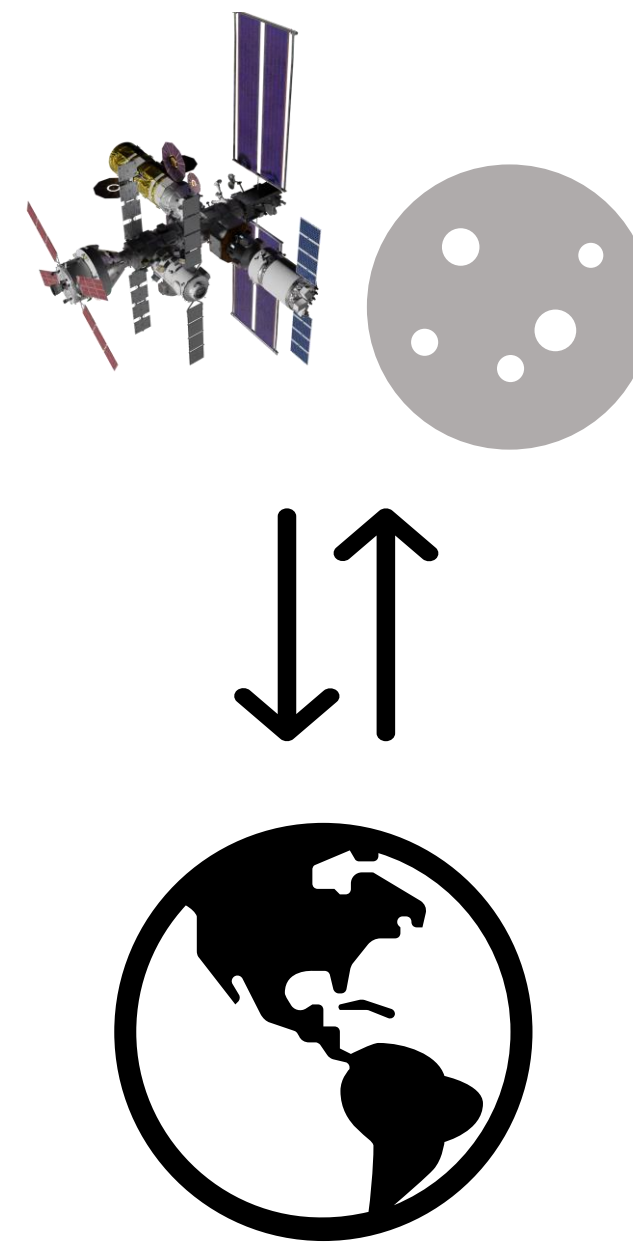
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## Background and Project Aims

- Due to communication network limitations, communication delays are an inherent challenge of space missions to the Moon and beyond
- Adverse effects of 50+ second delays on individual well-being, team cohesion, and overall task performance have been observed (Kintz et al., 2016; Larson et al., 2019; Parisi et al., 2024)
- There is a need to understand the effects of shorter delays expected during the upcoming Artemis missions, i.e., 4-12 seconds

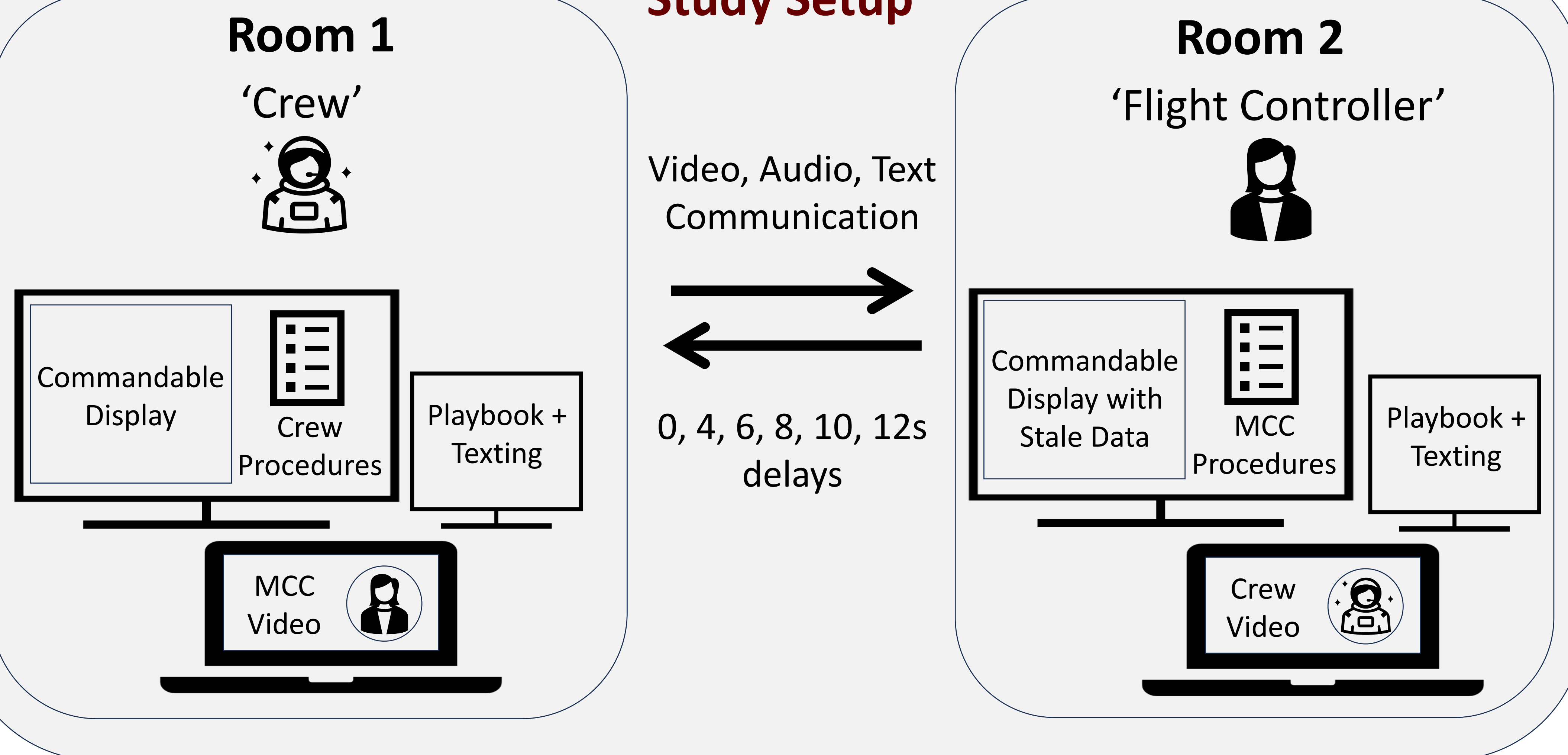


### Project Aims

- 1) Develop spaceflight-relevant experimental tasks and technology for studying collaborative performance under communication delays
- 2) Using nominal and off-nominal task scenarios, identify performance and team-related issues and workaround strategies
- 3) Identify cis-lunar communication delay that leads to "break points" in team and human-system performance

## Method

### Study Setup



- 48 participants/24 pairs (planned)
- Participants recruited from the Johnson Space Center (JSC) Human Test Subject Facility
- Each participant attends six study sessions (for six delay levels) on separate days
- Delays produced using "virtual cables" in Open Broadcaster Software (OBS)

### Independent Variables

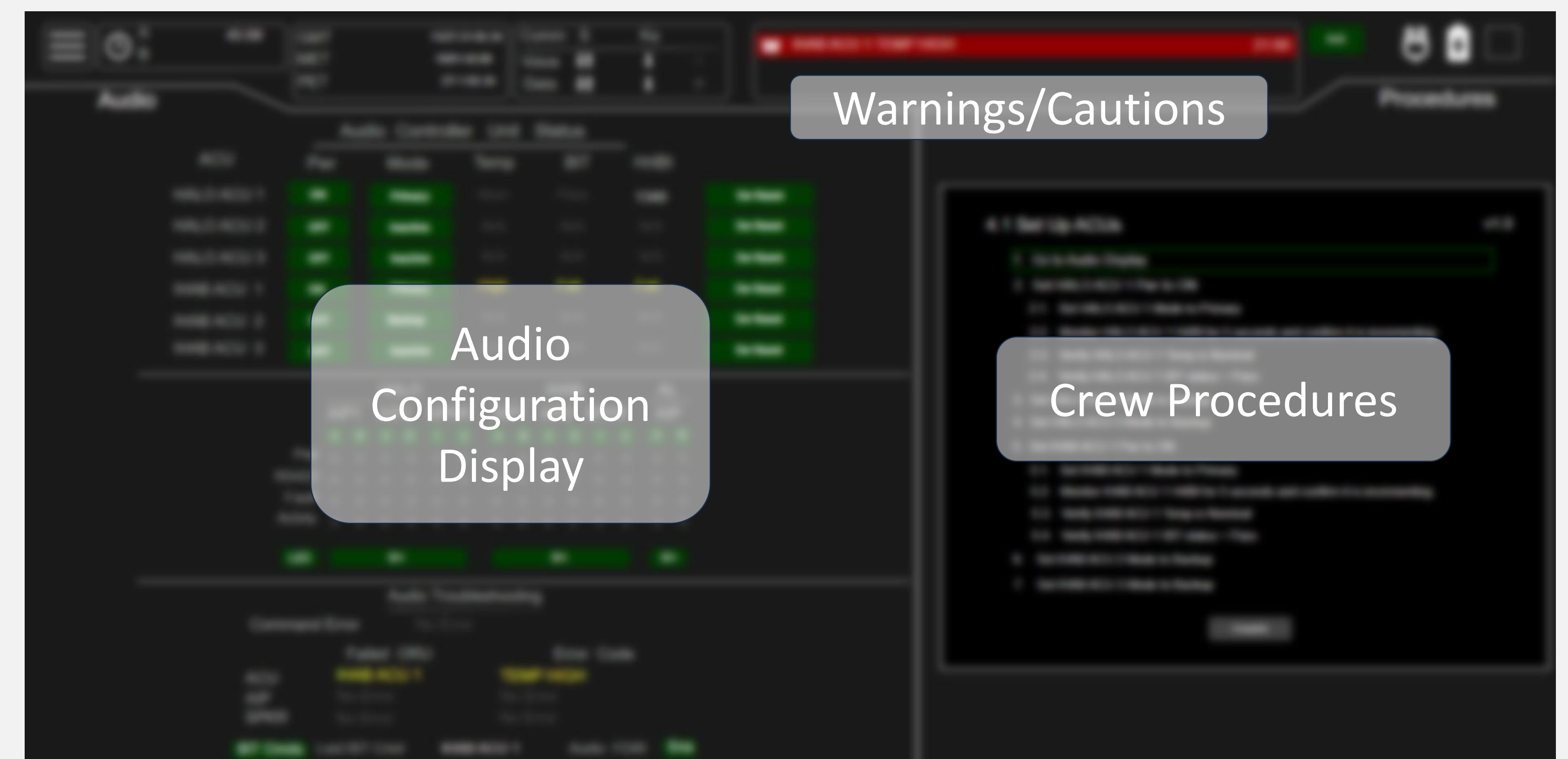
Within-subject	Delay (6 levels) Task Difficulty (Nominal; Off-nominal)
Between-subject	Role (Crew; Flight Controller)

❖ Testing is in progress. Contact the JSC Human Test Subject Facility ([Rebekah.e.duplechin@nasa.gov](mailto:Rebekah.e.duplechin@nasa.gov)) to participate.

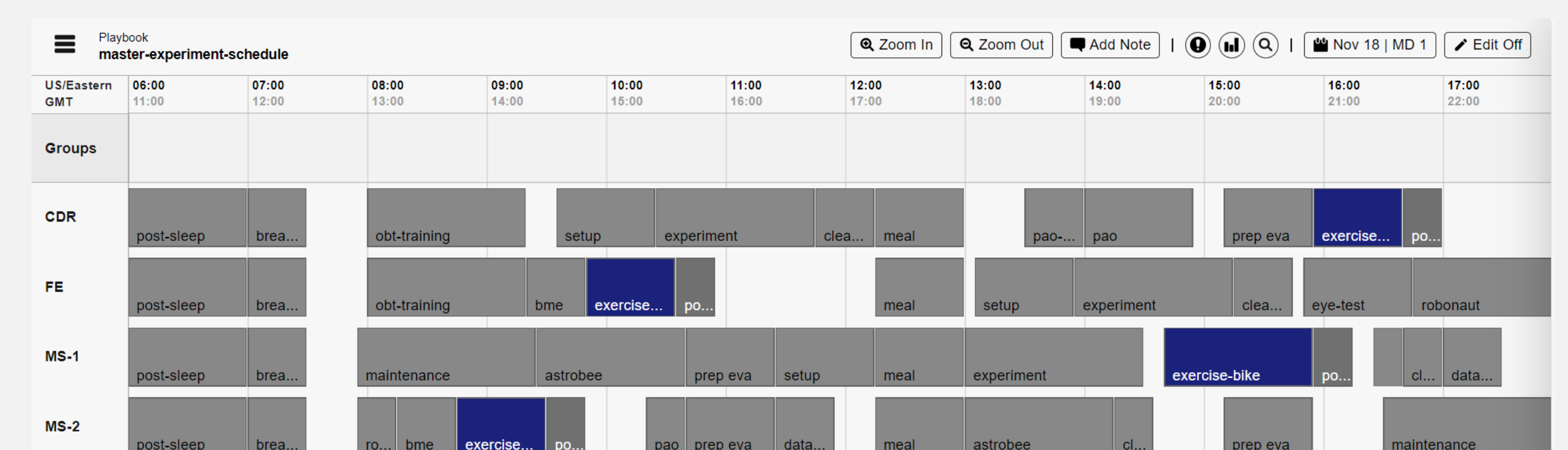
### Dependent Variables

Individual-based measures	Task performance (success, completion time, errors), workload, fatigue/stress, situation awareness, system usability, mood, sleep, delay frustration, personality
Team-based measures	Team processes, autonomy, cohesion, communication quality, shared mental models, communication strategies

## Study Prototype and Software



### Gateway-inspired Audio Configuration Display Prototype



### Playbook (Text Messaging and Activity Scheduling)

### Types of Tasks

- Conference Call setup (Nominal)
- Activity Scheduling (Nominal)
- Audio system alert resolution (Off-nominal)
- Procedural inconsistencies (Off-nominal)

## References

- [1] Kintz, N. M. et al. (2016) Acta Astronautica 129, 193-200.
- [2] Larson, L. et al. (2019) Acta Astronautica 161, 108-114.
- [3] Parisi, M. et al. (2024) Advances in Human Factors of Transportation 148, 49-57.

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