The Path to Crew Autonomy - Situational Awareness in Scheduling and Rescheduling Tasks for Novice Schedulers

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Introduction

Future Long Duration Exploration-Class Missions

- As space exploration missions increase in duration, **communication limitations will necessitate the transfer of tasks** such as mission scheduling and rescheduling **from ground-based teams to onboard crew.**

Scheduling in a space exploration context

- Scheduling in dynamic, complex environments such as the International Space Station can take teams of experts **months** to complete.
- Schedules must adhere to strict requirements (such as energy resources) to **ensure crew health and safety and completion of mission objectives.**
- Expert schedulers **have years of experience-based training and display impressive amounts of situational awareness (SA)**, particularly with regards to scheduling constraints that are not formally documented (e.g. space/layout, abilities of the crew, crew preferences).

Motivation

- Previous work indicates that **SA is a critical component of effective scheduling** and, as a result, is crucial for the successful transfer of scheduling from ground-based experts to astronaut crews.
- Currently, **literature on scheduling and SA is limited**, especially in the context of space exploration.

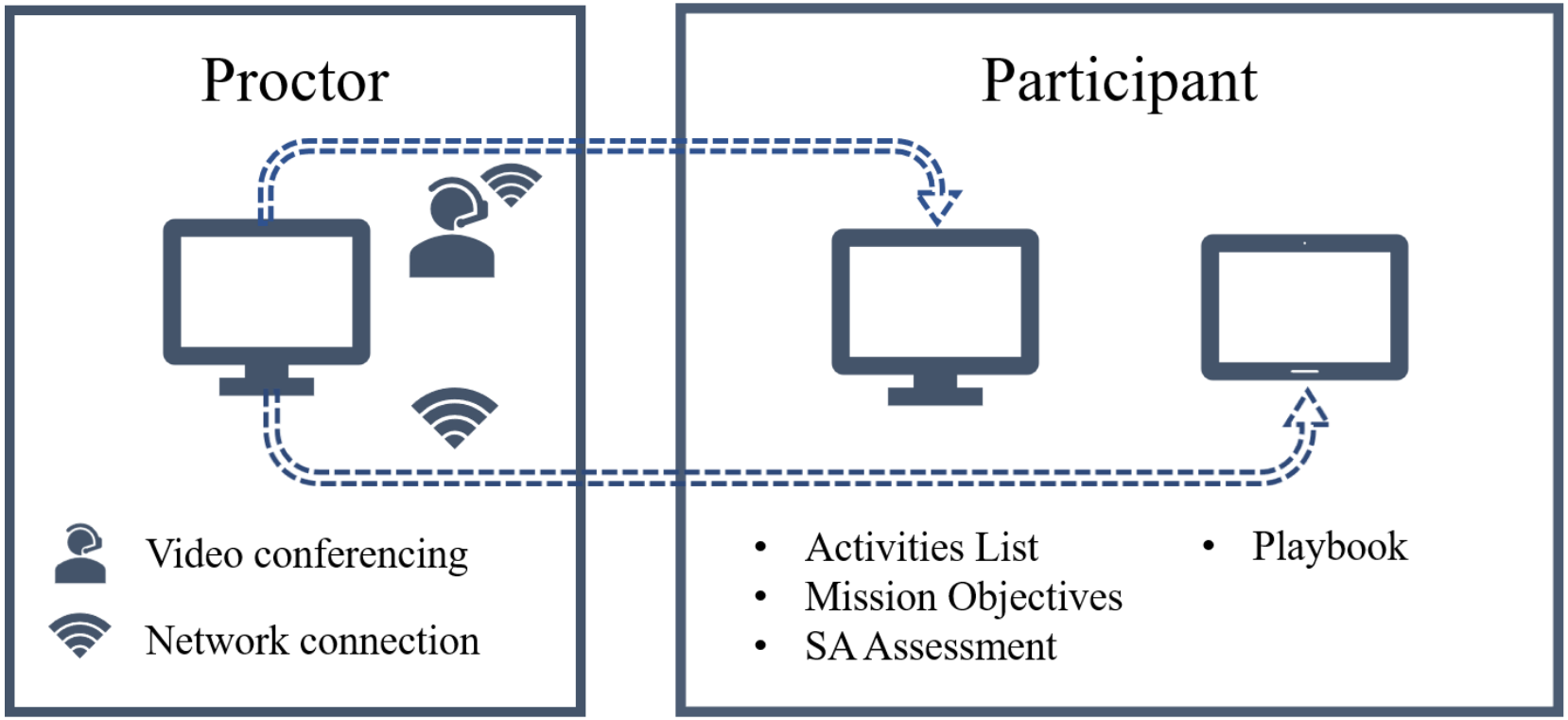
Study Objectives

1. Evaluate SA in novice schedulers for scheduling and rescheduling task.
2. Identifies potential barriers to establishing good SA in scheduling/rescheduling tasks

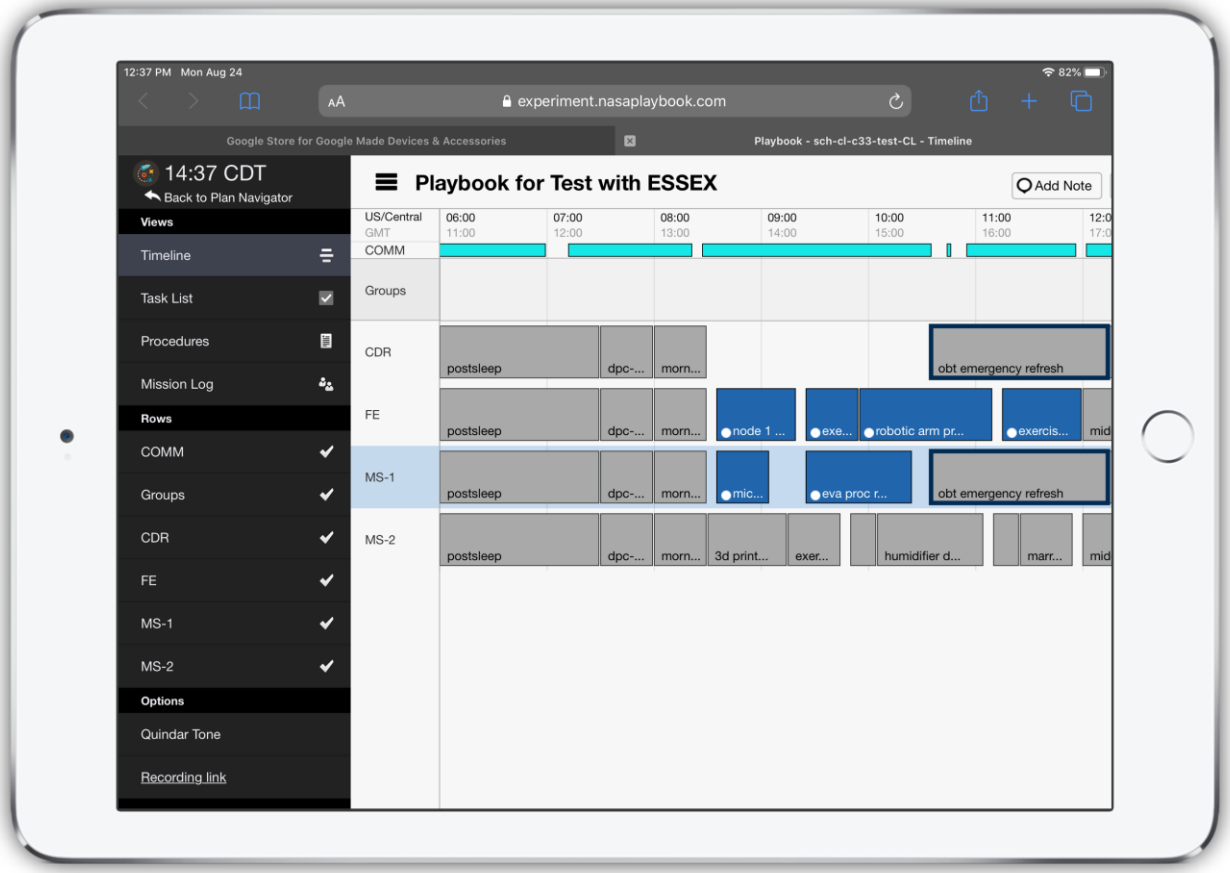
Methods

Experimental Setup

- 31 participants (18 females; 18-64 years old); All participants held a Bachelor's degree or higher



Playbook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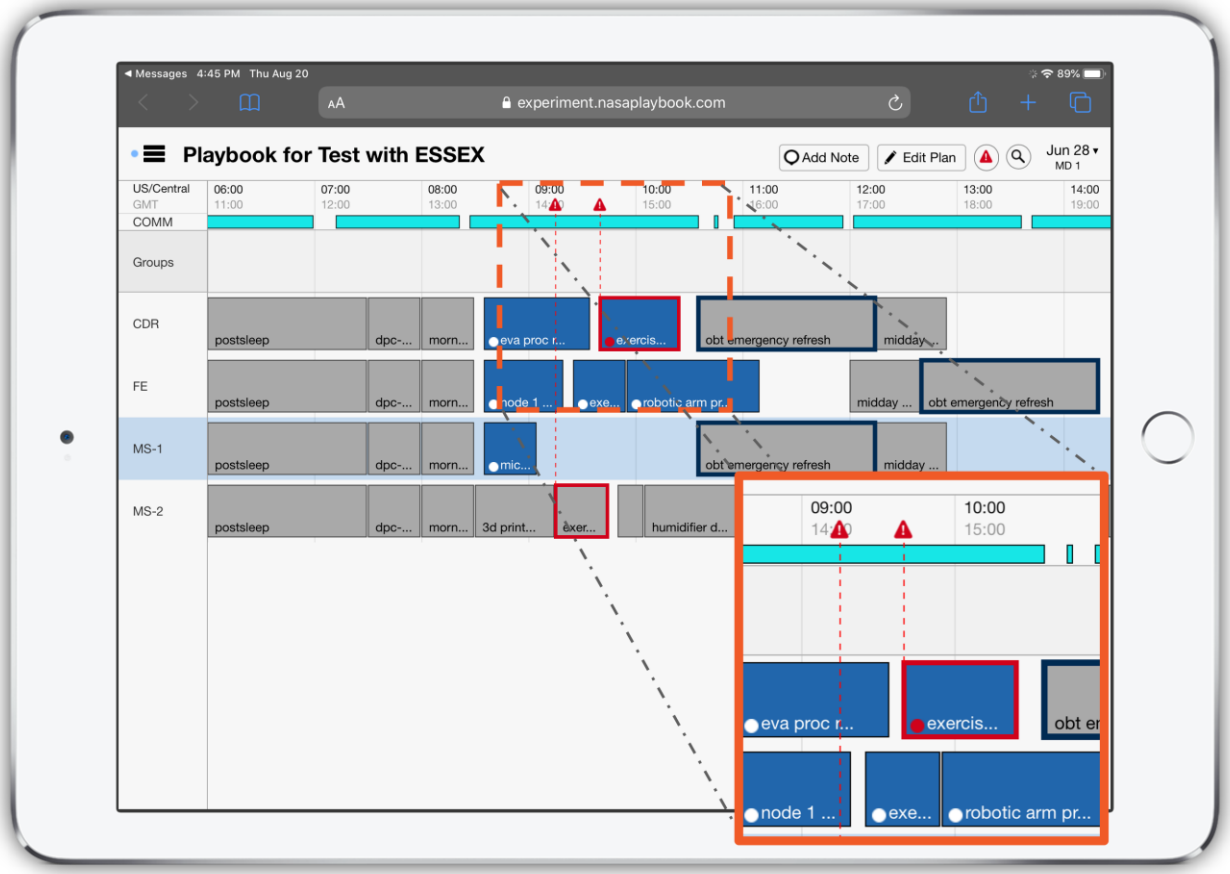
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4×2×2 Experimental Design

- Within-subject
  - Type of constraint: **4 types**
    1. Time Range Constraint (T)
    2. Requires Constraint (R)
    3. Claim Constraint (C)
    4. Ordering Constraint (O)
  - Number of constraints: **2 levels**
    1. Low (33% of activities constrained)
    2. High (66% of activities constrained)
- Between-subject
  - Type of task: **2 types**
    1. Schedule
    2. Reschedule

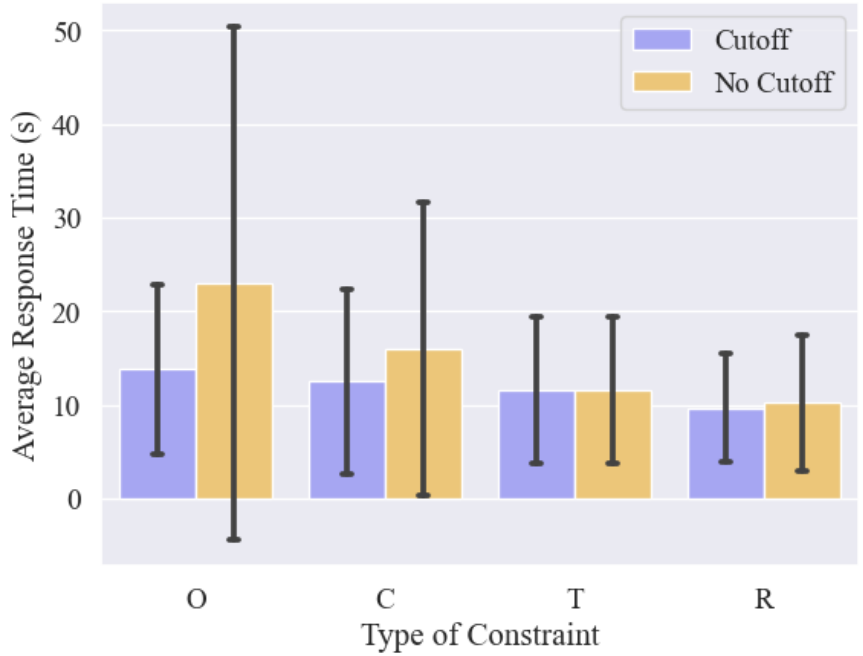
Type of Constraint

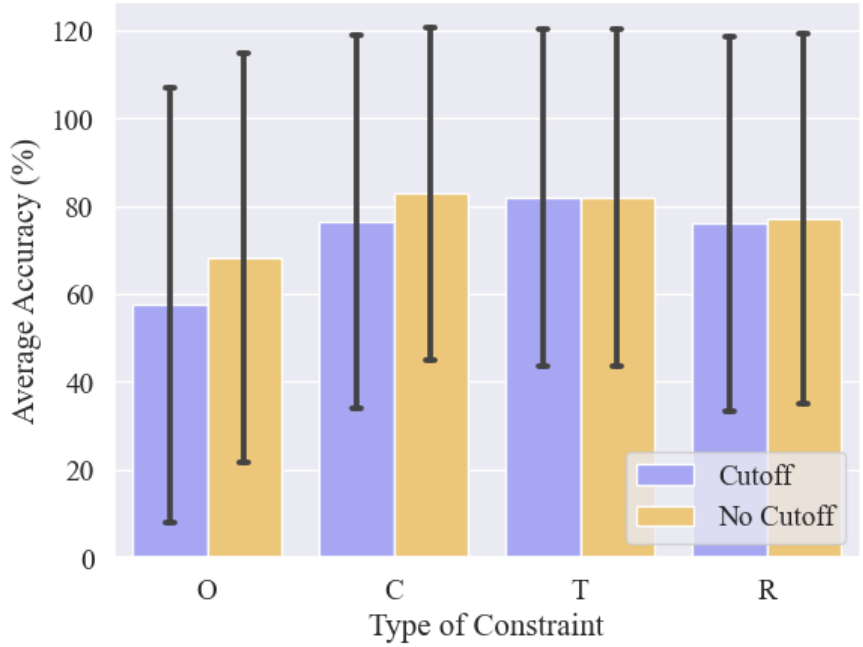
- Type of constraint: **4 types**
  1. Time Range Constraint (T) -> **Activity A** must start no earlier than 0900 and end no later than 1030
  2. Requires Constraint (R) -> **Activity A** requires communication availability
  3. Claim Constraint (C) -> **Activities A** and **Activity B** both claim a treadmill, and therefore cannot be scheduled at the same time
  4. Ordering Constraint (O) -> **Activity A** must be scheduled before **Activity B**

Assessment of Situational Awareness

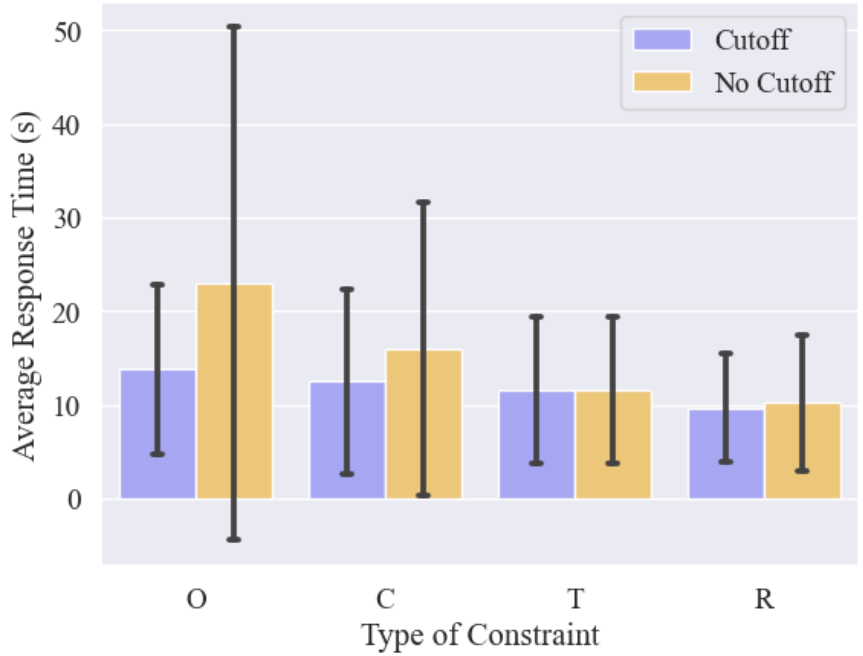
- Following a Situation Present Assessment Method (SPAM) methodology
  - 3 true-or-false questions administered at trial conclusion
  - Asked to answer as quickly as possible, but could refer back to the schedule they created as needed

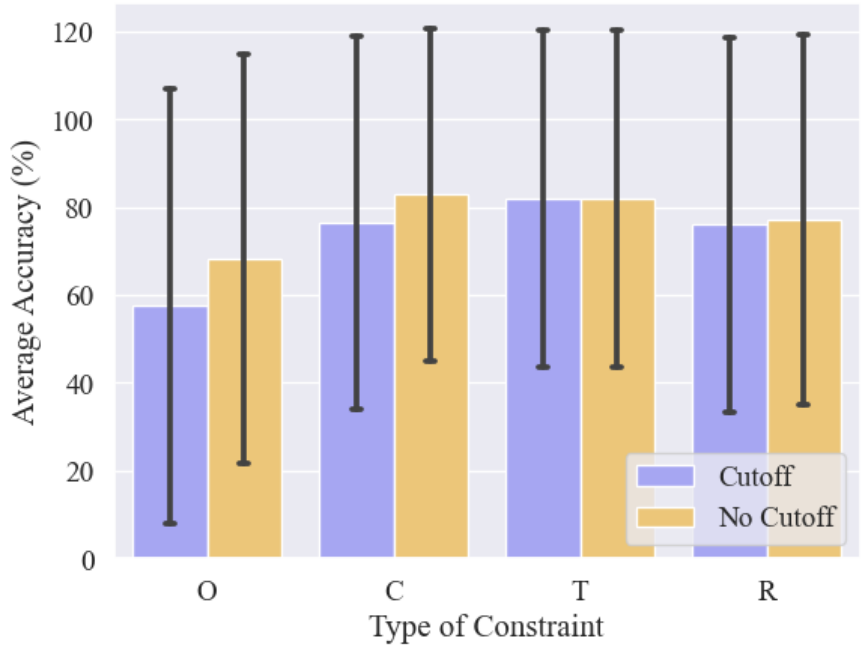
Results & Discussion





	Average Response Time (s)		*Average Accuracy (%)*	
	Cutoff	***No Cutoff***	***Cutoff***	***No Cutoff***
Independent Variables				
Type of Task				
Type of Constraint	F = 4.775 p = 0.003	F = 13.534 p < 0.001	F = 12.60 p < 0.001	F = 5.346 p = 0.001
Number of Constraints				F = 5.328 p = 0.022
Interactions				
Type:Number			F = 5.264 p = 0.002	
Covariates				
Trial		F = 5.934 p = 0.016		
Post-Hoc				
O – C		p = 0.016	p < 0.001	p = 0.003
O – T		p < 0.001	p < 0.001	p = 0.005
O – R	p = 0.003	p < 0.001	p < 0.001	
C – T				
C – R		p = 0.044		





Question	Count of cutoff trials
O-low Q2	6
C-high Q2	6
O-high Q1	5
O-high Q2	5
C-high Q1	4
O-low Q3	3
C-low Q2	2
O-high Q3	1
R-low Q1	1
R-low Q3	1
Total	**34**
O	20
C	12
T	0
R	2

Conclusion

Summary of Key Points

- **Type of constraint** seems effect SA more than number of constraints in both scheduling and rescheduling tasks.
- There is **no evidence of a difference between SA for scheduling and rescheduling** tasks.
- Novice schedulers could benefit from **software aids** to assist with SA, specifically for constraints that are dependent on more than one activity (O & C).

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Thank you!