Collabor-Action! Evaluating an Adaptive Model of Robot Performative Autonomy for Human-Robot Collaboration

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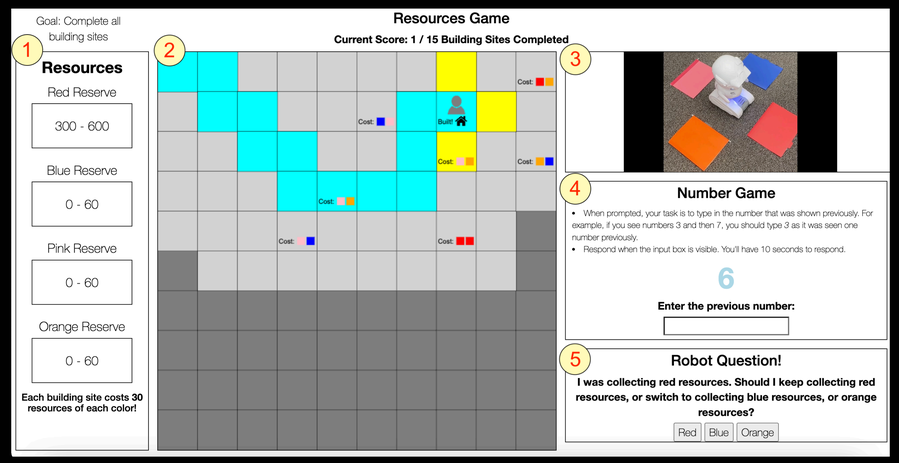
Experiment Interface



1 Resource information 2 Primary task 3 Robot video monitor
4 Secondary task (n-back) 5 Awareness questions / Robot comm

Can we **increase situational awareness** while maintaining **low cognitive workload** with **adaptive autonomy?**

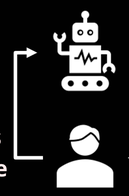
- We developed an **online resource management game** and **compared** the **effects** of **static** models of **robot autonomy** to an **adaptive reinforcement-learning (RL)** based model
- We found that the **autonomy preferences** may be more important than **adaptive autonomy**

Algorithm Development

RL for Adaptive Autonomy

State: Human's cognitive state

Reward: Maximize situational awareness and minimize cognitive workload



Action: Change robot's level of autonomy

RL Model Comparison

Model	Reward
Q-learning	1.016
Soft actor-critic	0.764
Deep Q	0.775

Autonomy Level Models

SA \ CW	0	1	2	3
0	L	L	M	H
1	L	L	M	H
2	M	M	M	H
3	H	H	H	H

Heuristic

SA \ CW	0	1	2	3
0	M	M	H	L
1	M	M	H	H
2	M	M	L	L
3	M	M	M	H

Q-learning

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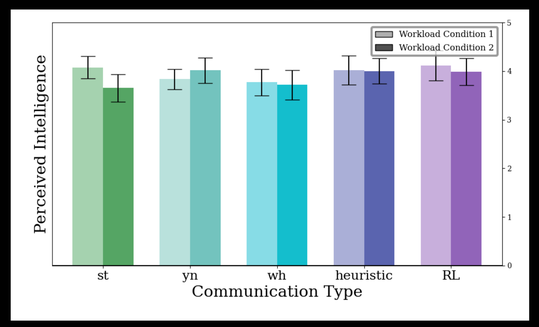
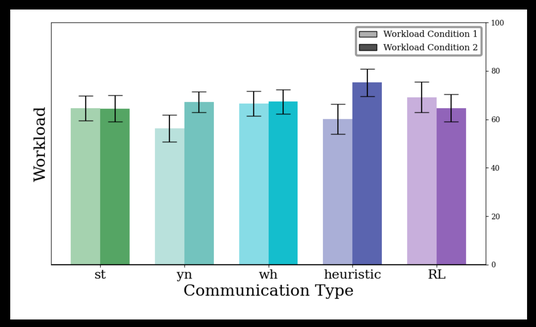
Quantitative Results



Extreme evidence (BF = 5.6x10^4)



Strong evidence (BF = 12.0)

- Extreme evidence (BF = 828.9) for comm. type on completion time
- Strong evidence (BF = 27.6) for workload on SA
- Strong evidence (BF = 0.085) *against* an effect of comm. type on perceived intelligence
- Moderate evidence (BF = 0.13) *against* an effect of comm. type on trust

Qualitative Results

- **Participants either wanted the robot to be *more* or *less* autonomous than it was:**
  "I would just let the robot do whatever it wants to do and not be burdened."
  "I think I would allow the user to choose which color to collect."
- **Some participants were confused by the heuristic model:**
  "Dynamic feedback was helpful but sometimes overly complex."
- **Participants often thought the robot's communication was helpful but wanted more control over the frequency of communication**

Takeaways

- Adapting to **personal preference** (adaptable model) for level of autonomy may be preferred to adaptive models based on **situational awareness** and **cognitive workload**
- **Communication autonomy** does *not* impact **trust** or **perceived intelligence**, which is encouraging for other forms of adaptive and adaptable autonomy

Adaptable vs **Adaptive**