Evaluating Feedback Modality Preferences of Power Wheelchair Users During Manual Robotic Arm Control

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Empower Veterans with upper limb impairment that use a power wheelchair with improved robotic arm end effector awareness.

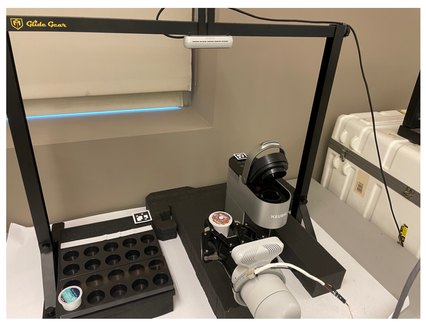
- Depth perception, obstructed lines of sight, and object alignment are difficult with limited trunk control.
- Situational awareness can ease control.
- Non-verbal feedback can improve task understanding.

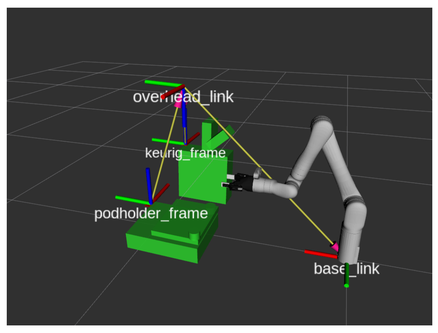


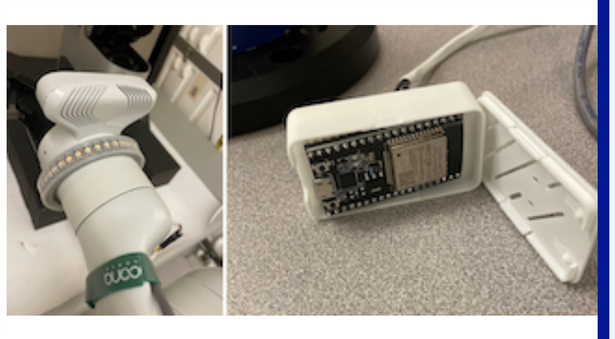
Coffee making task.



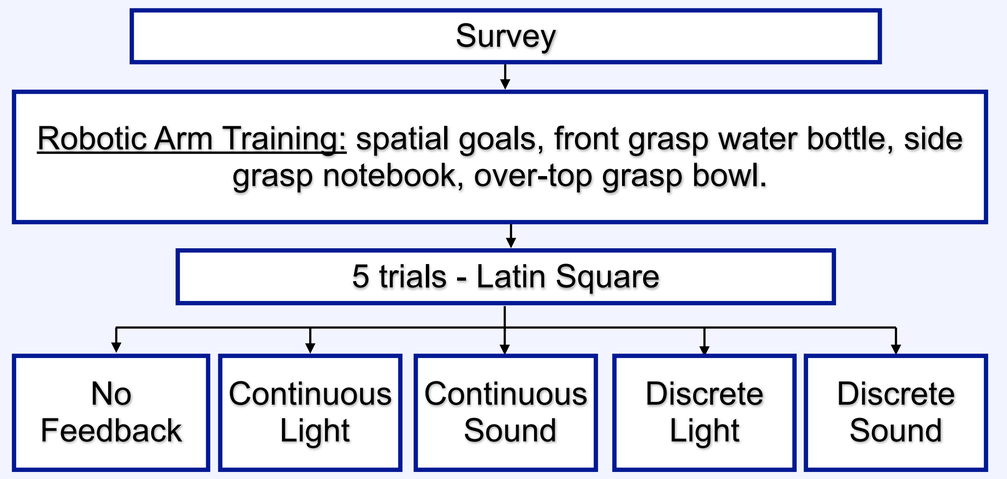
Software and hardware setup.



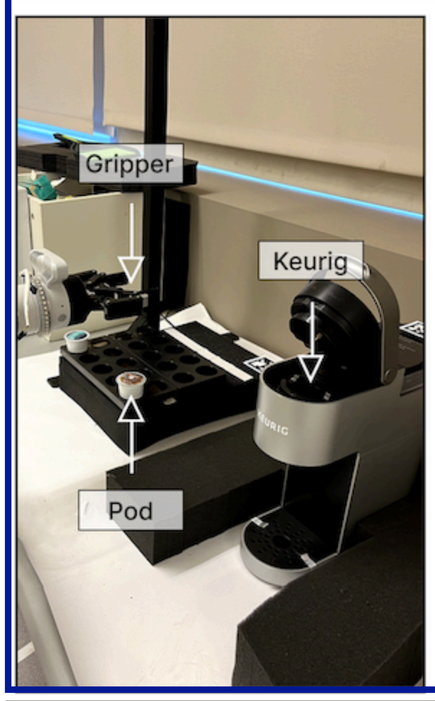


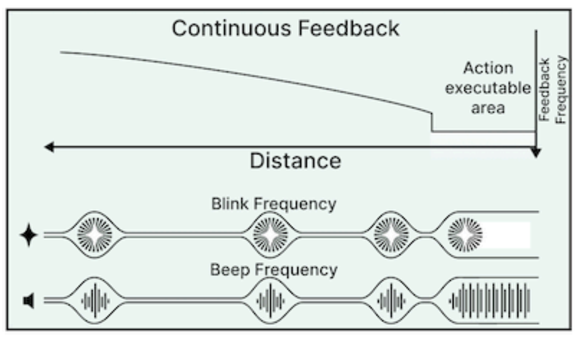


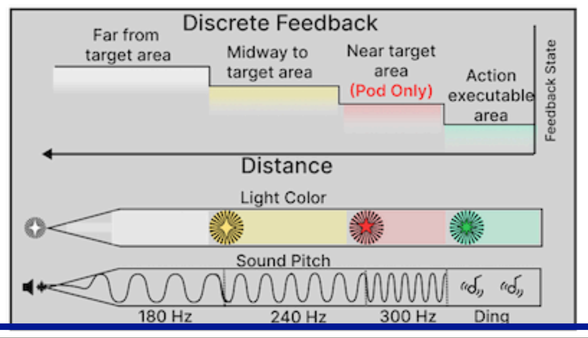
Thirteen participants went through the study.

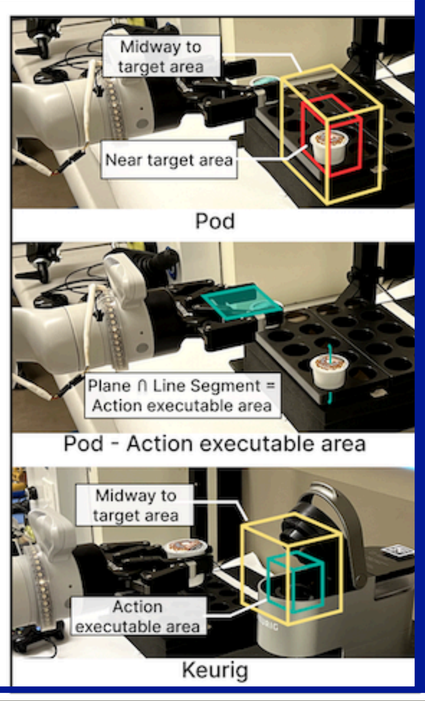


Continuous and discrete feedback methods using light or sound.









Demographics.

Diagnosis	Age	Cognitive Impairment	Hearing Loss	Vision Loss
SCI/TBI	74	Yes	No	mono vision
SCI	28	No	Left	No
SCI	67	No	No	No
Stroke	63	Yes	Both	No
MS	58	Yes	Left	No
MS	64	Yes	No	No
SCI	52	No	No	No
SCI/Stroke	75	Yes	Both	forgot glasses
SCI	64	No	Both	No
MS	60	Yes	No	No
SCI	64	No	Both	No
SCI/TBI	62	Yes	Right	double vision
SCI	64	No	No	forgot glasses

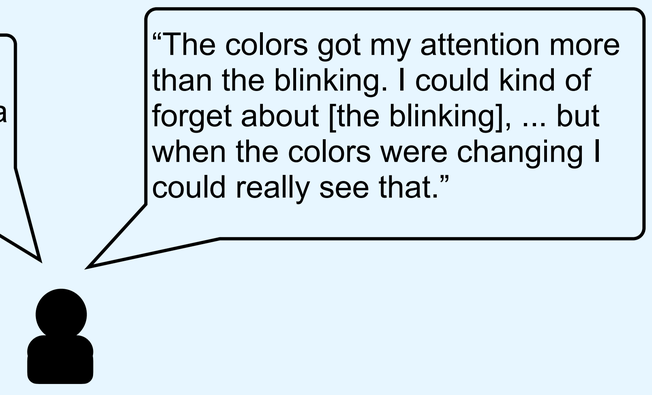
Quantitative outcomes
- performance: success rate, task time
- usability: SUS, NASA Task Load

Qualitative outcomes
- feedback preference ranking
- likes and dislikes

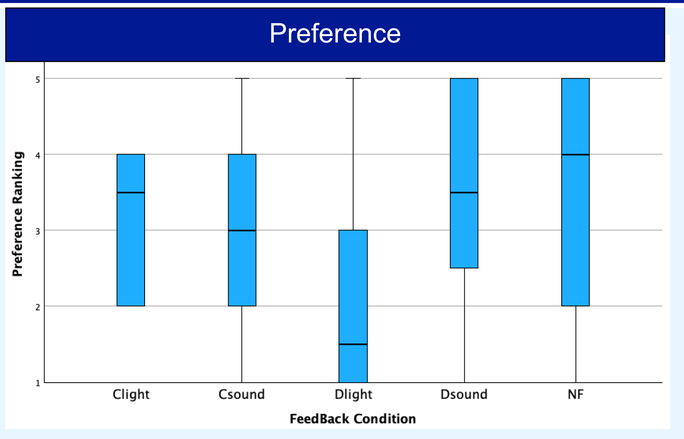
Results

Performance

	Success Rate	Mean Task Time (s)
No Feedback	0.69 ± 0.48	232.8 ± 114.5
Continuous Light	0.92 ± 0.28	257.8 ± 150.4
Discrete Light	1.00 ± 0.00	248.5 ± 104.6
Continuous Sound	1.00 ± 0.00	191.9 ± 090.5
Discrete Sound	0.77 ± 0.44	255.9 ± 145.1



Preference



Discussion and Conclusions

1. **Usability**: Do users find feedback-enhanced methods more usable?
2. **Performance:** Does the addition of feedback methods increase task efficiency and success?
3. **Workload**: Does feedback improve ease and intuitive use of the system by decreasing mental workload?
4. **Preference:** Do users prefer light or sound feedback more when grasping and placing objects?

- Usability high across all, did not significantly vary.
- Yes, but **Performance metrics do NOT indicate preference.**
- No, but order effect was detected.
- Trend towards color. Light more subtle than sound.

Users connect familiarity to feedback preferences which are influenced by individual experiences.