TAILORED: Training for Independent Living through Observant Robots and Design

PIs: **Laurel Riek**, **Elizabeth Twamley**, **Kamalika Chaudhuri,** UC San Diego

Goal: Create **human-centered robots** to provide **personalized neurorehabilitation** to adults with mild cognitive impairment.

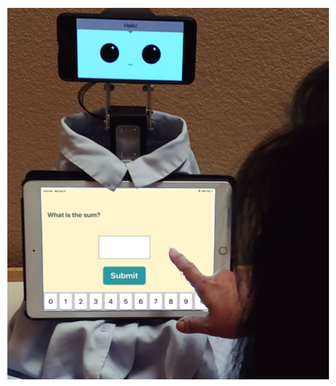
Problem

- **MCI → cognitive function impairments**
  - Problem solving, planning, medication management
- **20% of people >65 have MCI**, many convert to dementia
  - No pharmacological treatments available
- **Cognitive Neurorehabilitation (CN) may slow progression** [4]
  → *Limited accessibility. Can we translate CN to be delivered via robots @ home?*

Approach

- **Robot-delivered CN @ home [1, 2, 3]**
  - Co-designed w/ stakeholders
- **New machine learning methods [5, 6]:**
  - Personalized, long-term learning
  - Sustained engagement
- **New methods for stakeholders to easily program robots [2]**

Highlight: HRI Design Patterns for Translational Science [1]



For adults, little guidance exists on how to translate human-delivered, clinic-based interventions into robot-delivered, home-based ones to support longitudinal interaction. This is particularly problematic in neurorehabilitation, where adults with cognitive impairments require unique styles of interaction to avoid frustration or overstimulation. We address this gap by exploring the design of robot-delivered neurorehabilitation interventions for people with mild cognitive impairment (PwMCI). Through a multi-year collaboration with clinical neuropsychologists and PwMCI, we developed robot prototypes which deliver cognitive training @ home. We used these prototypes as design probes to understand how participants envision long-term deployment of the intervention, and how it can be contextualized to the lives of PwMCI. We report our findings and specify design patterns and considerations for translating neurorehabilitation interventions to robots. This work will serve as a basis for future endeavors to translate cognitive training and other clinical interventions onto a robot, support longitudinal engagement with home-deployed robots, and ultimately extend the accessibility of longitudinal health interventions for people with cognitive impairments

Highlight: JESSIE (Just Express Specifications, Synthesize, and Interact) [2]

Clinician specifies complex robot behaviors

Robot controller automatically synthesized

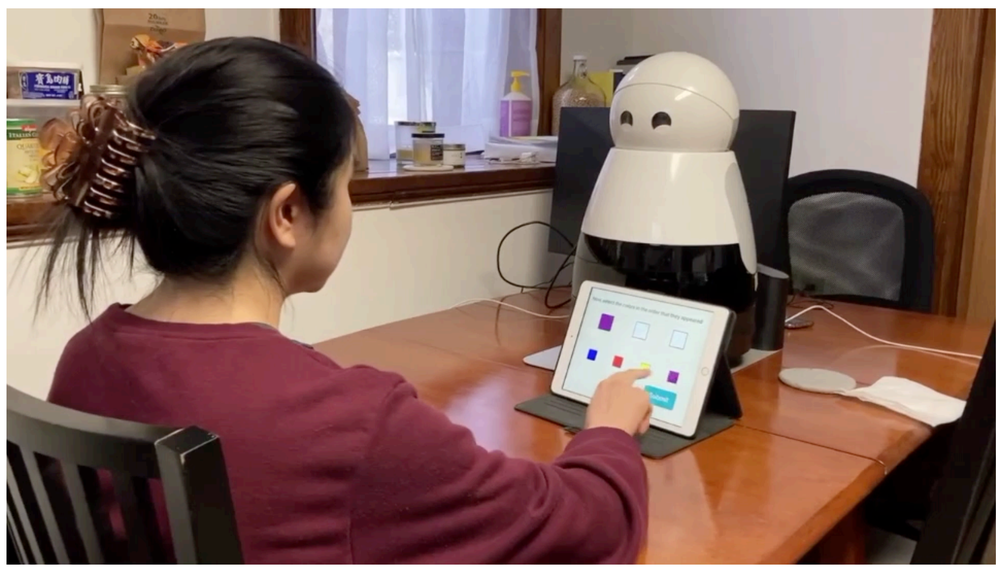
Robot delivers personalized intervention

For robot-delivered health interventions to be effective, clinicians must be able to easily personalize and program them. JESSIE is a system that enables novice programmers to program robots by expressing high-level specifications. It employs control synthesis + a tangible front-end to allow users to define complex behavior; for which we automatically generate control code. We demonstrated JESSIE in the context of enabling clinicians to create personalized treatments for people with MCI; they did so quickly and without error.

We exhibited JESSIE's reproducibility by replicating a clinician-created program on a TurtleBot 2. As an open-source means of accessing control synthesis, JESSIE supports reproducibility, scalability, and accessibility of personalized robots for HRI.

Source code: http://github.com/UCSD-RHC-Lab/JESSIE

Demo:



[1] Kubota, A., Cruz-Sandoval, D., Kim, S., Twamley, E., and Riek, L.D. (2022). "Cognitively Assistive Robots at Home: HRI Design Patterns for Translational Science." HRI 2022. [Acceptance rate: 24.8%]. Best Paper Honorable Mention.

[2] Kubota, A., Peterson, E., Rajendren, V., Kress-Gazit, H., and Riek, L.D. (2020). "JESSIE: Synthesizing social robot behaviors for personalized neurorehabilitation and beyond." HRI 2020. [Acceptance rate: 24%].

[3] Guan, C., Bouzida, A., Oncy-Avila, R., Moharana, S., and Riek, L.D. (2021) "Taking an (Embodied) Cue From Community Health: Designing Dementia Caregiver Support Technology to Advance Health Equity". CHI 2021. [Acceptance rate: 26.3%]

[4] Huckans, M., Hutson, L., Twamley, E., Jak, A., Kaye, J., & Storzbach, D. (2013). Efficacy of cognitive rehabilitation therapies for mild cognitive impairment (MCI) in older adults: working toward a theoretical model and evidence-based interventions. Neuropsychology review,

[5] Wang, Z., Zhang, C., Singh, M., Riek, L.D., and Chaudhuri, K. (2021). Multitask Bandit Learning Through Heterogeneous Feedback Aggregation In Proceedings of The 24th International Conference on Artificial Intelligence and Statistics (AISTATS). [Acceptance rate: 29%]

[6] Kubota, A. and Riek, L.D. "Methods for Robot Behavior Adaptation for Cognitive Neurorehabilitation". (2021). Annual Review of Control, Robotics, and Autonomous Systems.

UC San Diego JACOBS SCHOOL OF ENGINEERING

Healthcare Robotics Lab @UC San Diego

NSF

UC San Diego SCHOOL OF MEDICINE

Award ID#: 1915734