TAILORED: Training for Independent Living through Observant Robots and Design

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Goal: Create **cognitively assistive robots** to provide **personalized neurorehabilitation** to adults with mild cognitive impairment.

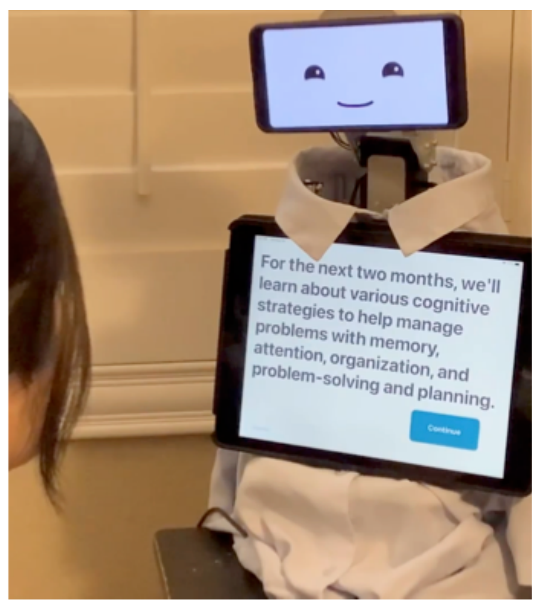
Problem

- **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 [5]**
  - Limited accessibility. How to translate to be robot-delivered @ home?

Approach

- **Robot-delivered CN @ home [2, 3, 4, 5]**
  - Co-designed w/ stakeholders, collaborative goal setting
- **New machine learning methods [6, 7]:**
  - Personalized, long-term learning
  - Sustained engagement
- **New methods for stakeholders to easily program robots [3]**

Collaborative Goal Setting w/ Cognitively Assistive Robots [1]



Many robot-delivered health interventions aim to support people longitudinally at home to complement or replace in-clinic treatments. However, it is unknown how robots can support collaborative goal setting (CGS). CGS is the process in which a person works with a clinician to set and modify their goals for care; it can improve treatment adherence and efficacy. However, for home-deployed robots, clinicians will have limited availability to help set and modify goals over time, which necessitates that robots support CGS on their own. In this work, we explore how robots can facilitate CGS in the context of our robot CARMEN (Cognitively Assistive Robot for Motivation and Neurorehabilitation), which delivers neurorehabilitation to people with mild cognitive impairment (PwMCI). We co-designed robot behaviors for supporting CGS with clinical neuropsychologists and PwMCI, and prototyped them on CARMEN. We present feedback on how PwMCI envision these behaviors supporting goal progress and motivation during an intervention. We report insights on how to support this process with home-deployed robots and propose a framework to support HRI researchers interested in exploring this both in the context of cognitively assistive robots and beyond. This work supports designing & implementing CGS on robots, which will ultimately extend robot-delivered health intervention efficacy.

HRI Design Patterns for Translational Science [2]

For adults, little guidance on translating human-delivered, clinic-based interventions to robot-delivered ones @ home. This is problematic in neurorehabilitation, where people w/ mild cognitive impairment (PwMCI) require unique styles of interaction to avoid frustration or overstimulation. We addressed this gap by co-designing robot prototypes that deliver neurorehabilitation interventions w/ clinical neuropsychologists and PwMCI. Participants envisioned long-term deployment of the robot, and how it can be contextualized to people's lives. We report our findings & specify design patterns for translating neurorehabilitation interventions to robots. This work serves 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 interventions for people w/ cognitive impairments.

Design Pattern
Promote engagement
Connect the intervention to the real world
Relate the intervention to a user's interests
Reward perseverance over performance
Obtain feedback from users
Goal setting
Reminders
Personalization

JESSIE (Just Express Specifications, Synthesize, & Interact) [3]

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

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[2] 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.

[3] 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%].

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[6] 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%]

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