Robot Embodiment & Re-Embodiment

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NRI 1832758: FND: Human-Robot Collaboration with Distributed and Embodied Intelligence

Introduction

We investigate how a robot's form and behavior impact how people coordinate and collaborate with robots and with other people. We conducted two studies (both currently in submission to ACM CHI).

Study 1: Embodiment, Collaboration, and Deceit
Studies investigating agent embodiment, context, and task have produced conflicting results. People expect embodied agents to understand tasks they collaborate on. Embodiment can make people trust robots they should not trust. Finally, deceptive robots are sometimes viewed as more socially intelligent. Currently, it is mostly unknown when an agent's role might or might not benefit from having a body.

Study 2: Re-embodiment
Voice agents and social robots are becoming more common. Robot designers have uncertainty about how to design their behaviors. Agents and robots have a non-human ability to jump from body to body. Should they use this ability? Should a person have a single agent for interacting with a hotel? One that takes their reservation over the phone, takes their bags at the curb and checks them in, answers questions in the room, and takes their order at the bar? Or, imagine that a person has a voice agent like Amazon's Alexa in their home, and the agent uses knowledge of their medical history to offer better advice. If they interact with an Alexa in their hotel room, then have they shared their medical history with the hotel, or should the hotel's Alexa just know less about them when offering advice? Should the agent that drives a person's car also appear in their home speaker and ask about ordering new windshield wipers? Should robots and agents talk to each other?

Designers currently lack design patterns and an understanding of related social mores to help them envision how people should collaborate with an ever-increasing number of agents and robots in sequential interaction.

Embodiment, Collaboration, and Deceit

We conducted a 3 x 2 between-subjects Wizard-of-Oz experiment. We used three distinct agent forms (Robot, Tablet, and Voice) and had the agents provide good or bad advice. 48 participants took part in a simulated escape room, where they needed to collect clues and solve puzzles. Participants in the Good Clue condition received (5) helpful clues and (2) unhelpful clues. Participants in the Bad Clue condition received (2) helpful clues and (5) unhelpful clues.
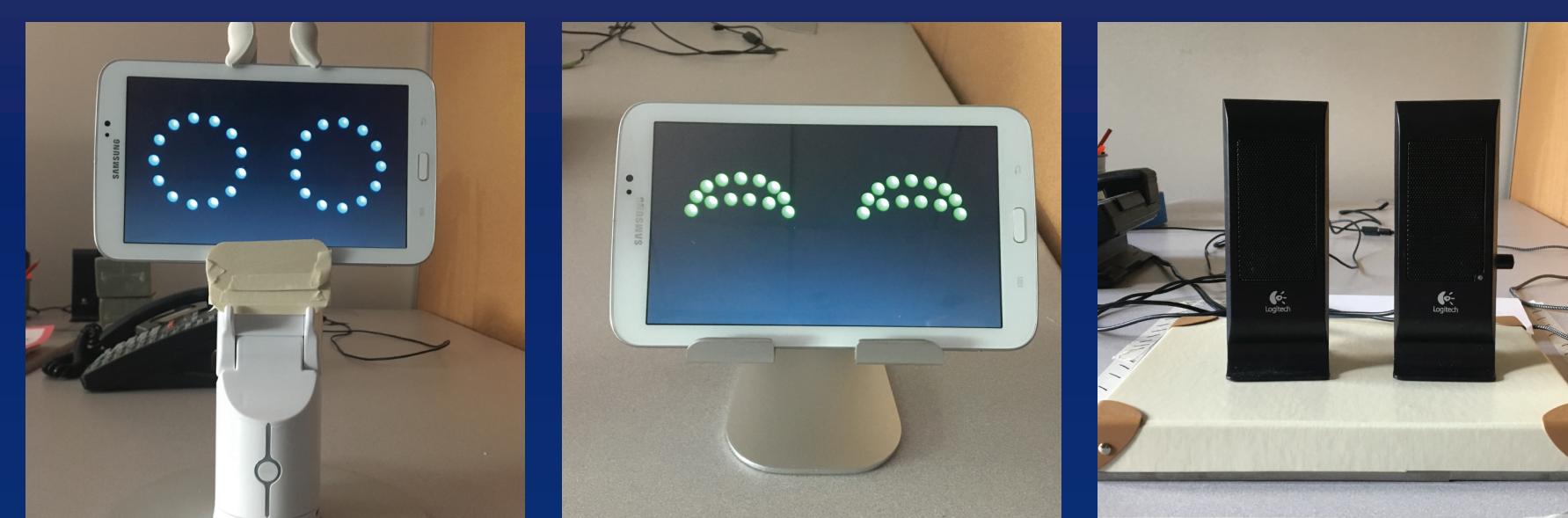
Robot   **Tablet**   **Voice**

Simulated Escape Room

Findings
Participants were less willing to take the suggestions of a robot than a tablet or a voice.

Embodiment played a minor role in perceptions of helpful and misleading agents.

Misleading agent can be perceived as capable of loyalty and/or betrayal.

Voice agent perceived to make more mistakes than robotic agent.

Robot and voice agent perceived to help more for time-sensitive tasks.

Re-embodiment

We conducted a user enactments study looking at four types of robot behavior: One-for-one, One-for-all, Re-embody, and Co-embody. Eighteen participants interacted with a sequential set of social robots in different contexts. These included:

- **DMV:** A visit to the DMV to get a new driver's license photo.
- **Home-Work:** Checking on a situation at work from home.
- **Health:** A follow up appointment to the hospital that includes waiting at a coffee shop for x-rays to finish.
- **Car:** Being driven by an autonomous car and interacting with a home agent about chores

DMV	Home-Work	Health	Car
One-for-one	Re-embody	Re-embody	One-for-one
Re-embody	One-for-all		Co-embody

One-for-one   **All-for-one**

Re-embody   **Co-embody**
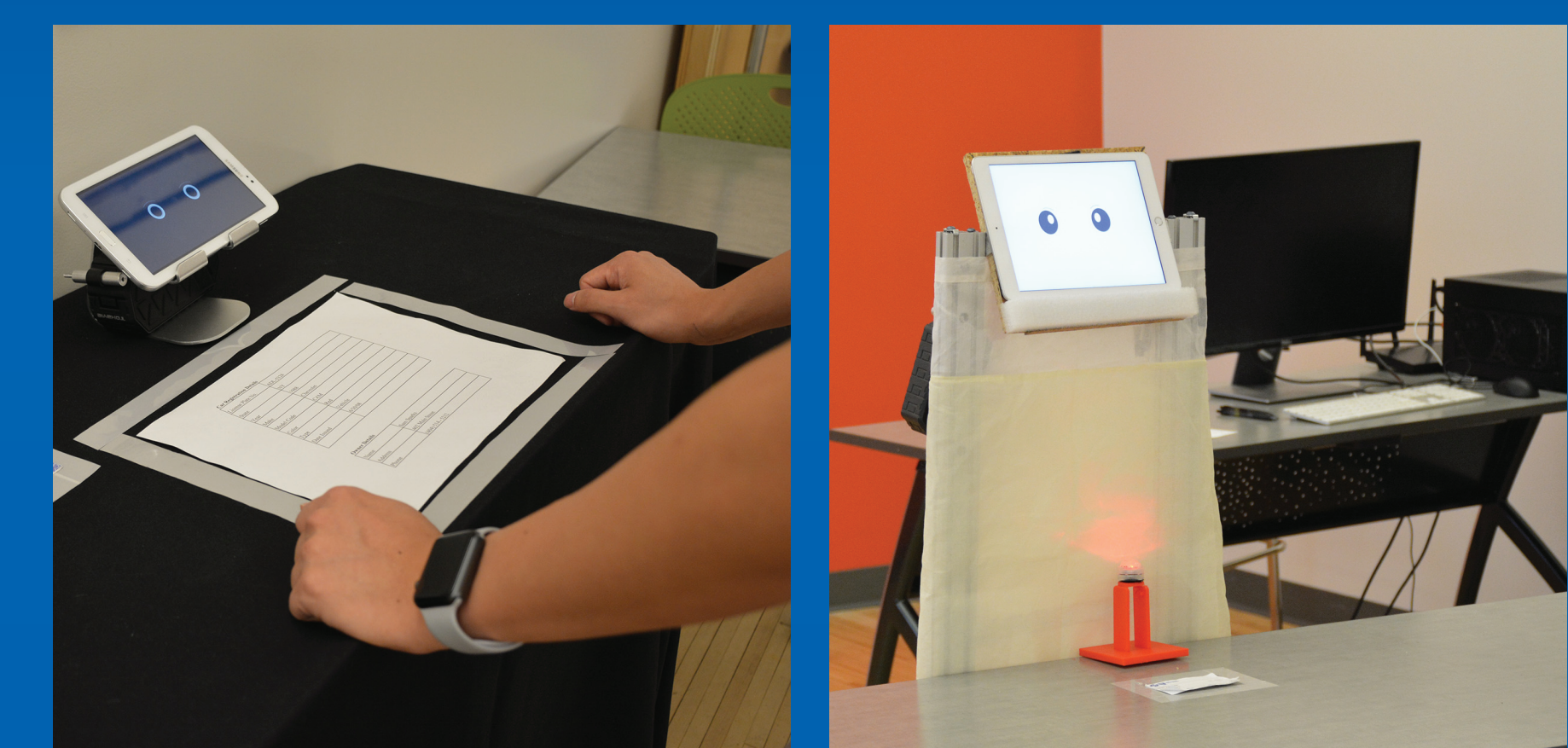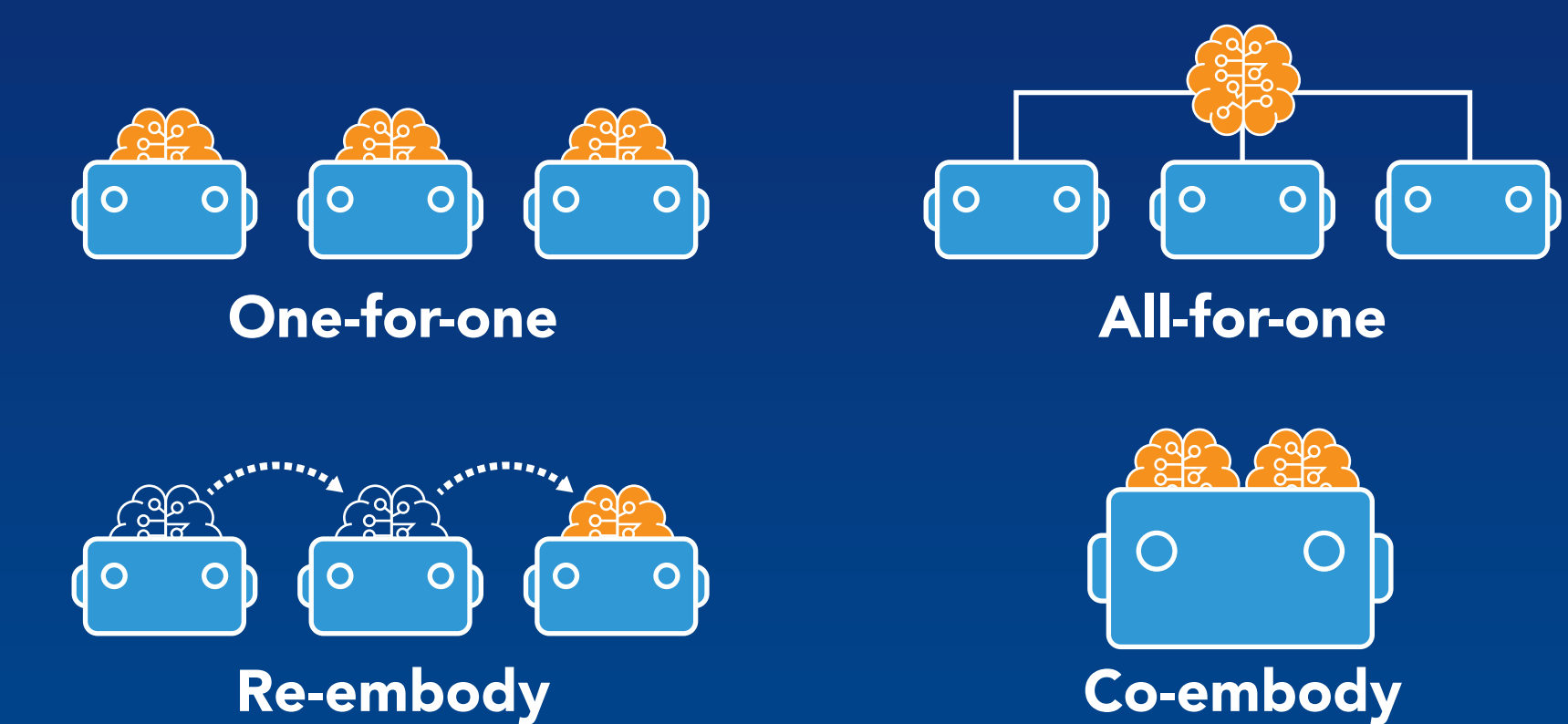
Findings
Participants were comfortable with robots that take on non-human behaviors.

Re-embodiment within a service made interactions feel more seamless and efficient.

Re-embodiment worked less well when robots needed more expertise.

Participants struggled to make sense of co-embodiment, and it raised uncomfortable issues.

Some people worried an *all-for-one* future would be very boring.