How Does Delegation in Social Interaction Evolve Over Time? Navigation with a Robot for Blind People

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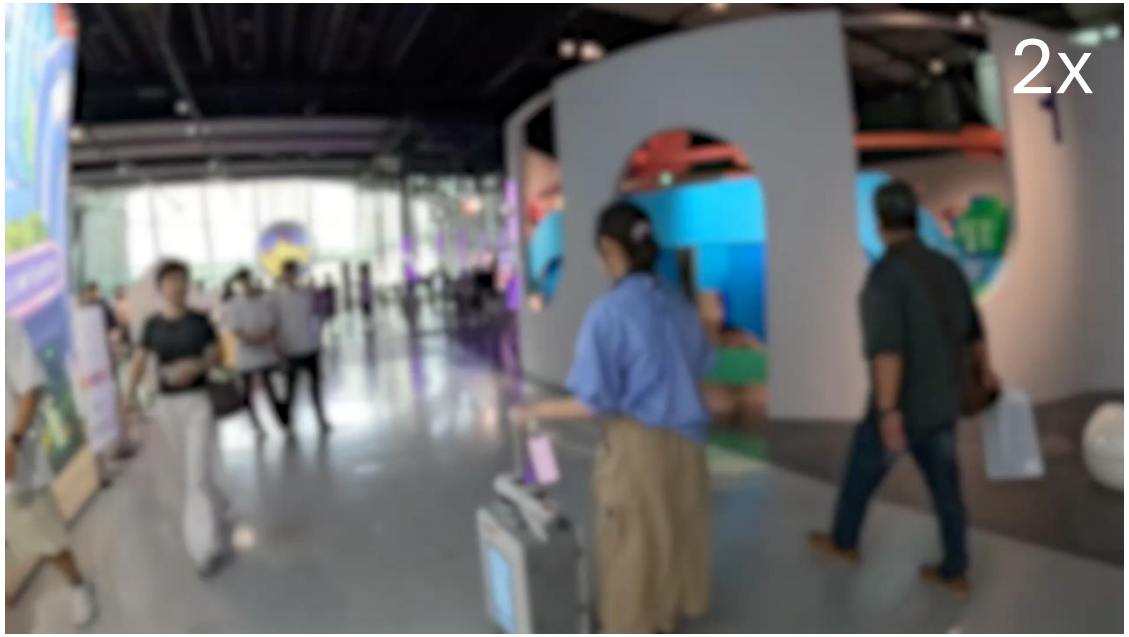
The Freezing Robot Problem [1]

In complex environments, the robot may stop because it cannot identify a safe path forward



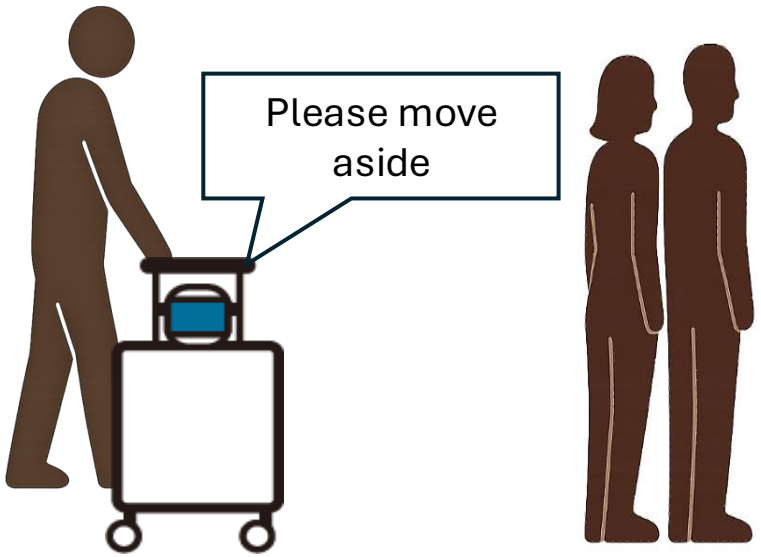
Typical triggers:

- Dense crowds
- Queues / lines
- Large obstacles blocking the path

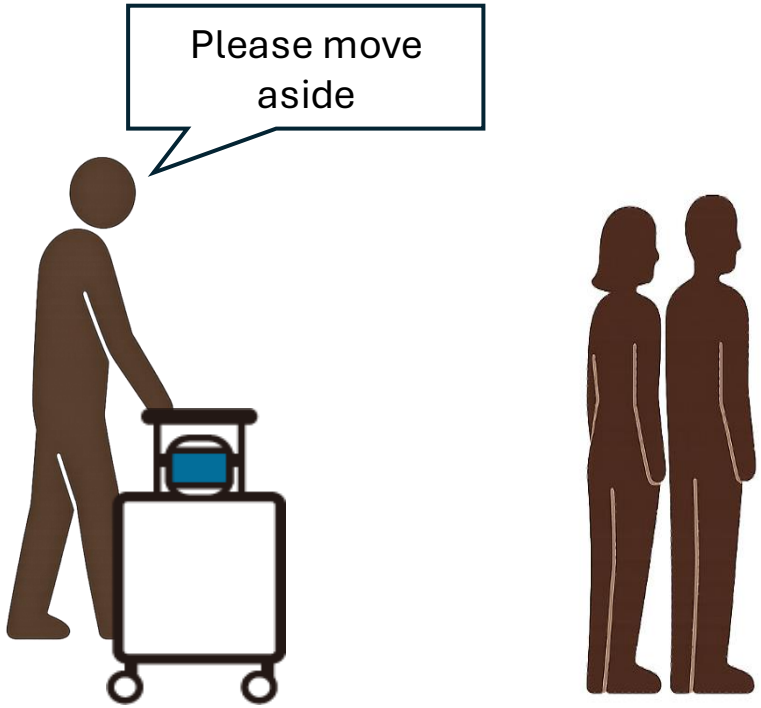
[1] Trautman, Peter, and Andreas Krause. "Unfreezing the robot: Navigation in dense, interacting crowds."

Who solves the problem?

Robot-Initiated Interaction



User-Initiated Interaction



Delegation In Shared Control

Shared Control
Humans and robots **jointly contribute** to making decisions [1]

Users benefit from **selectable modes** [2]

Many users prefer to **remain in control** when given the choice [3]

[1] D. A. Abbink *et al*. "A Topology of Shared Control Systems—Finding Common Ground in Diversity."
[2] Ranganeni, Vinitha, et al. "Exploring levels of control for a navigation assistant for blind travelers."
[3] Kamikubo, Rie, et al. "Beyond omakase: Designing shared control for navigation robots with blind people."

Study Design: 3 Week Repeated Exposure

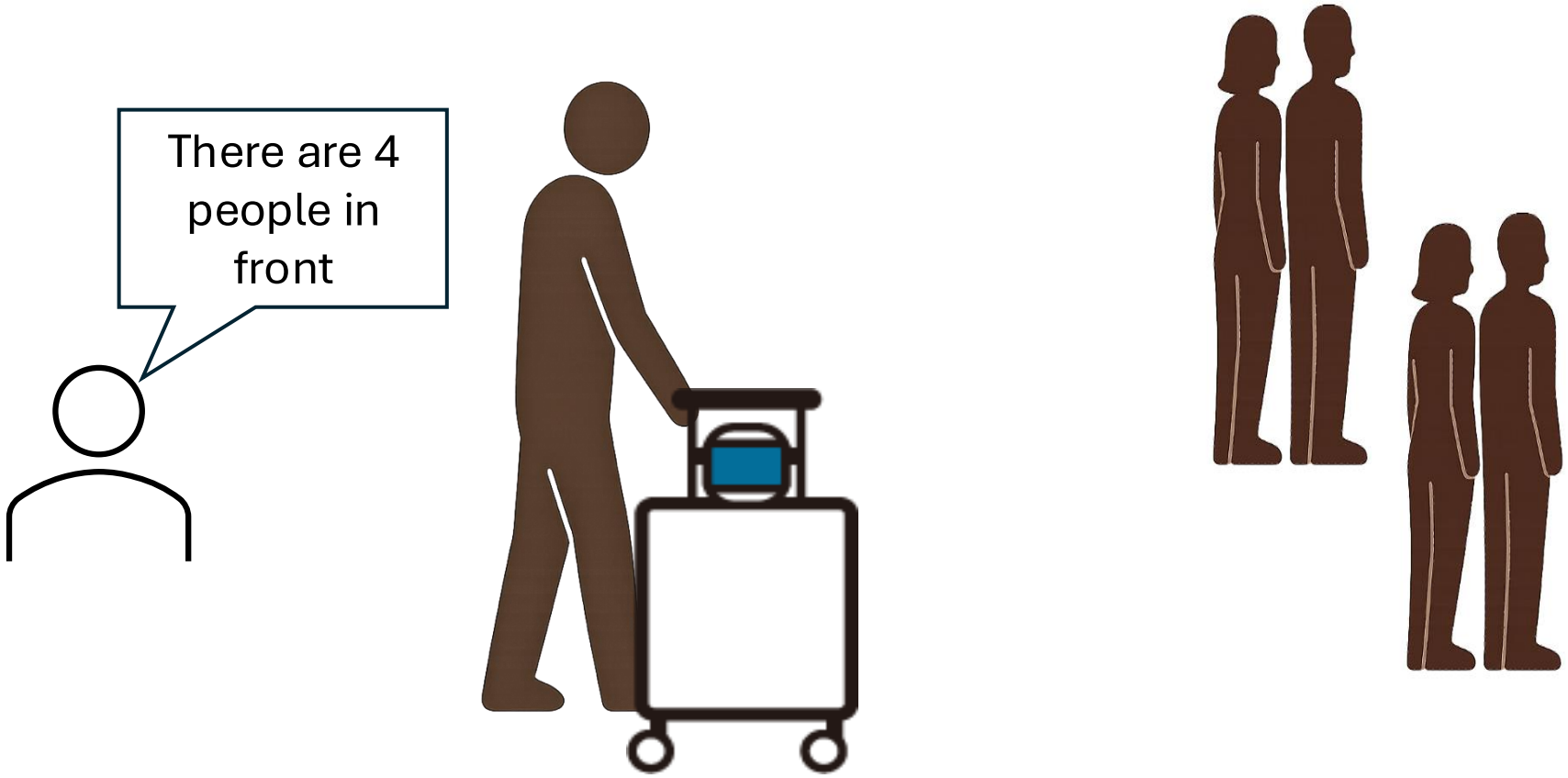
Prior works **do not** evaluate long term use leading to the novelty effect

Week 1

Week 3

System Design: Autonomous Descriptions

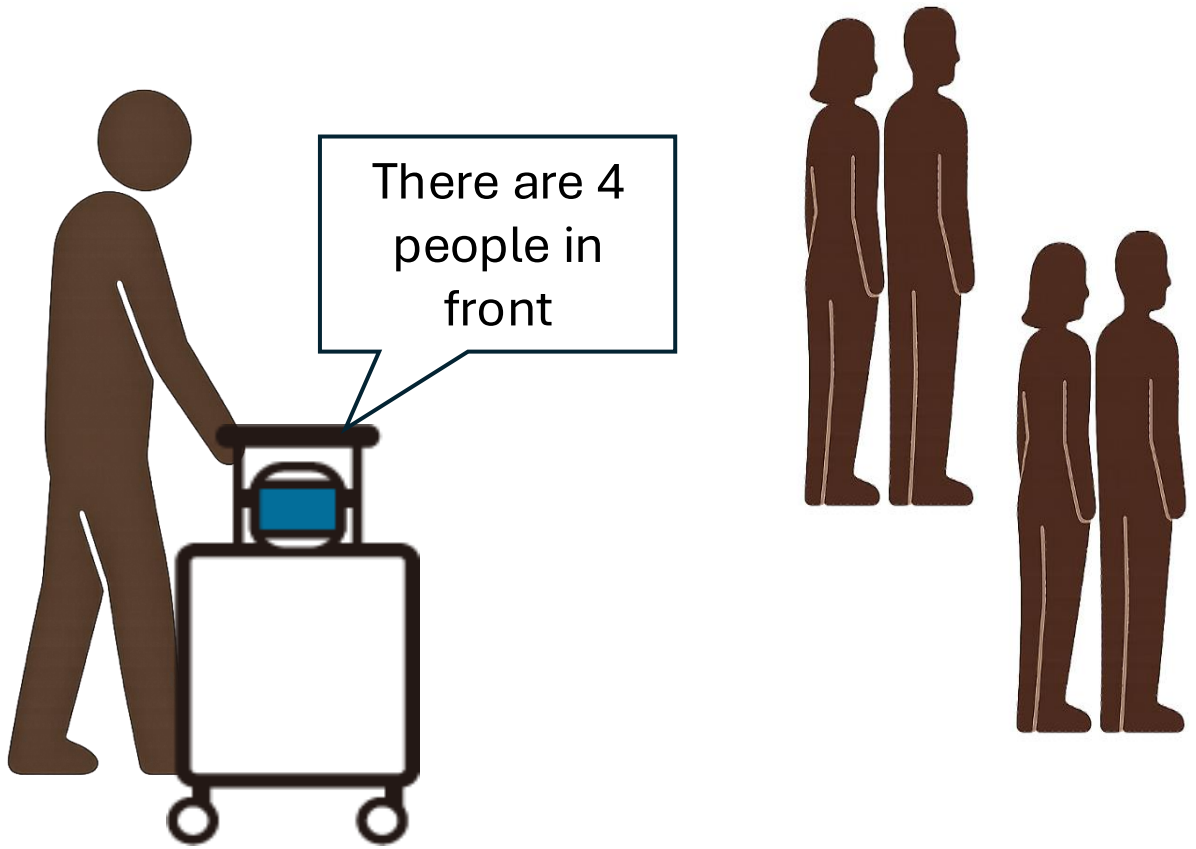
Prior works have **Wizard of Oz** descriptions of surroundings[1]



[1] Kamikubo, Rie, et al. "Beyond omakase: Designing shared control for navigation robots with blind people."

System Design: Autonomous Descriptions

Autonomously detects the obstacle and gives the description



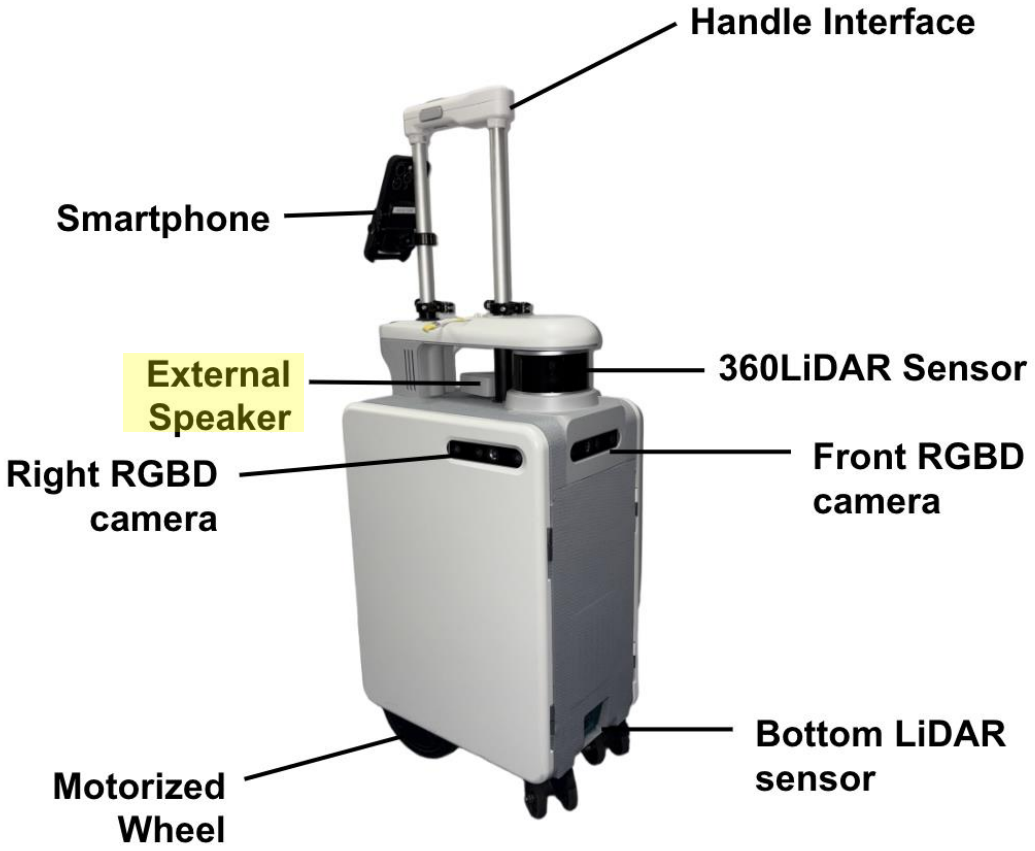
Delegation in Shared Control in Repeated Use

1. What information do users use to make delegation decisions?

2. When do users choose to delegate to the robot?

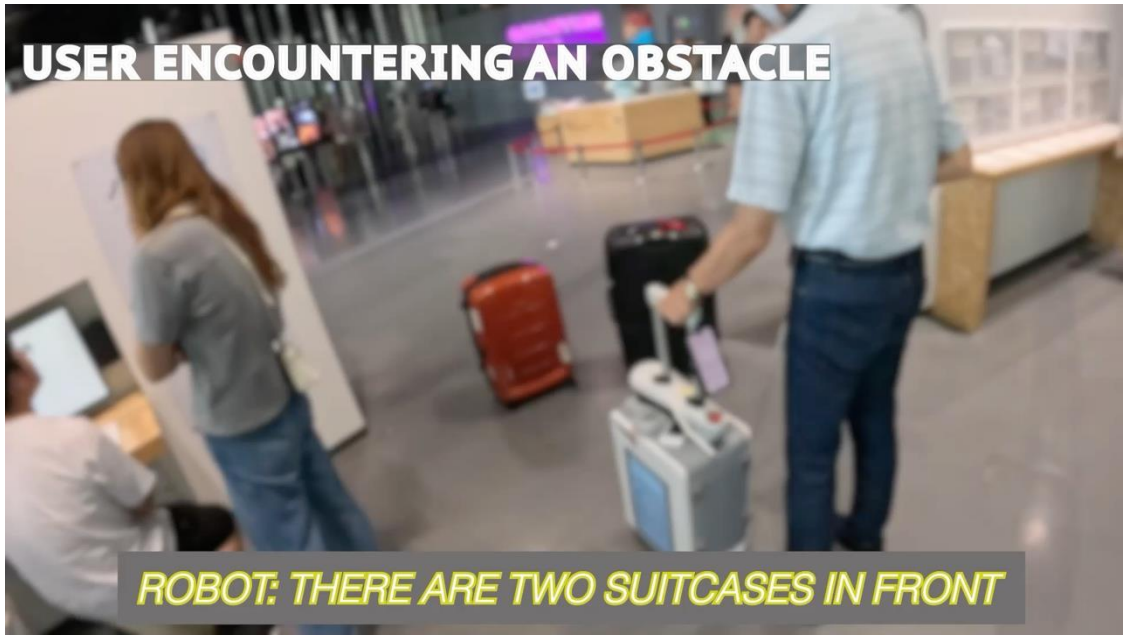
3. How does delegation change over repeated use?

Navigational Robot [1]



[1] Guerreiro, João, et al. "Cabot: Designing and evaluating an autonomous navigation robot for blind people."

Navigational Robot: Handle Interface[1]



[1] Guerreiro, João, et al. "Cabot: Designing and evaluating an autonomous navigation robot for blind people."

Surrounding GPT

Users can request additional information about their surroundings at any time independently from obstacle triggered explanation

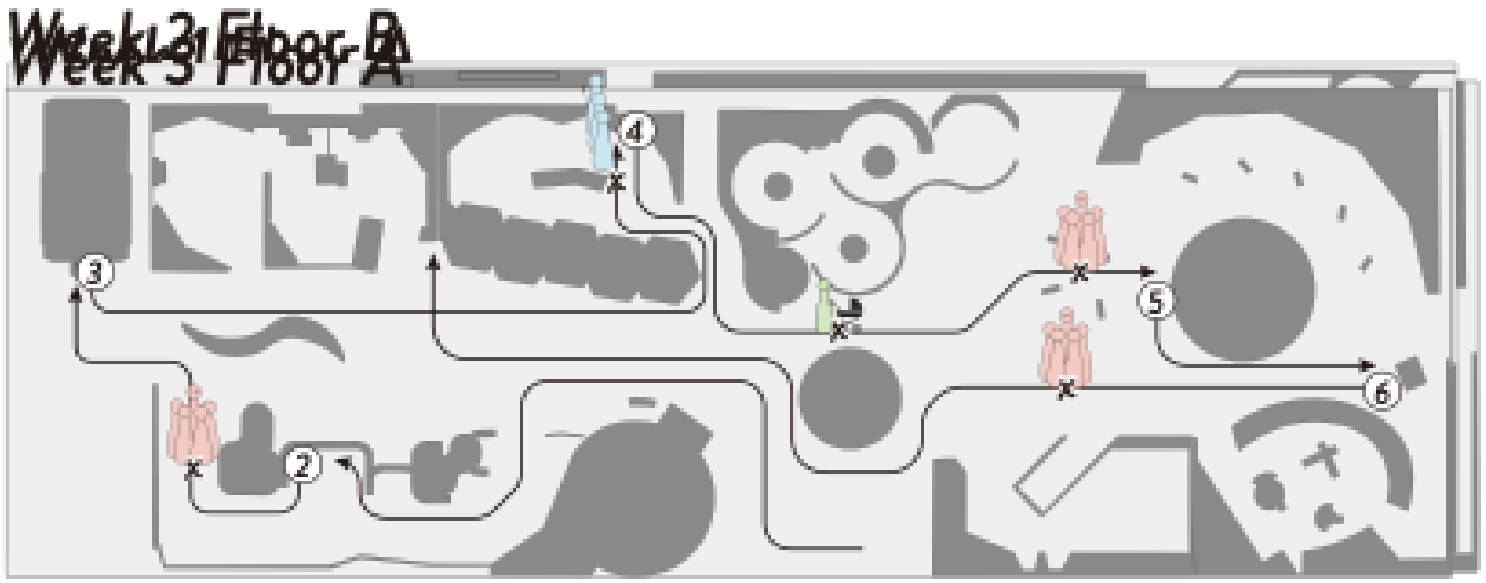
“This scene appears to take place in a **museum** or exhibition space. **Several children are looking at a large interactive display** ….. There are **also adults nearby,** …. **The exhibit may contain educational content.**”

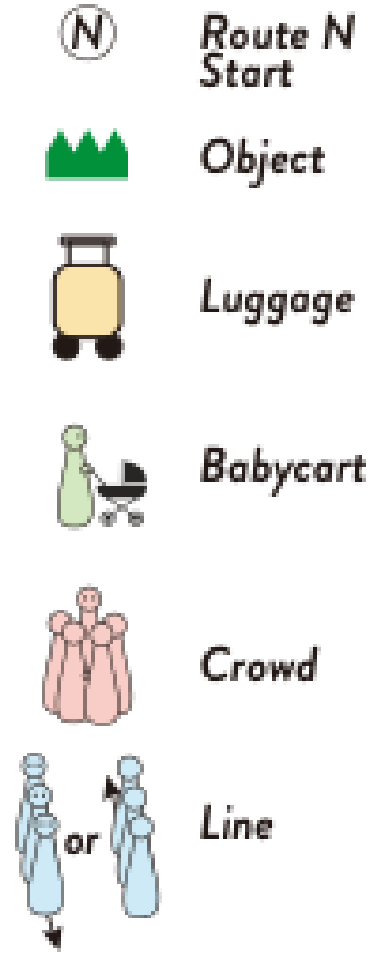
Obstacle Detection

“There are two suitcases in front of you”

“There is a **crowd** in front of you.
There are approximately **5 people**
and they are **facing away** from you”

Study Design





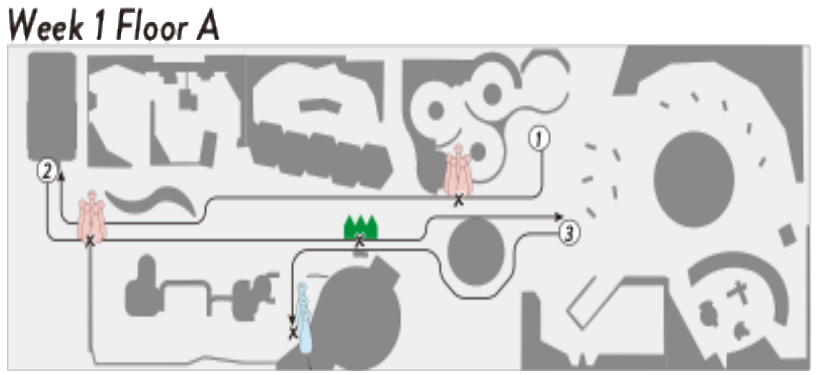
User Study with 6 Blind Participants

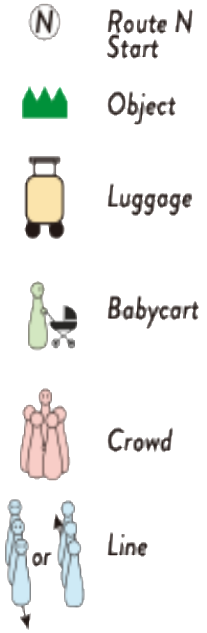
Participant demographics:

- 3F/3M
- Ages 18 to 69 years (M = 42.0, SD = 23.6)

Staged obstacles

Naturally occurring obstacles and crowds





Study Session Procedure

1. Practice Session (10~20 min)

2. Navigation on exhibit floor (~ 1 hour)

3. Post study interview

Results

Participant Delegation to the Robot

Most participants were delegating to the robot by **Week 3**

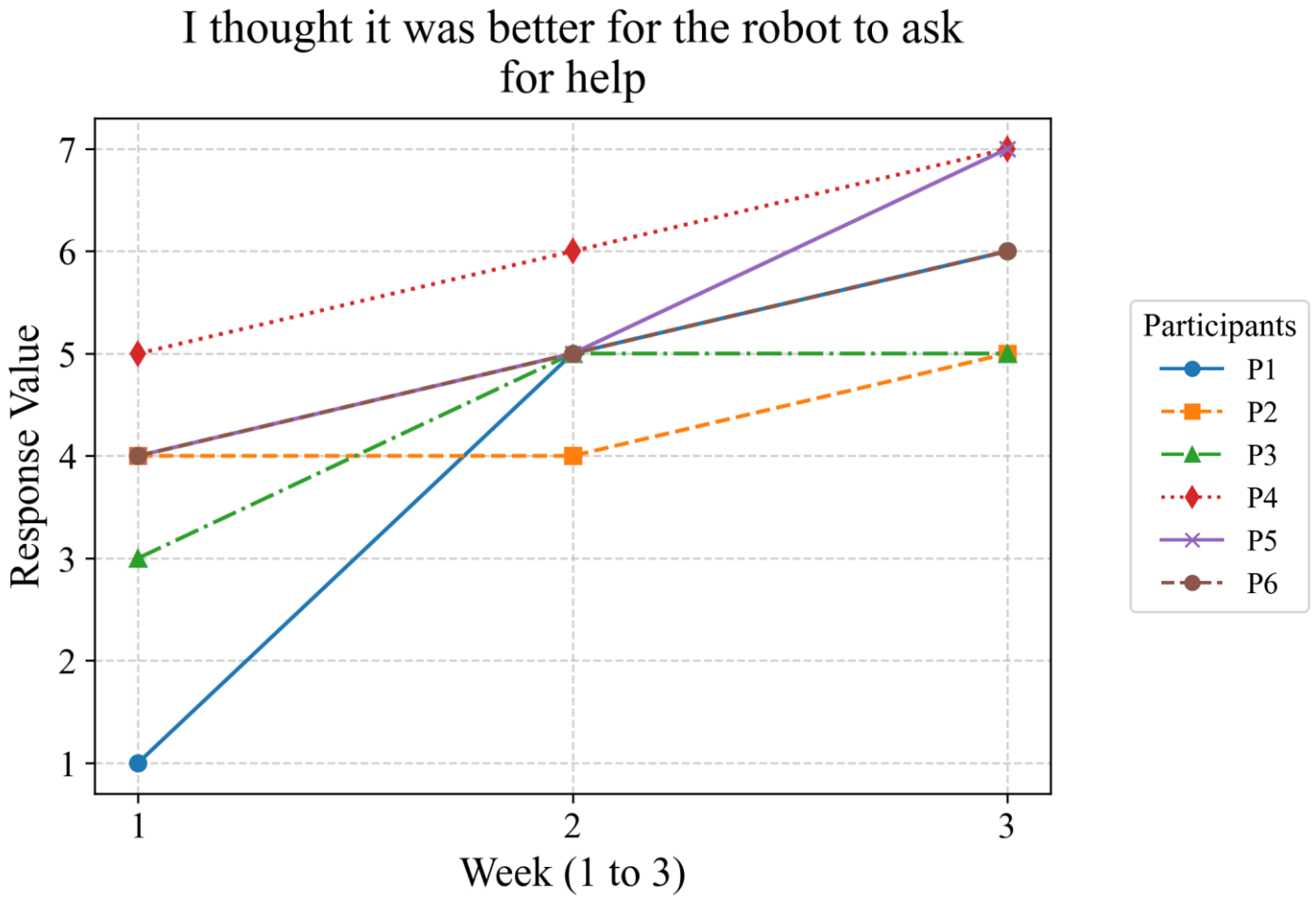
Participant	Week 1	Week 2	Week 3
P1	0.0%	57.1%	12.5%
P2	83.3%	87.5%	92.6%
P3	85.7%	100%	100%
P4	100%	100%	100%
P5	20.0%	100%	100%
P6	0.0%	20.0%	54.5%

Increase in Delegation to the Robot

Some participants began with low delegation, then increased reliance over time

Participant	Week 1	Week 2	Week 3
P1	0.0%	57.1%	12.5%
P2	83.3%	87.5%	92.6%
P3	85.7%	100%	100%
P4	100%	100%	100%
P5	20.0%	100%	100%
P6	0.0%	20.0%	54.5%

Stated preferences aligned with actual delegation behavior



Reasons for Delegation

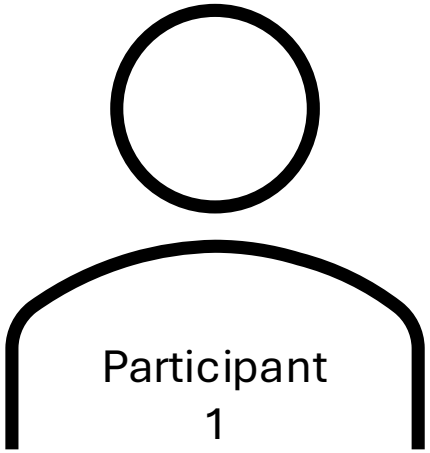
Shy personality and preferred robot-mediated social interaction

The robot’s voice carried better in **noisy environments**

Multilingual surroundings made robot communication easier

Effects of Repeated Exposure

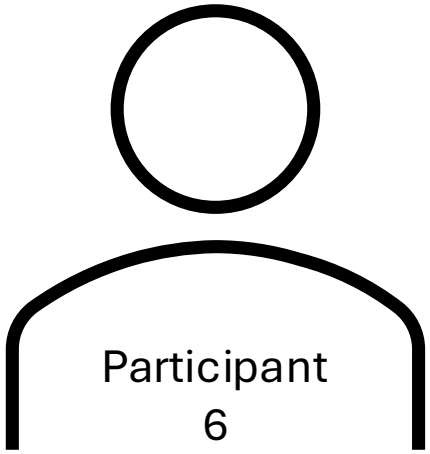
Changing Delegation Strategies



"I want to be able to do everything sighted people can do" – Week 1

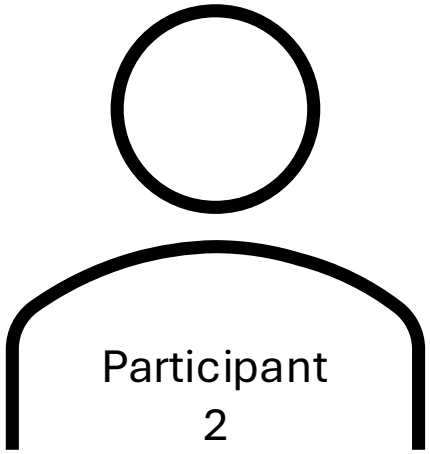
"At first, I thought I should say it myself and I did, but **it felt like people weren't really hearing me.** With the robot, I felt like people were actually paying attention." – Week 3

Decisions Based on Environmental Cues



“**When it was noisy**, I felt it was easier for people to notice and help because **the robot spoke louder** than my own voice. ” – Week 2

Familiarity With the System



“It was the way the robot moved when there were people around. The small movements, like backing up a little, moving forward, backing up again, turning left, and trying different directions -- **I gradually came to understand that it was searching for a path…..** ” – Week 2

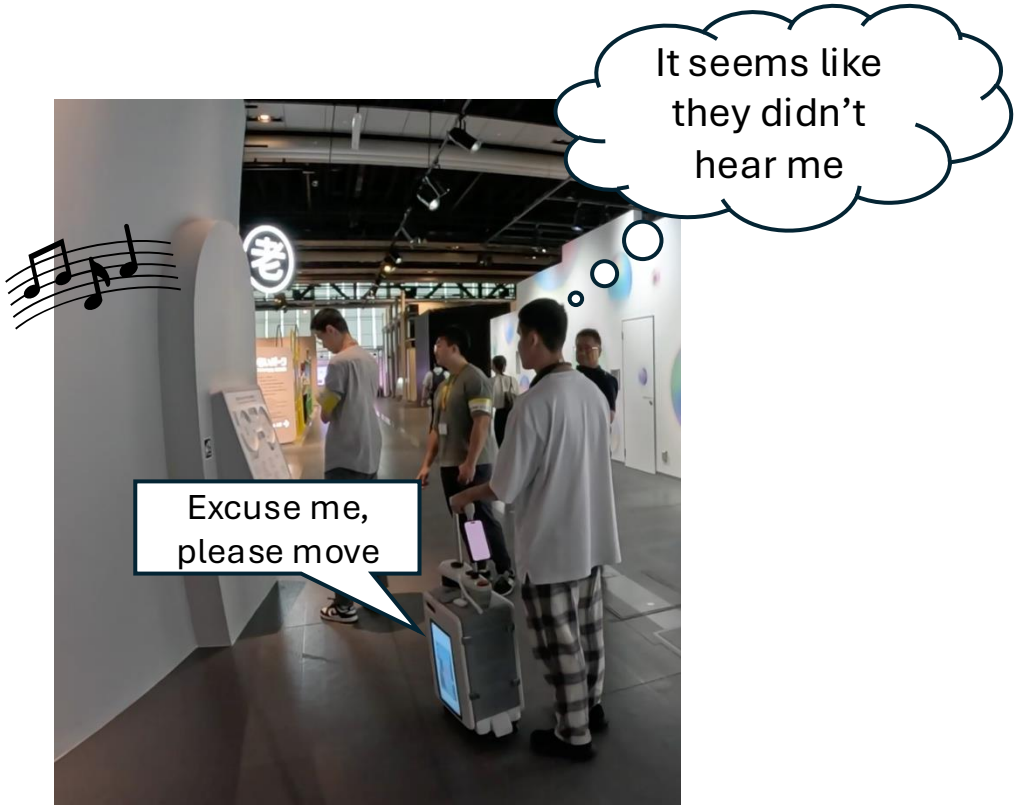
Thematic Analysis of User Types

Analysis of user delegation tactics and interview analysis

Three distinct types of users

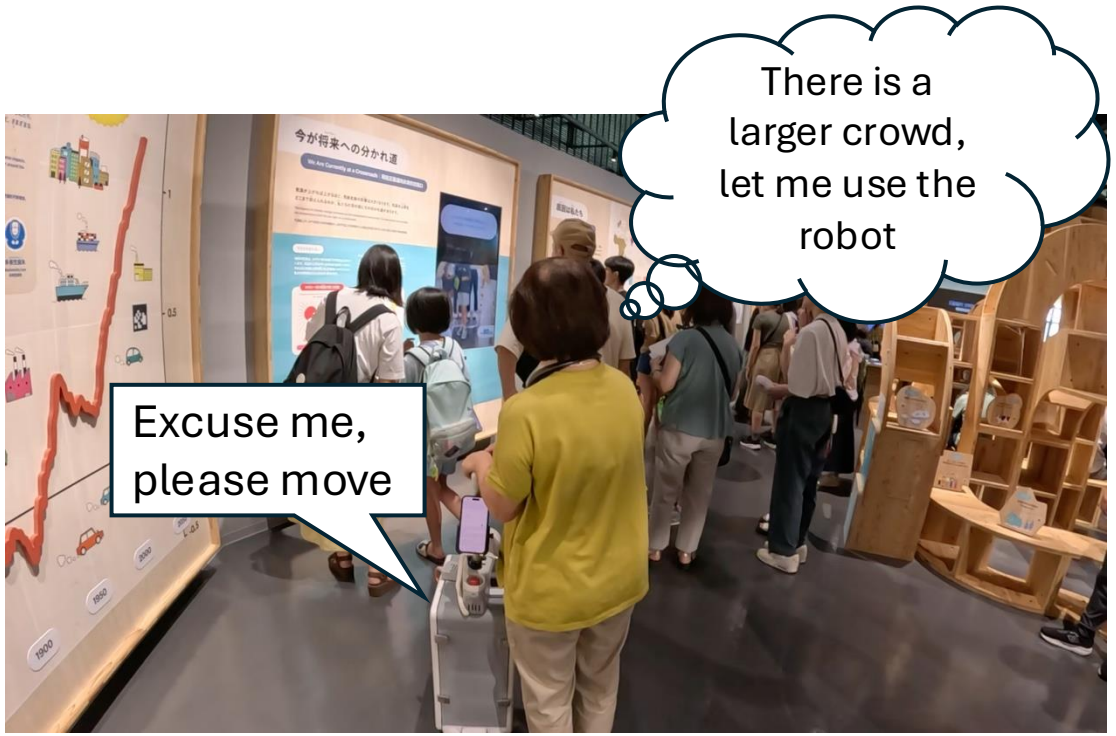
Independence First

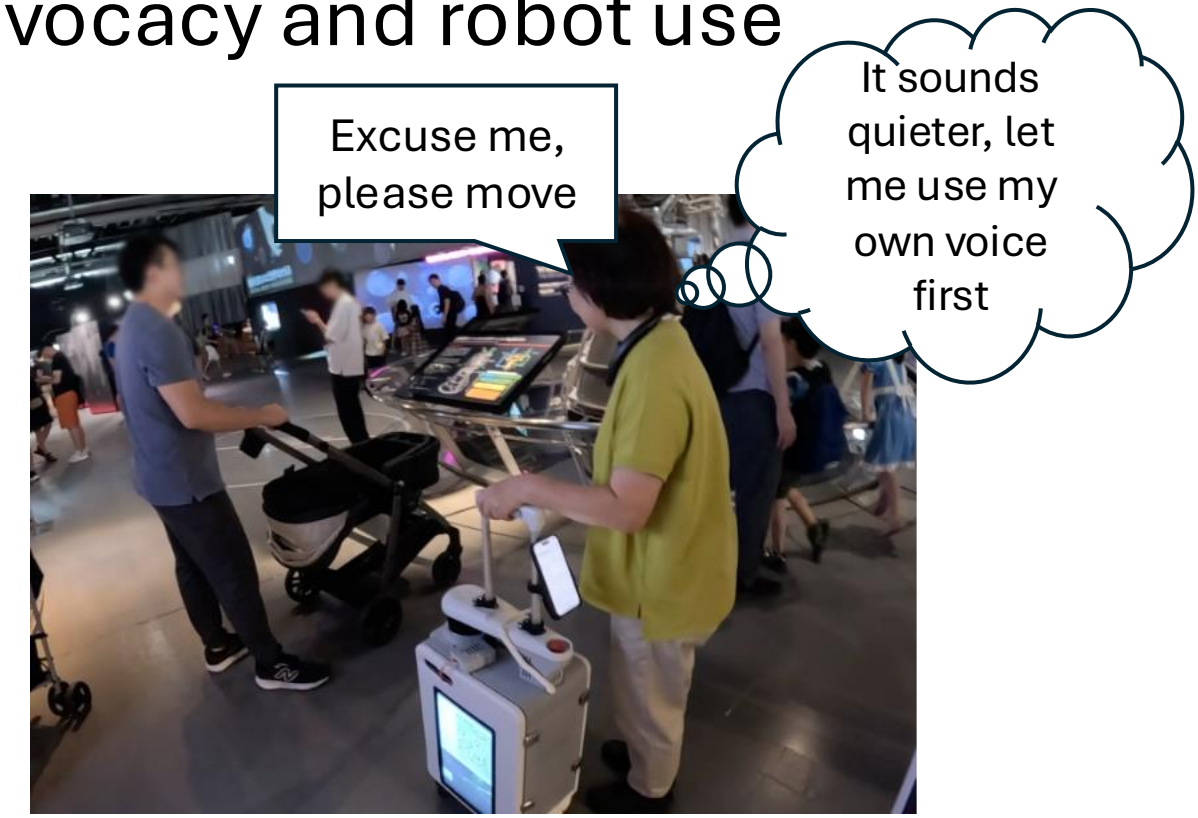
Prefers not delegating, but will if they feel the need



Balanced

Switched between self-advocacy and robot use





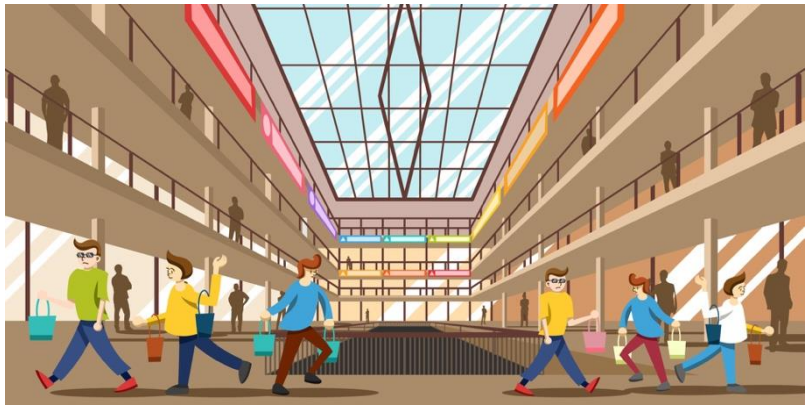
Delegation First

Prefers to only use the robot

Continued Robot Use

Preferred in situations that were more **challenging or cognitively demanding**

Supermarkets[1]



Shopping Malls[2]

Museums[2]

[1] https://stockcake.com/i/grocery-store-fun_311431_75549
[2] https://www.vecteezy.com/

Delegation in Shared Control in Repeated Use

1. What information do users use to make delegation decisions?
1. Environmental information, robot movements, obstacle descriptions

2. How does delegation change over repeated use?
2. Varied delegation tactics, initial preferences are not ending preferences

3. Why do users choose to delegate to the robot?
3. Overcome social barriers, robot voice carries better, multilingual surroundings

Takeaways

Flexibility is critical because preferences differ across users

Repeated exposure uncovers **evolving user tactics**

Assistive technology **should not be** designed based only on one-time encounters

Link to Paper

Thank you!

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