Microsoft Research

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Living with Social Robots

From Research to Commercialization

Cynthia Breazeal

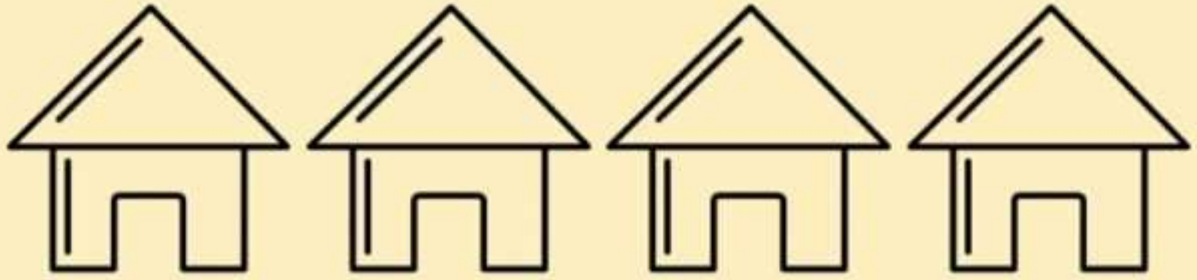
MIT Media Lab, Director Personal Robots Group

Co-Founder & CXO Jibo Inc.

Living with AI
47.3 million people in the United States now own a smart speaker

The home is *personal*
intimate
vulnerable
secure
comfortable
private

"Home—as well as technology—evokes strong feelings". When technology seeks to penetrate the home, the sense of ***comfort, routines, traditions,*** *and social norms that encapsulate the environment feel challenged, resulting in strong reservations and fear.*



Mattel Pulls Aristotle Children's Device After Privacy Concerns

NYT Oct 5, 2017

"We love our Amazon Echo. Among other tasks, my four year old finds the knock knock jokes hilarious, the weather captivating, the ability to summon songs comparable to magic and Echo to be the best speller in the house. But I fear it's also turning our daughter into a raging asshole. Because Alexa tolerates poor manners."

Dr. Dimitri Christakis, co-author of the American Academy of Pediatrics' 2016 media guidelines for children under 6, said he is "constantly dismayed by how much we are technologizing childhood" and believes it contributes to our dependency on digital devices."

The decision came after child advocacy groups, lawmakers and parents raised concerns about the impact the AI device could have had on children's privacy, development and well-being.

Social Robots

Studying Long-Term Interaction with Social Robots

Challenges in doing long-term studies

- Far more laborious to perform & analyze
- Technological brittleness
- Degree of autonomy

Reliance on commercial or corporate robots

Total of ~50 papers from 2003-2016

But roughly 50% with autonomy, often fairly limited.

Number of Studies	Domain	Years
13	Health & Therapy	2006--2016
21	Education (children)	2004--2016
7	Work Env. + Public Spaces	2003--2016
9	Home	2003--2016

I.Leite, C. Martinho, A. Paiva (2013) Social Robots for Long-Term Interaction: A Survey. International Journal of Social Robotics

Living with AI

Can AI Help us to Flourish?

A New Kind of Humanistic Relationship

Motivating Ally

Connected Tool

Attentive Companion

Relational AI that Holistically Supports Human Capacities

Emotion + Cognition + Social + Physical

#1
Emotional Lift
from Social Co-Presence

Clinical Trial @ Boston Children's Hospital

Sooyeon Jeong, Dr. Peter Weinstock, Deirdre Logan, Matthew Goodwin, et al.

- Children need social and emotional support when admitted to a hospital.
- Gap between supply and demand for human Child Life Specialist Services (CLSS)
- Can a social robot help augment Child Life Specialists for in patient support.

mit media lab

Boston Children's Hospital
Until every child is well

Northeastern

Comparative Study: Impact on Engagement and Emotion

n=54 in-patients, 3-10 years: Oncology, Surgical, MSICU

Robot

Avatar

Plush

mit media lab

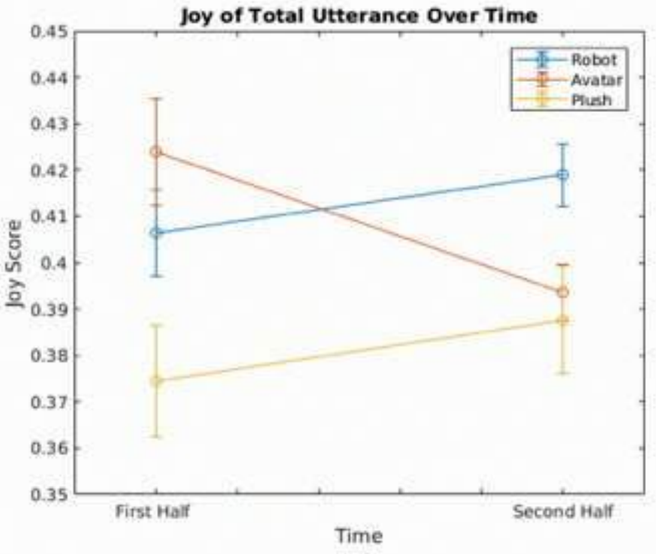
Boston Children's Hospital
Until every child is well

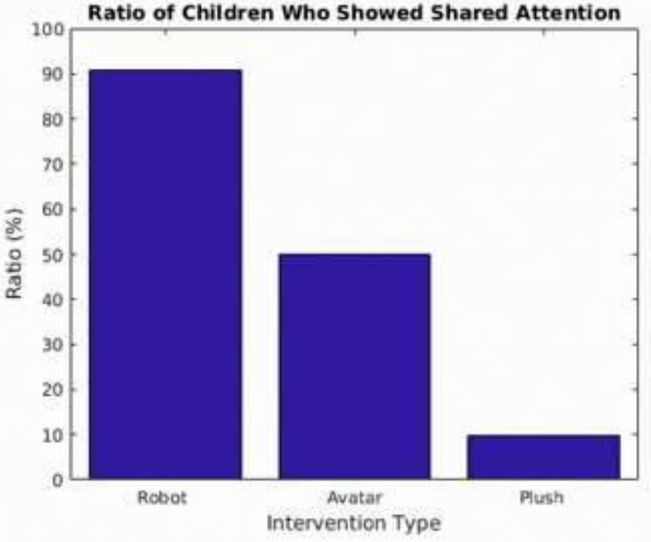
Northeastern

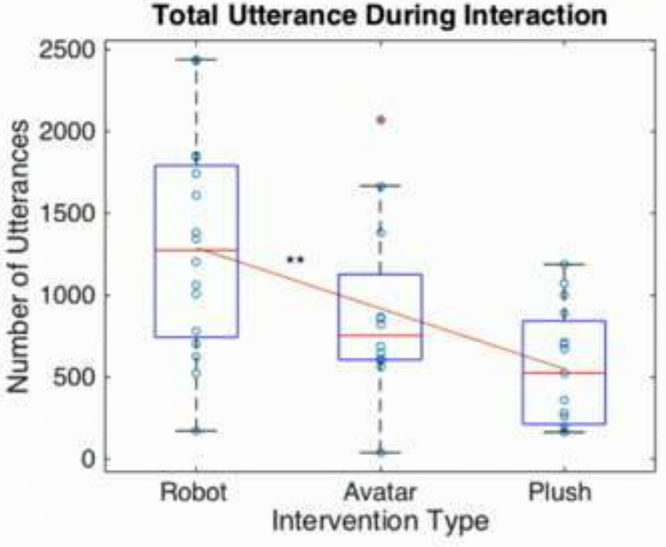
S.J. Jeong, D. Logan, C. Breazeal (2018) Huggable: The Impact of Embodiment on Promoting Socio-emotional Interactions of Young Pediatric Patients. To appear CHI 2018.

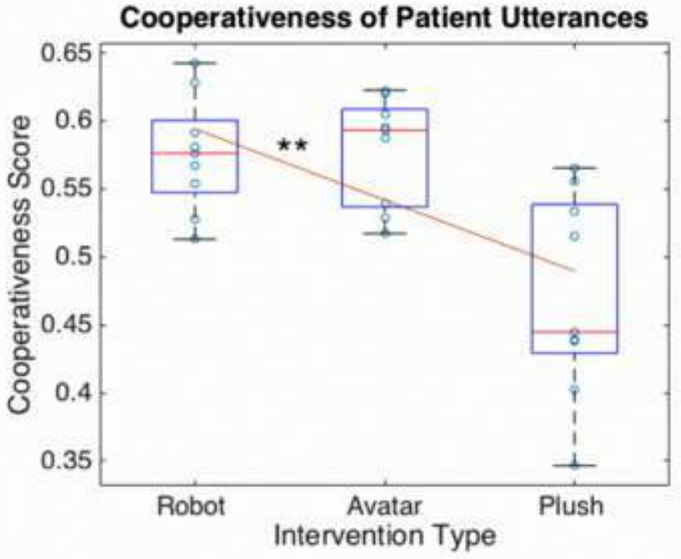
Pediatric Companion Clinical Trial Findings for In-Patient Care

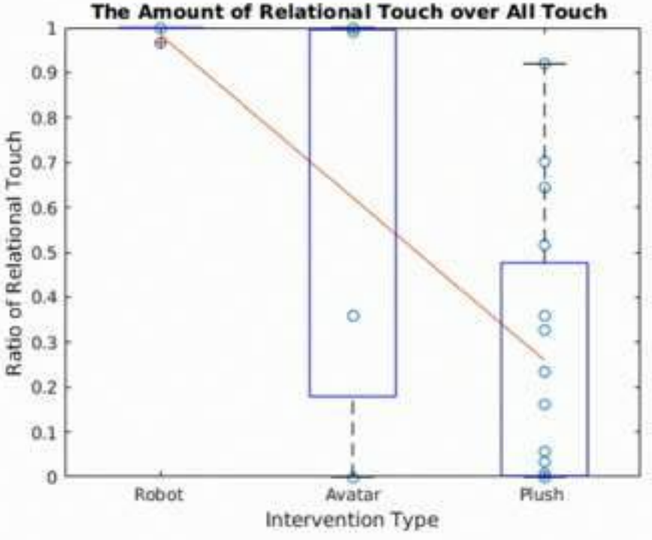
"Emotion is the 4th vital sign"











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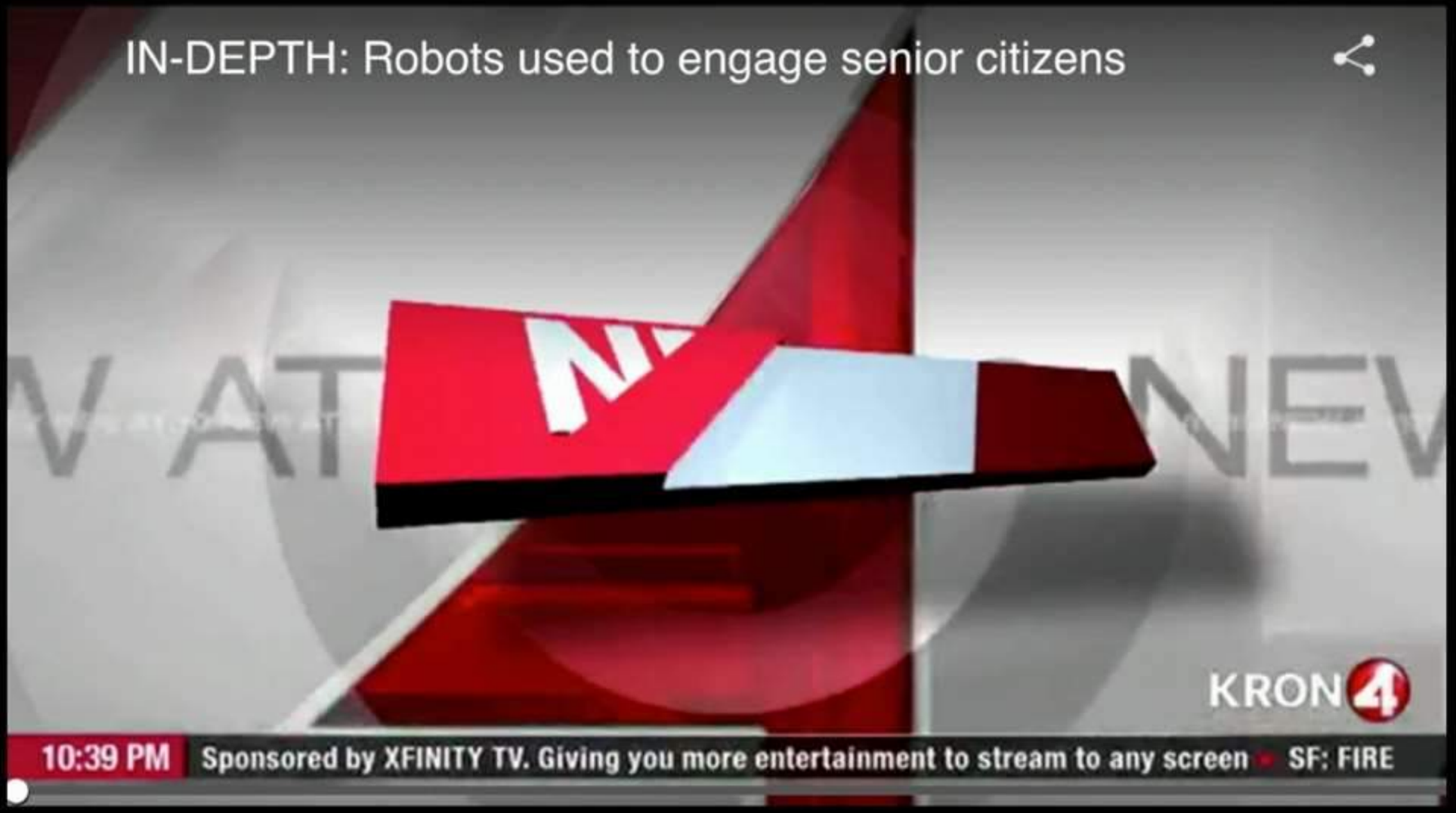
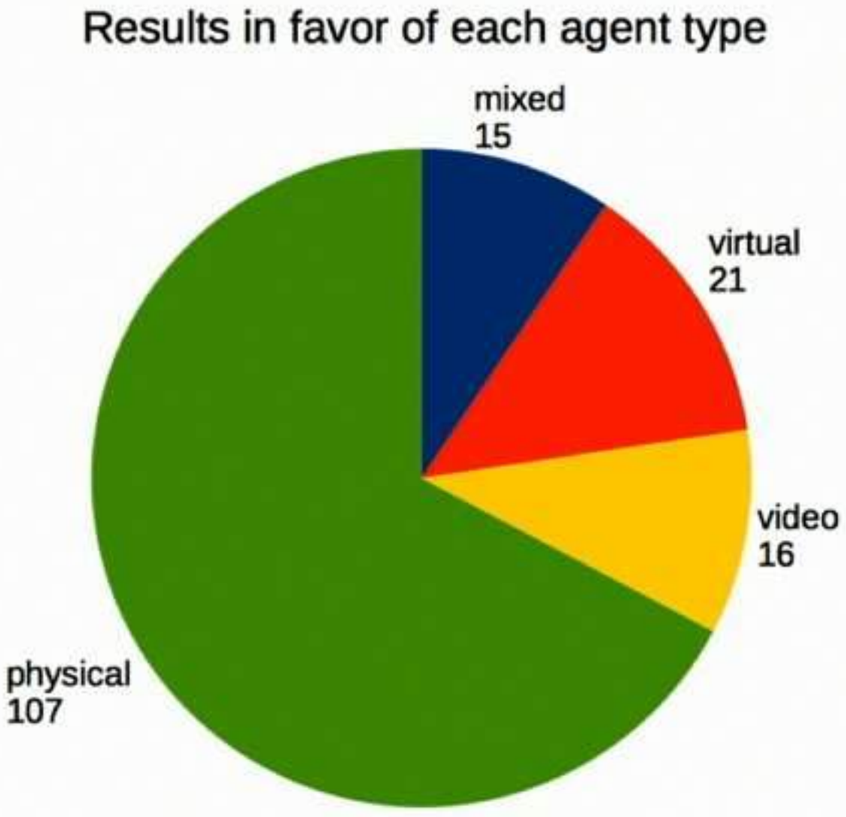
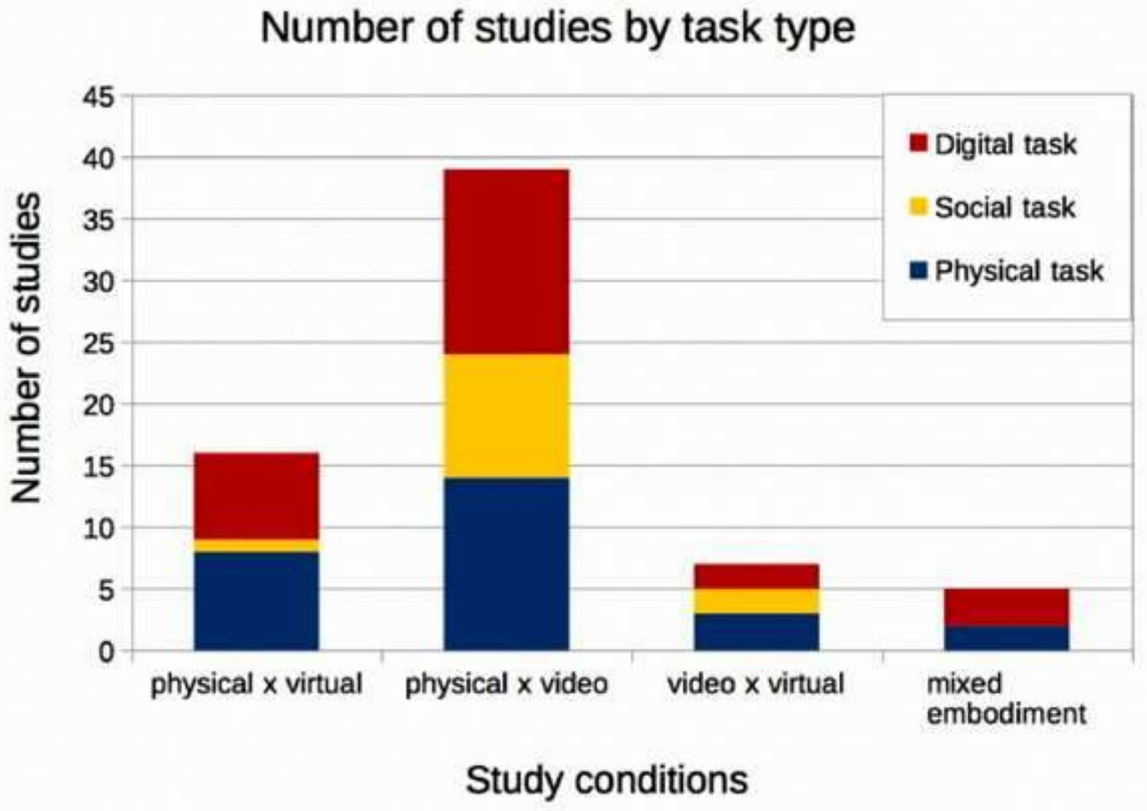

IN-DEPTH: Robots used to engage senior citizens
KRON 4
10:39 PM
Sponsored by XFINITY TV. Giving you more entertainment to stream to any screen
SF: FIRE

2001-2016 Survey of 60+ Unique Comparative Studies Worldwide

Results where statistical significance reported





Li, J. (2015). The benefit of being physically present: A survey of experimental works comparing copresent robots, telepresent robots and virtual agents. *International Journal of Human-Computer Studies*, 77, 23–37.

2001-2016 Survey of 60+ Unique Comparative Studies Worldwide

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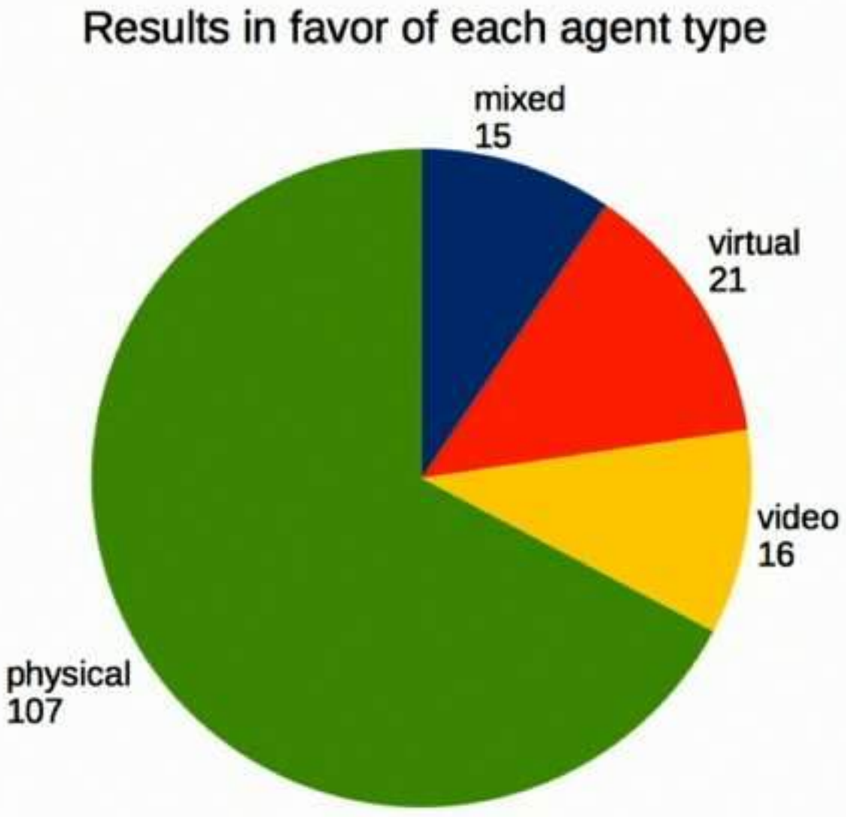
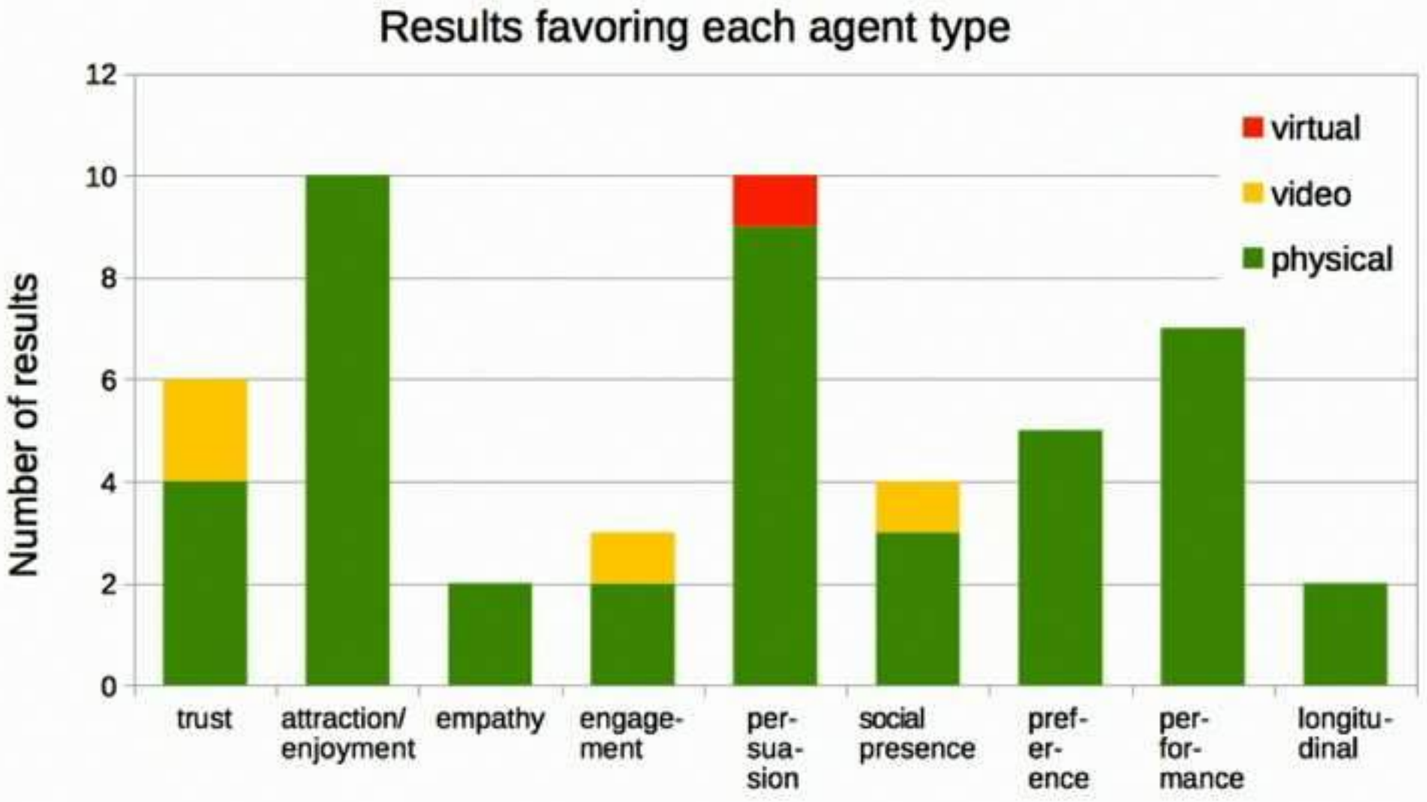




Li, J. (2015). The benefit of being physically present: A survey of experimental works comparing copresent robots, telepresent robots and virtual agents. *International Journal of Human-Computer Studies*, 77, 23–37.

#2

Allied Engagement with Interpersonal UI

beyond interface to building rapport

Robots as Conversational Learning Companions

Social Outcomes

friendliness
comfort
rapport
trust

Educational Outcomes

learning
attentiveness
attitudes
engagement

Encoding the Human Social Code into Machines

Gather data, analyze behavior, gain insights

Design or learn model for new robot skill

Apply and evaluate in interpersonal context

What Role Should a Learning Companion Take & When?

Huili Chen

World Quest Game: Robot and Child take turns finding objects that match the challenge word

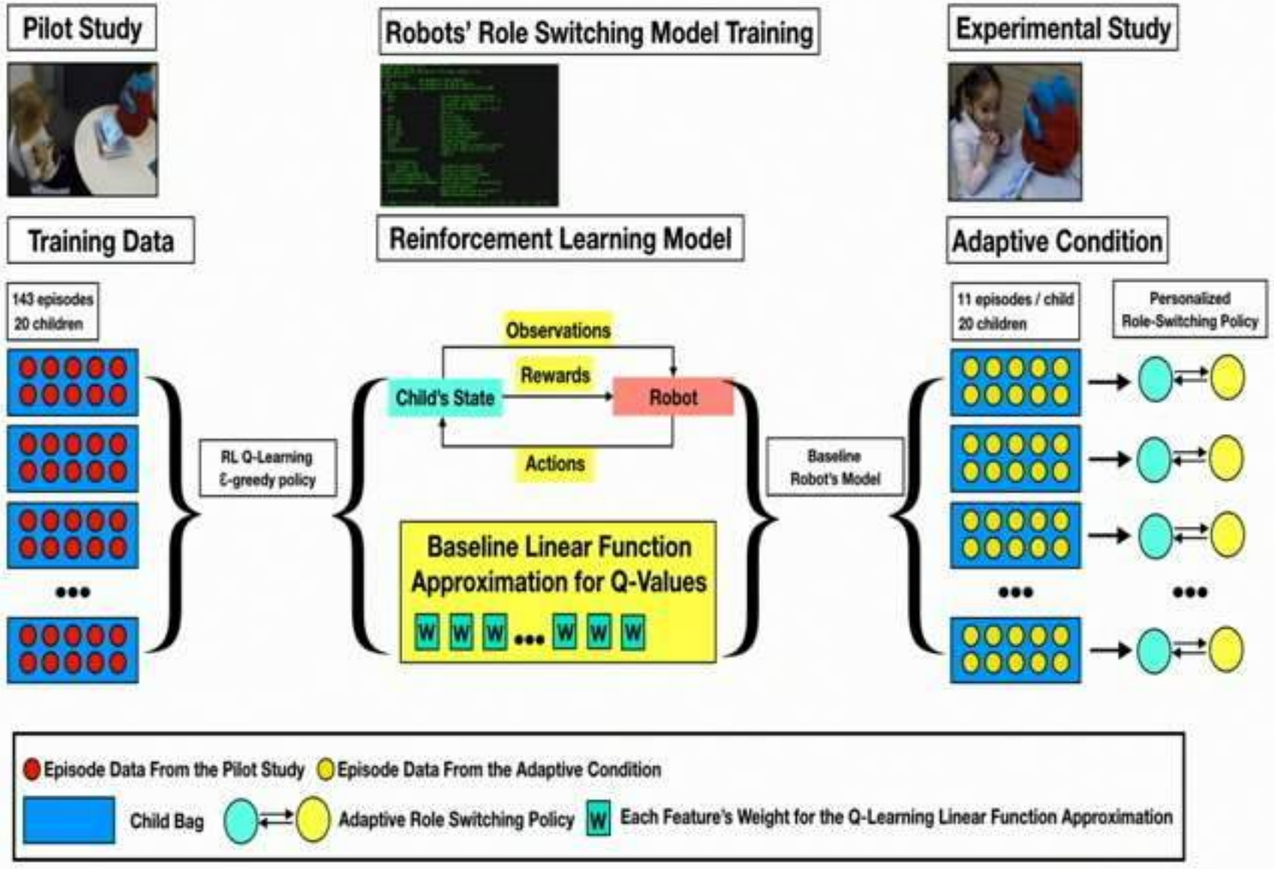
- **Collaborative**
- **Empathetic**
- **Playful**
- **Challenging**
- **Effective**

Learn policy for when to take *Expert* or *Novice* Role to maximize children's vocabulary acquisition

25 Pre-K children in Pilot Study
25-45 minute session
143 episodes in training dataset

Reinforcement Learning

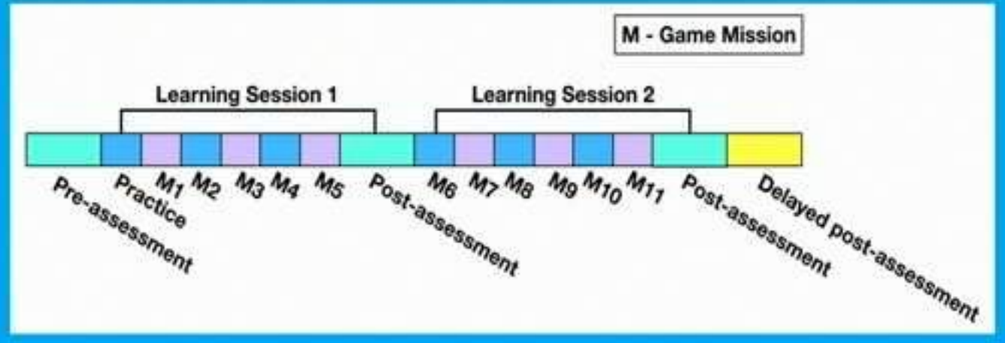
Learn Adaptive Role Switching Model from interacting with children

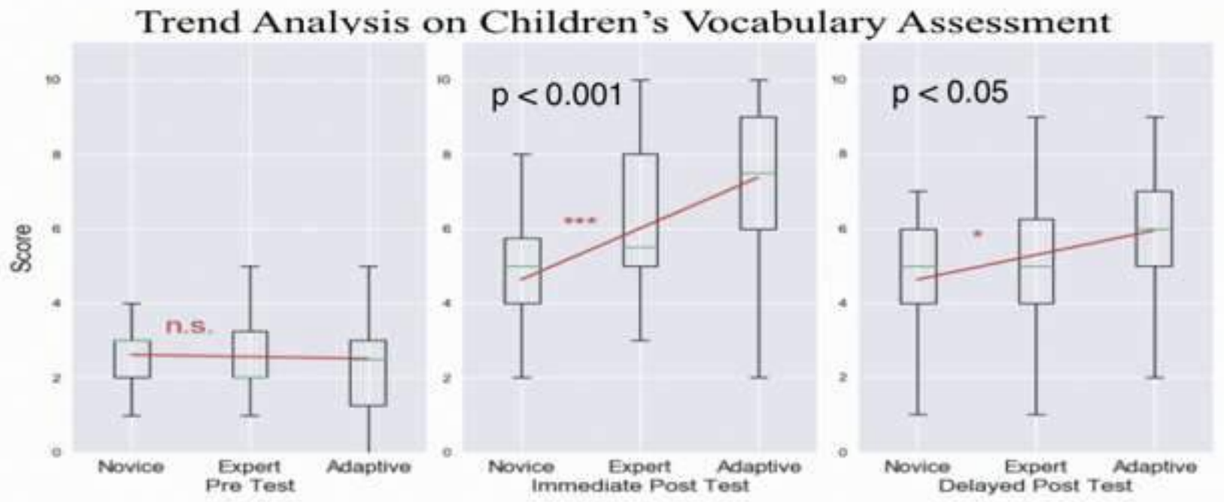


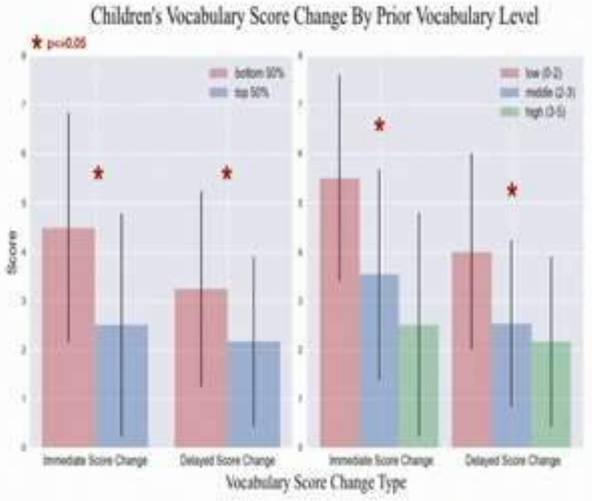
Child Learning Outcomes

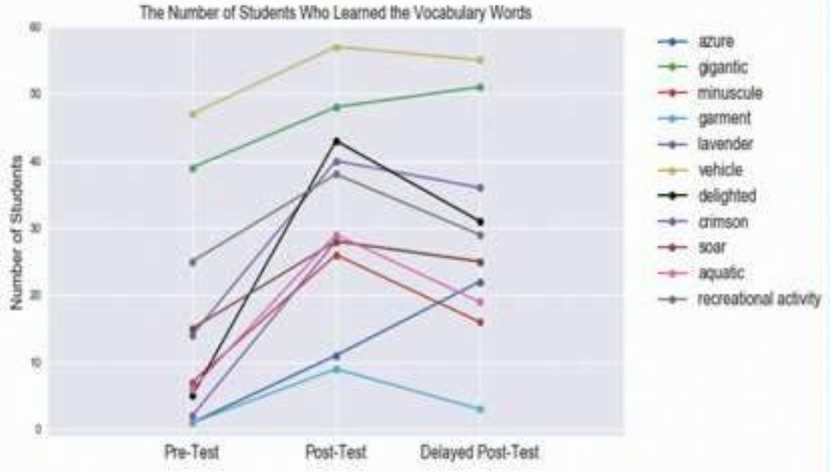
Effectiveness of Adaptive Role Switching Model

Condition	English Proficiency	Sex	Number children	Average Age (SD)
Fixed Expert	Native: 10 ESL: 11	F: 13 M: 8	21	5.85 (0.65)
Fixed Novice	Native: 10 ESL: 9	F: 11 M: 8	19	6.00 (0.74)
Adaptive Role Switching	Native: 11 ESL: 8	F: 9 M: 10	19	5.95 (0.60)









#3
Personalization
Learning you to optimize impact & engagement

PreK-12 US Education

Not Ready to Learn, Can't Catch Up

- 60% children do not attend preschool (US Dept. of Ed, 2015)
- 37% of 12-th graders read at or above *Proficient* (Nat. Assess. of Ed Progress NAEP, 2015)

Bloom's 2 sigma effect

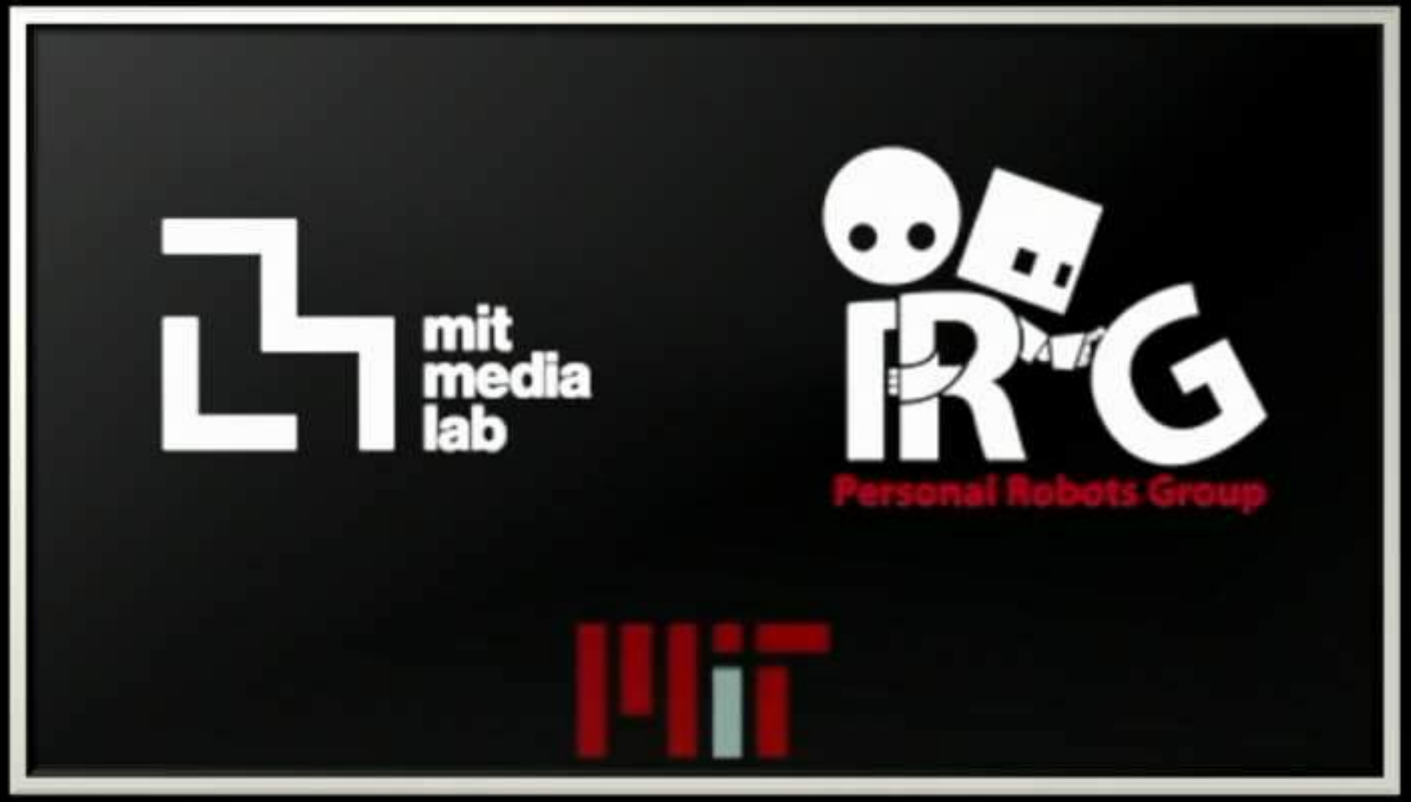
Fostering Oral Language and Storytelling

Personalized learning over 3-month interaction

Hae Won Park, Stephanie Gottwald, et al.

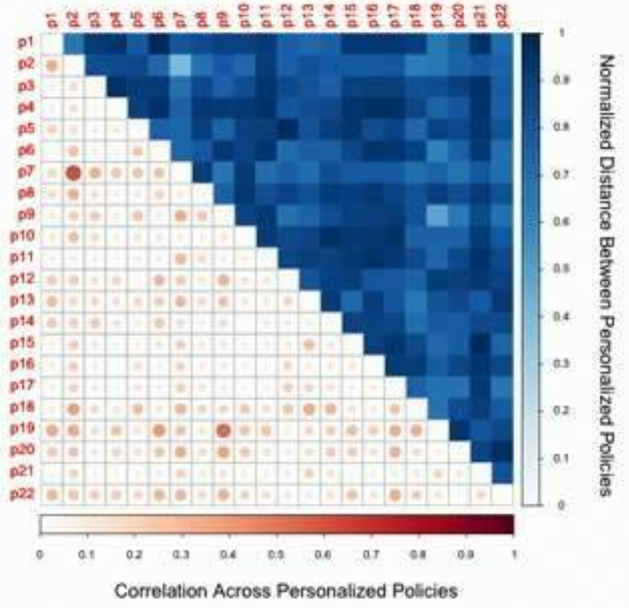
Personalized Storytelling Companion

- 3 months deployment in schools with high ESL population
- 66 Bilingual/ESL children (age: 4-6) in local preschools
- Reinforcement Learning for personalization on each child's engagement, syntactic and lexical abilities

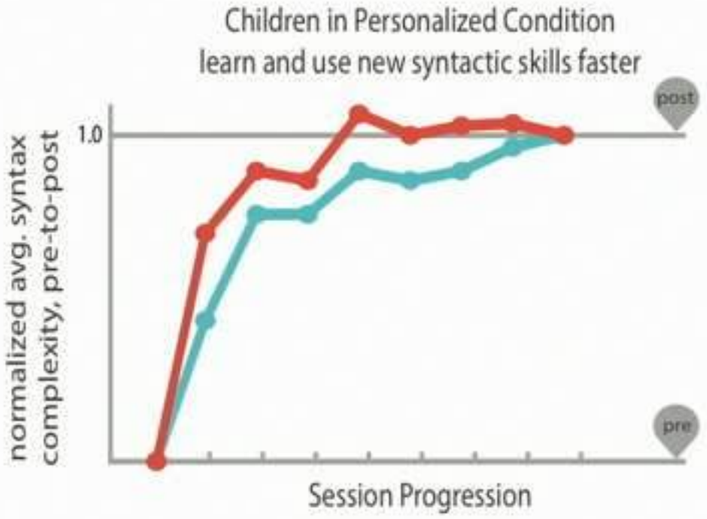


Learning how to Personalize Learning from Interacting with People

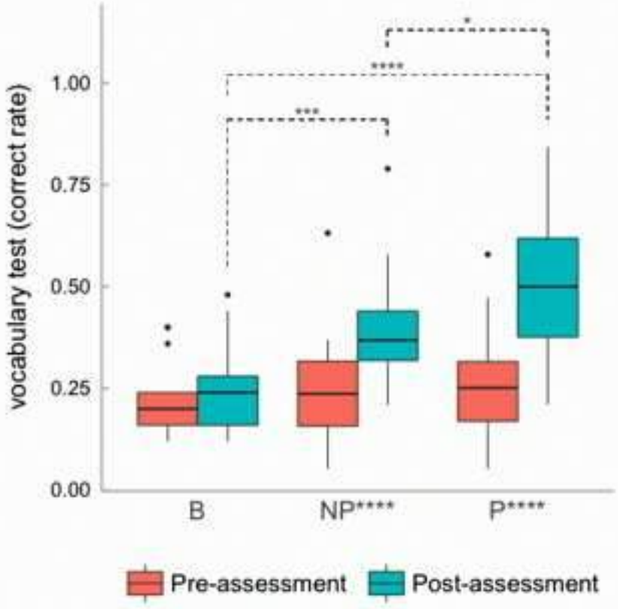
Personalized Policies



Oral Language Gains



Vocabulary Gains



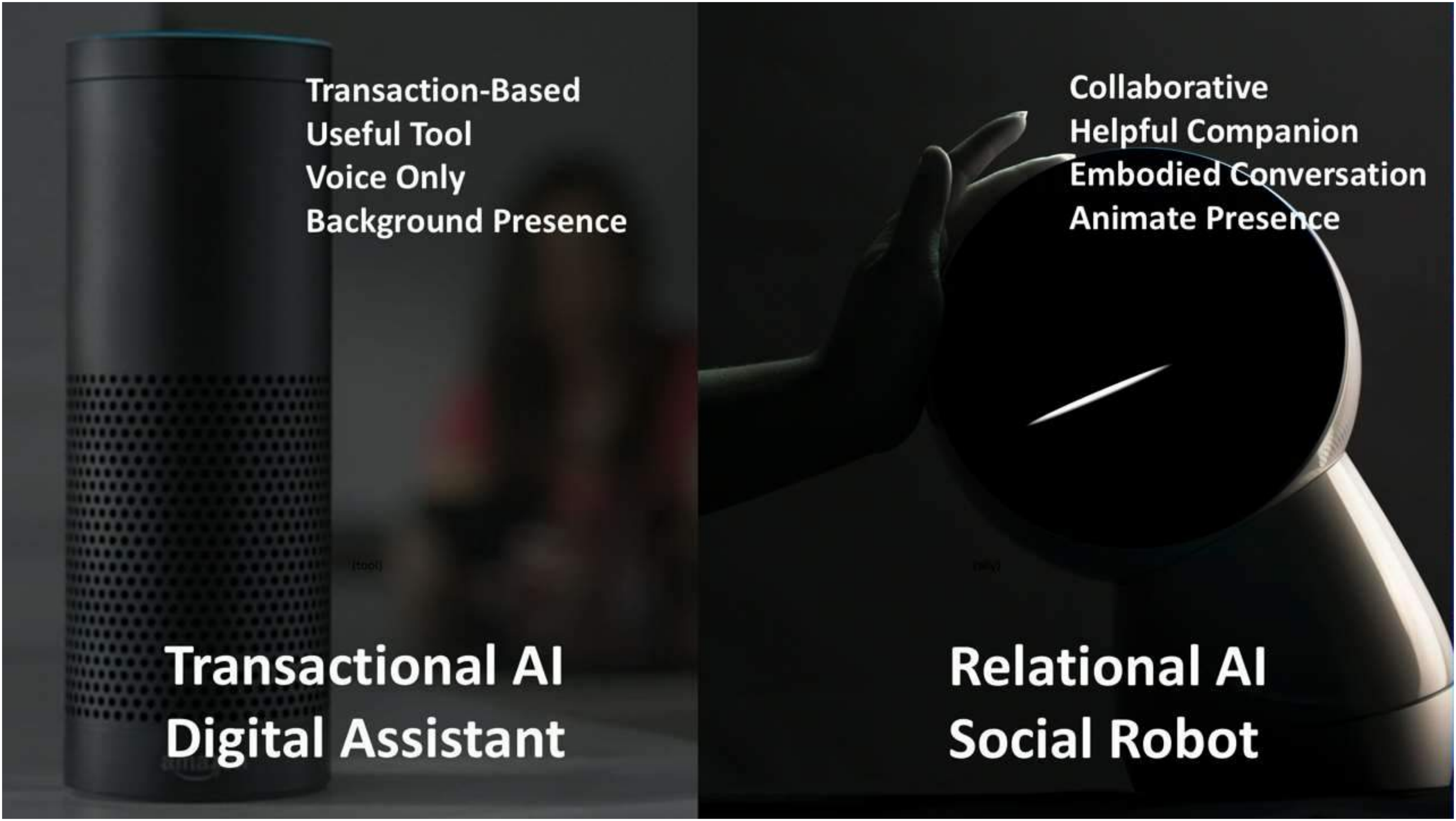
Build personalized models + policies to accelerate early literacy skills

mit media lab

NSF

High Impact for Relational AI

Democratize Personalized Services that Extends Professionals and Continues Support at Home


Transaction-Based
Useful Tool
Voice Only
Background Presence
Collaborative
Helpful Companion
Embodied Conversation
Animate Presence
Transactional AI
Digital Assistant
Relational AI
Social Robot

Living with Social Robots

who?

How do **different generations** live with
different voice-based agents in the **home**?

what?

where?

How should these technologies be
designed to incorporate people's
preferences, desires, and boundaries?

Functional

General Information
Timers
IoT
Etc.

Entertainment

Music
Games
Dance
Etc.

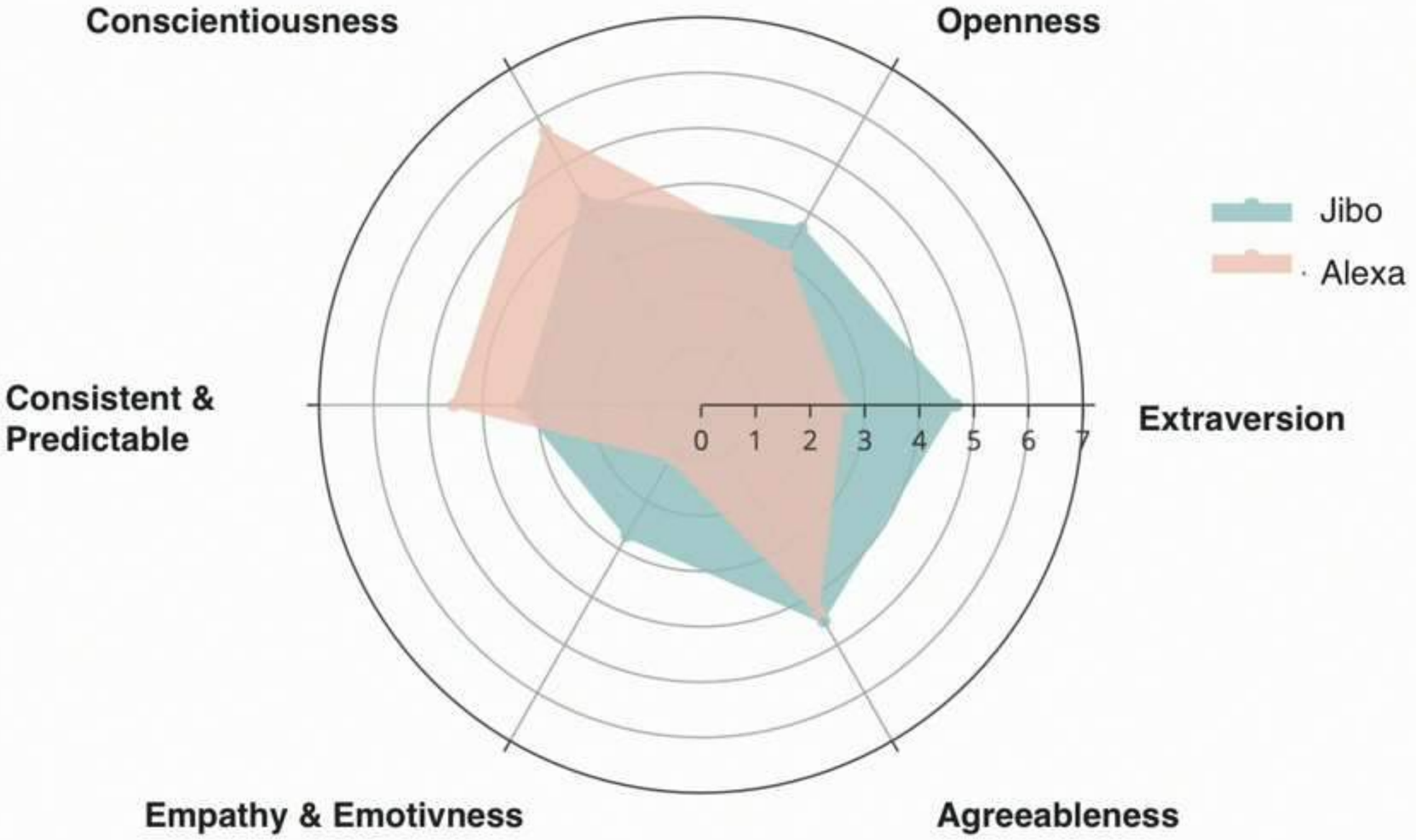
Social Companion

Chit Chat
Jokes
Greetings
Etc.

Digital Assistant
Transactional

Helpful Companion
Relational

Personality Design Differences



Smart Speaker

How do different generations live with AI agents in the home?

Nikhita Singh
Anatasia Ostrowski

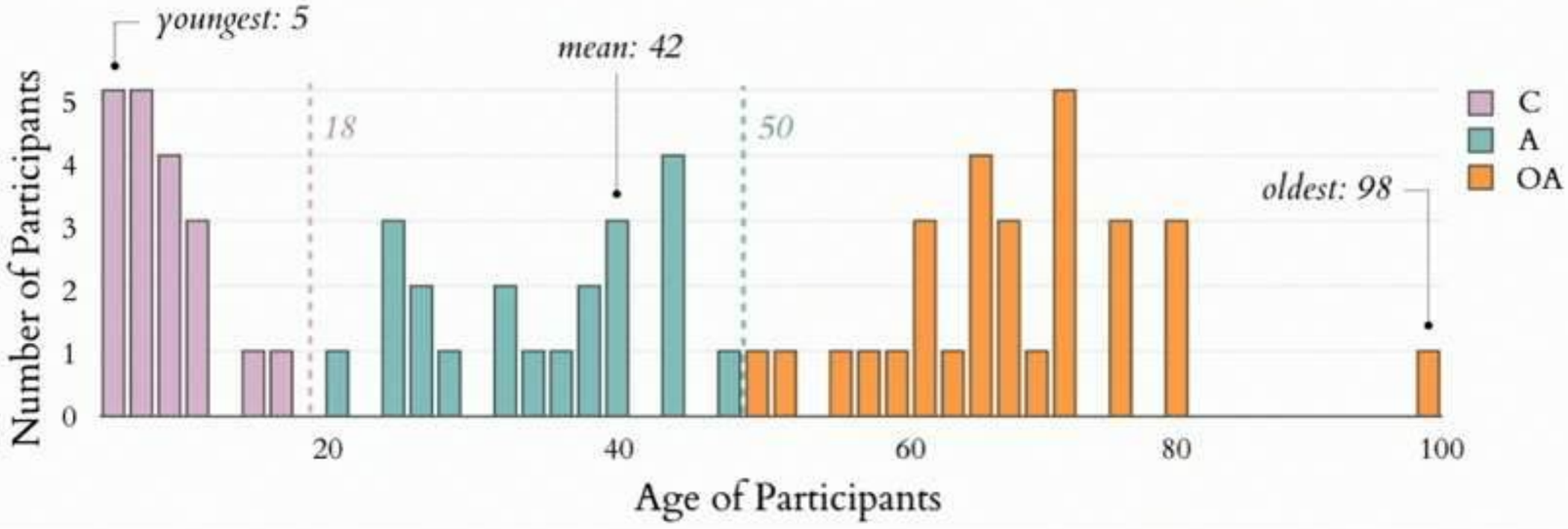
Social Robot

5—17 years

18—49 years

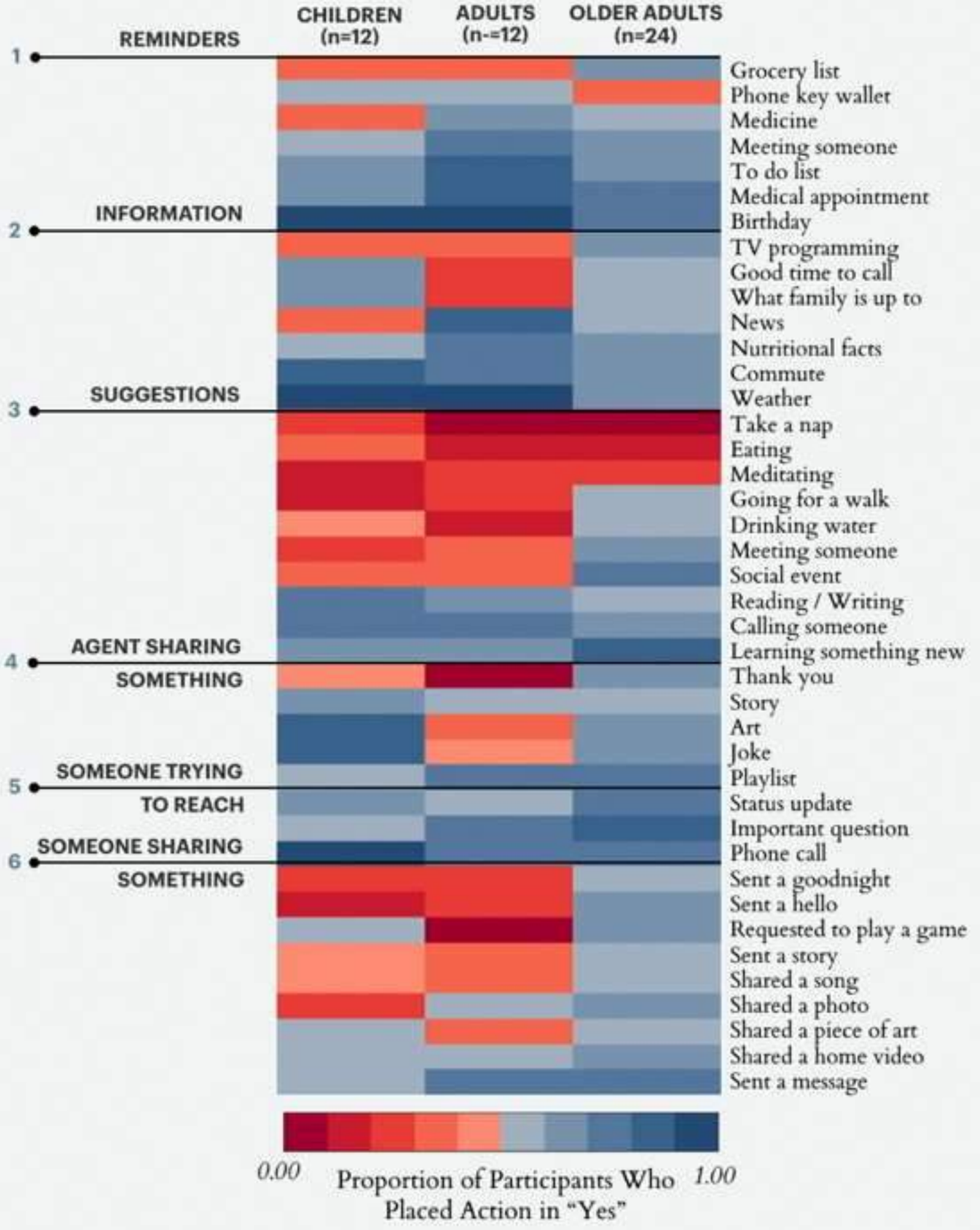
50+ years

We took 69 children, adults, and older adults on a journey with voice-based agents

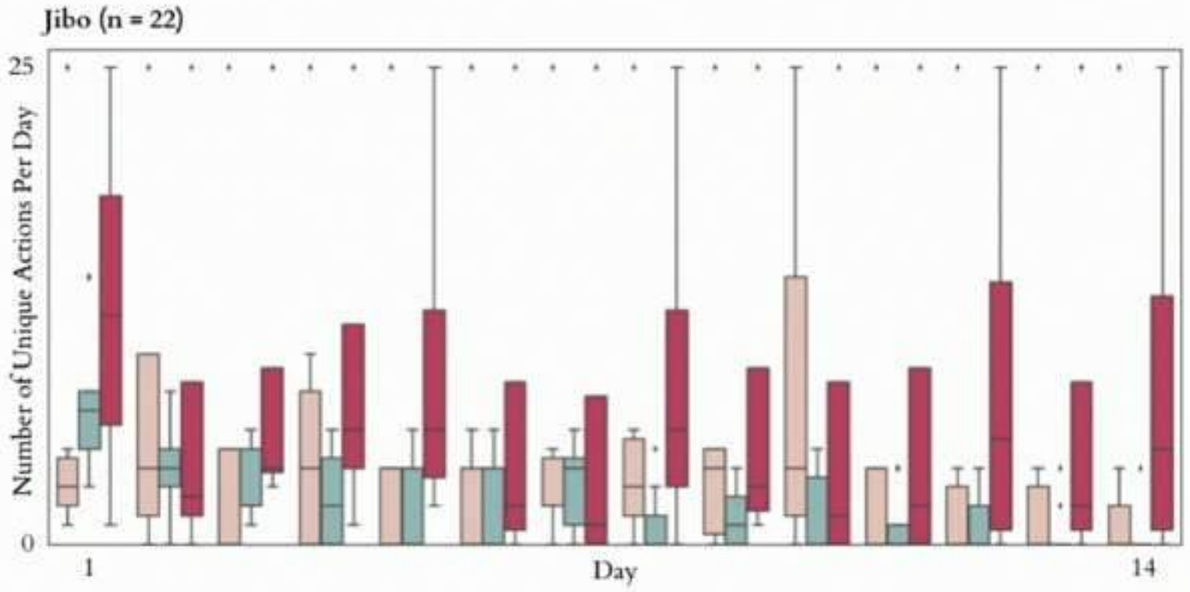


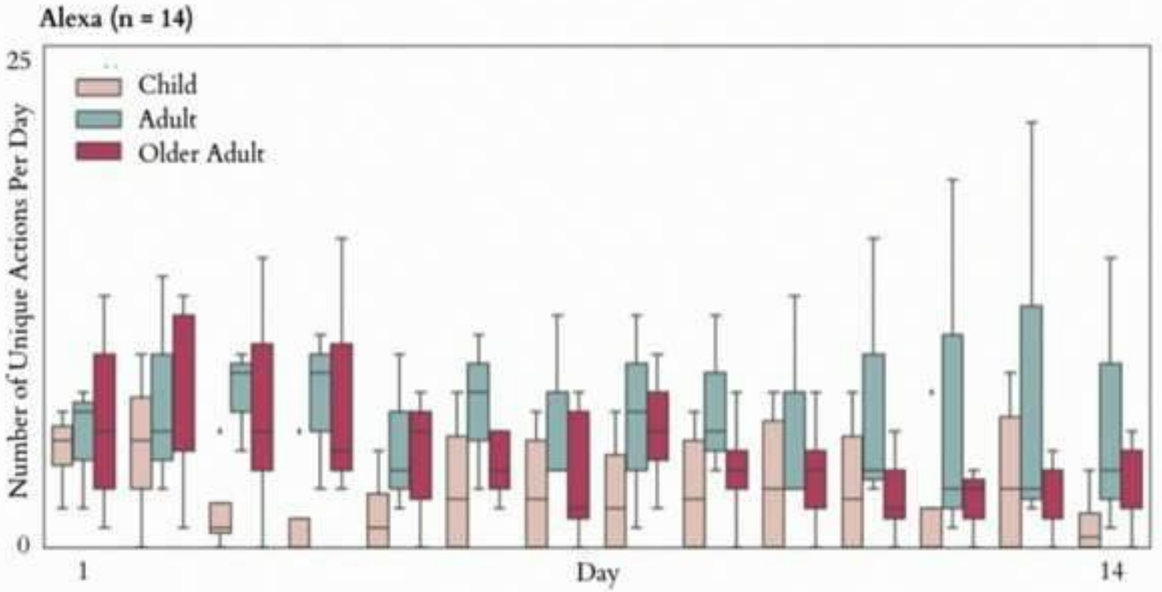
First Impressions & Preferences

differences in preferences are *nuanced*



Long-Term, In-Home Use (1-month)

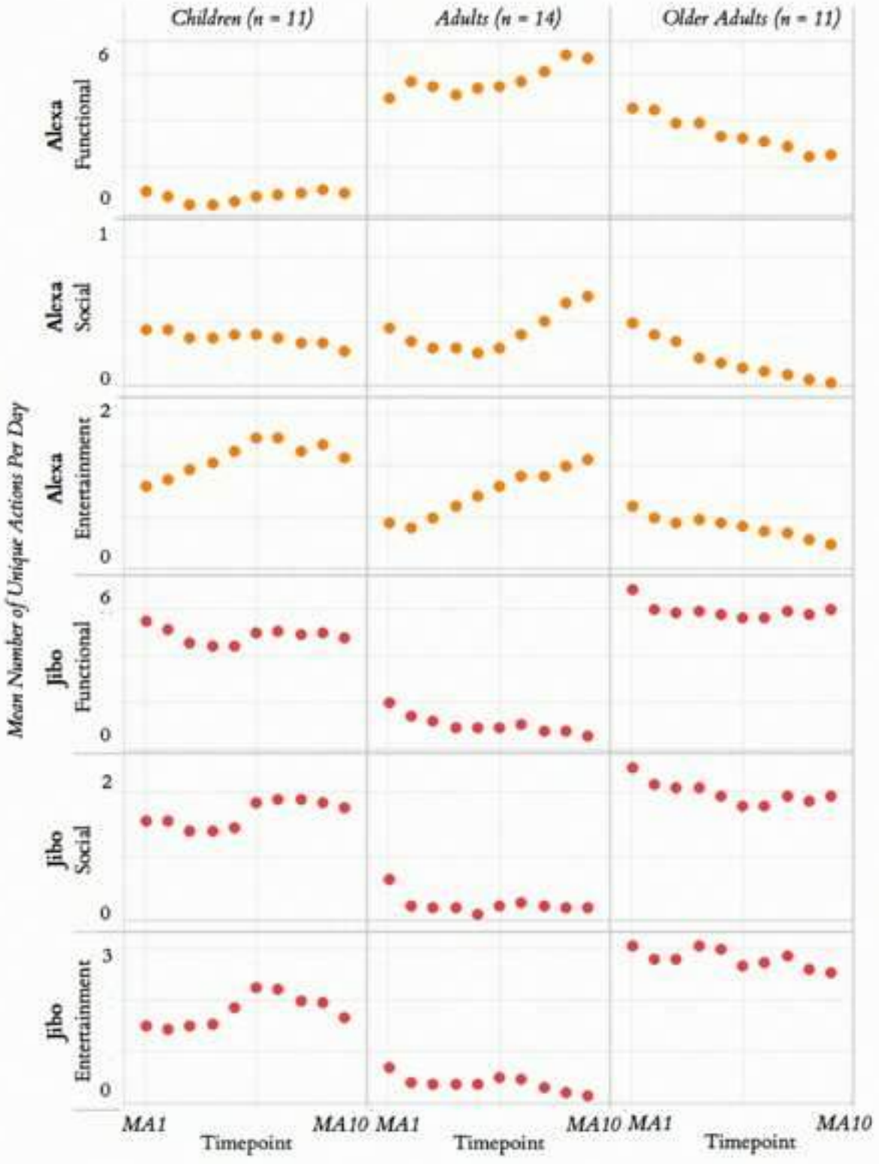




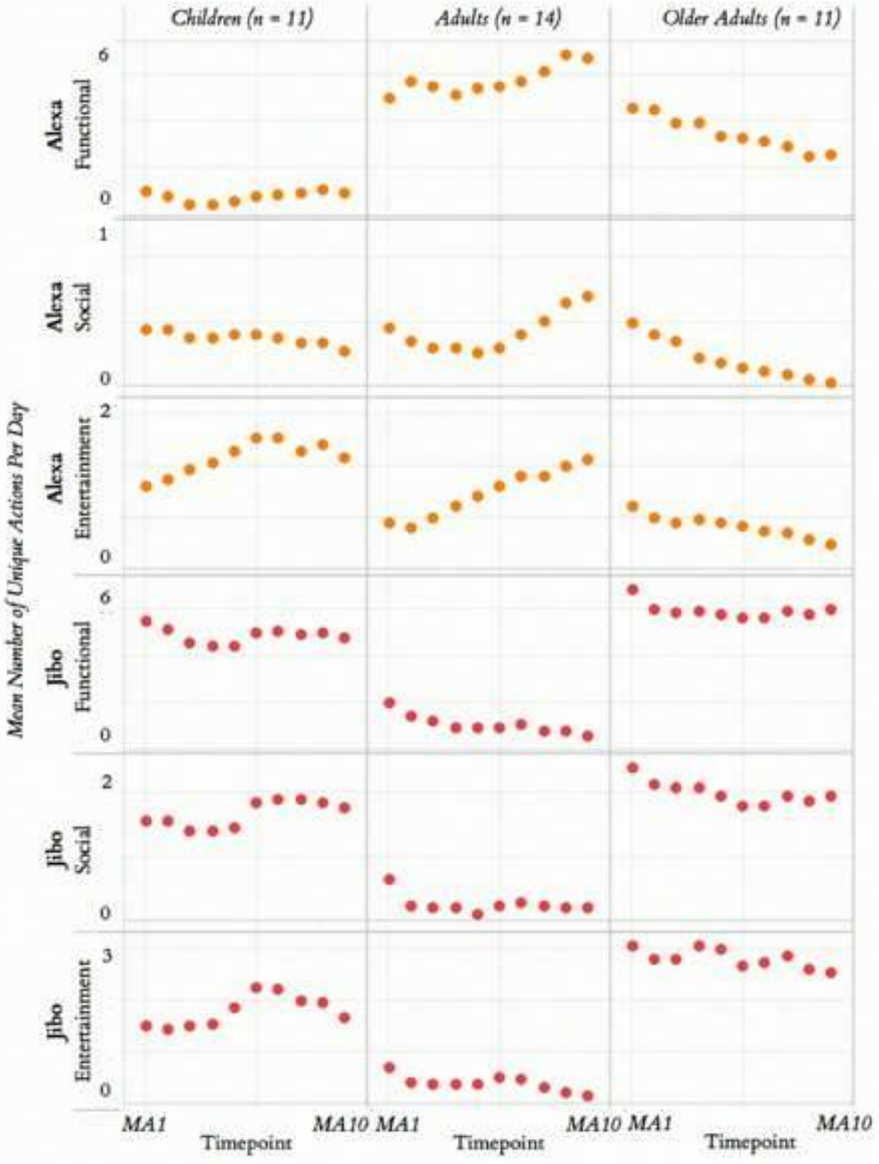
Adults anchor their usage in **functional** attributes. Later adoption of social + entertainment capabilities.

Children anchor their usage with **social** + **entertainment** skills. Gives traction to usage of functional skills.

Older Adults anchor their usage with **social** + **entertainment** skills. Gives traction to usage of functional skills.



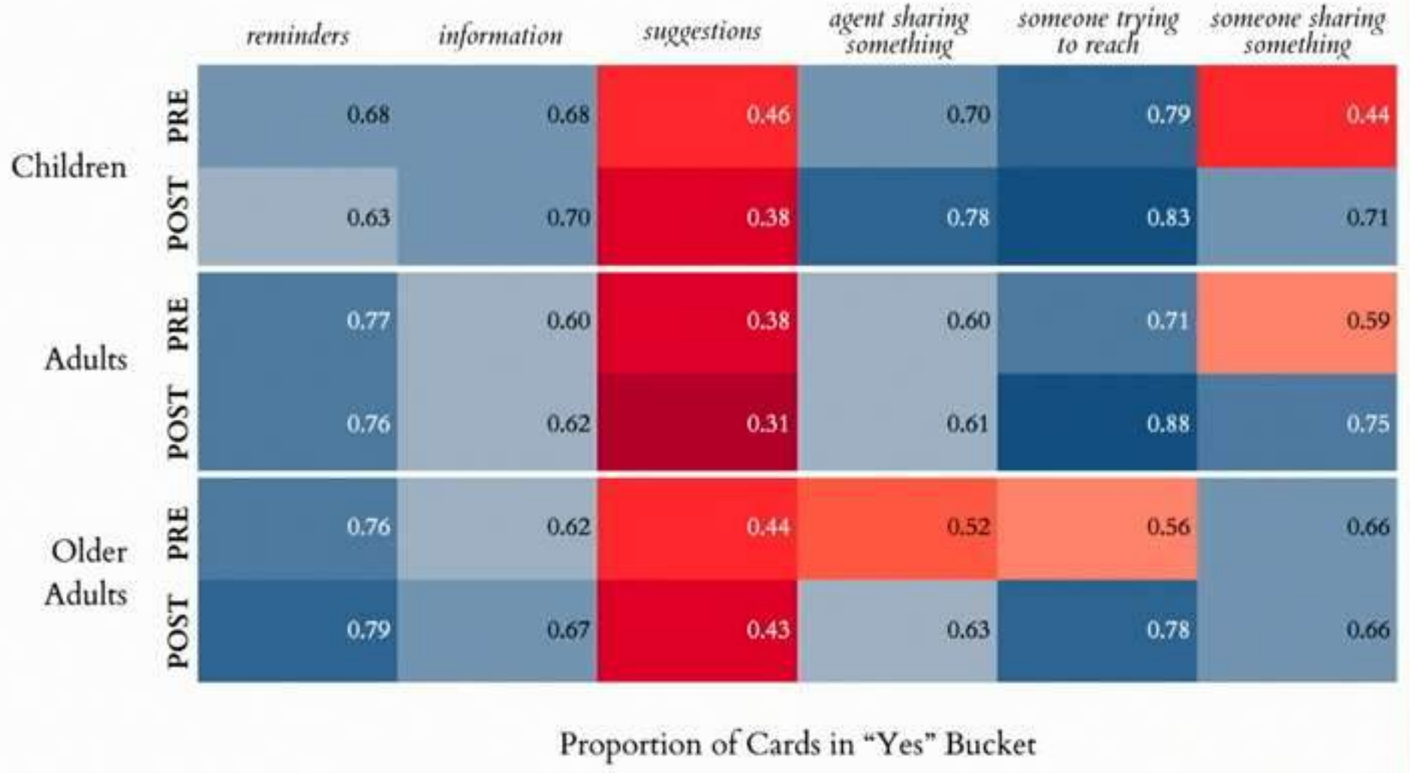
Participant Agent and Action Category	Mean and SD of Number of Unique Actions Per Day By Agent and Generation (for 14 days)		
*n = # participants	Children (n = 12)	Adults (n = 17)	Older Adults (n = 12)
***Alexa* (n = 14)**			
Functional	n = 4 μ = 0.80 σ = 1.38	n = 3 μ = 5.17 σ = 3.55	n = 7 μ = 3.49 σ = 2.68
Social	n = 4 μ = 0.57 σ = 0.73	n = 3 μ = 0.79 σ = 1.07	n = 7 μ = 0.45 σ = 1.01
Entertainment	n = 4 μ = 1.57 σ = 1.81	n = 3 μ = 1.17 σ = 1.08	n = 7 μ = 0.86 σ = 0.94
***Jibo* (n = 22)**			
Functional	n = 7 μ = 3.24 σ = 5.10	n = 11 μ = 1.34 σ = 1.76	n = 4 μ = 4.76 σ = 6.19
Social	n = 7 μ = 1.08 σ = 1.78	n = 11 μ = 0.35 σ = 0.72	n = 4 μ = 1.59 σ = 2.11
Entertainment	n = 7 μ = 1.24 σ = 1.82	n = 11 μ = 0.49 σ = 0.85	n = 4 μ = 2.13 σ = 1.99



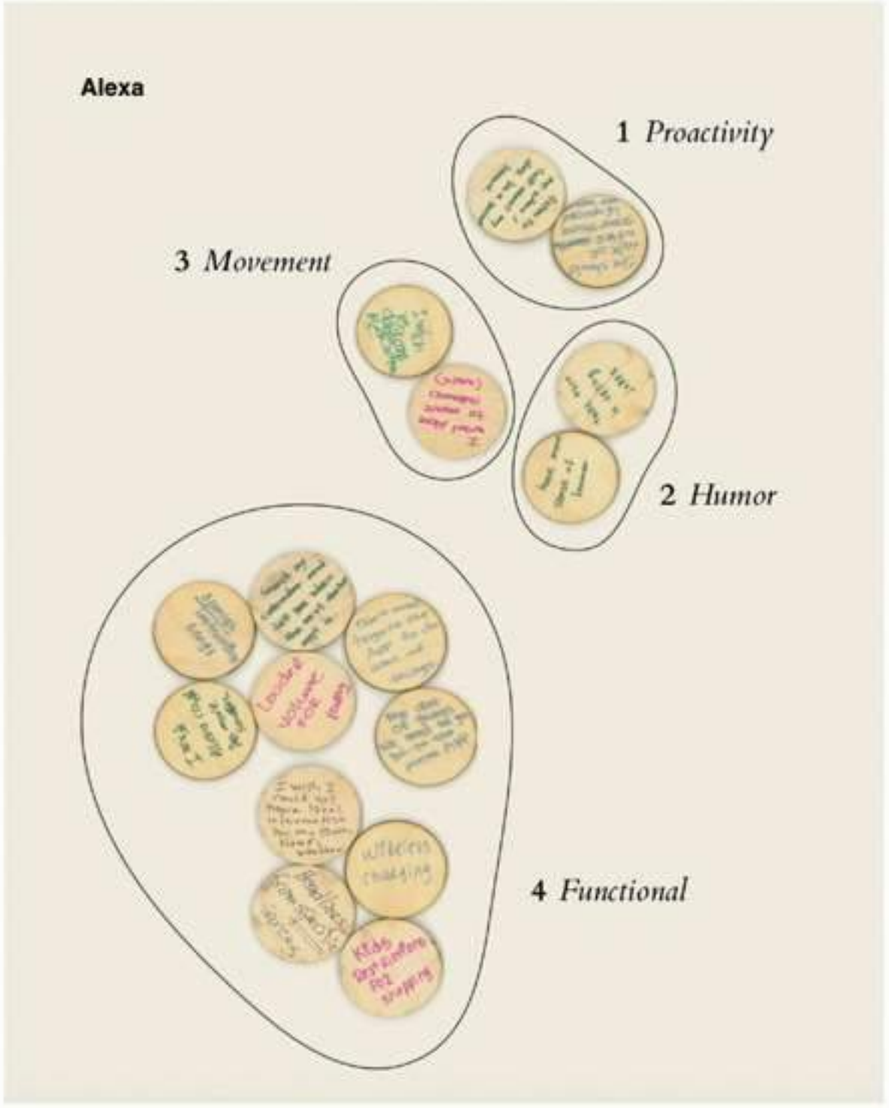
How preferences change over time

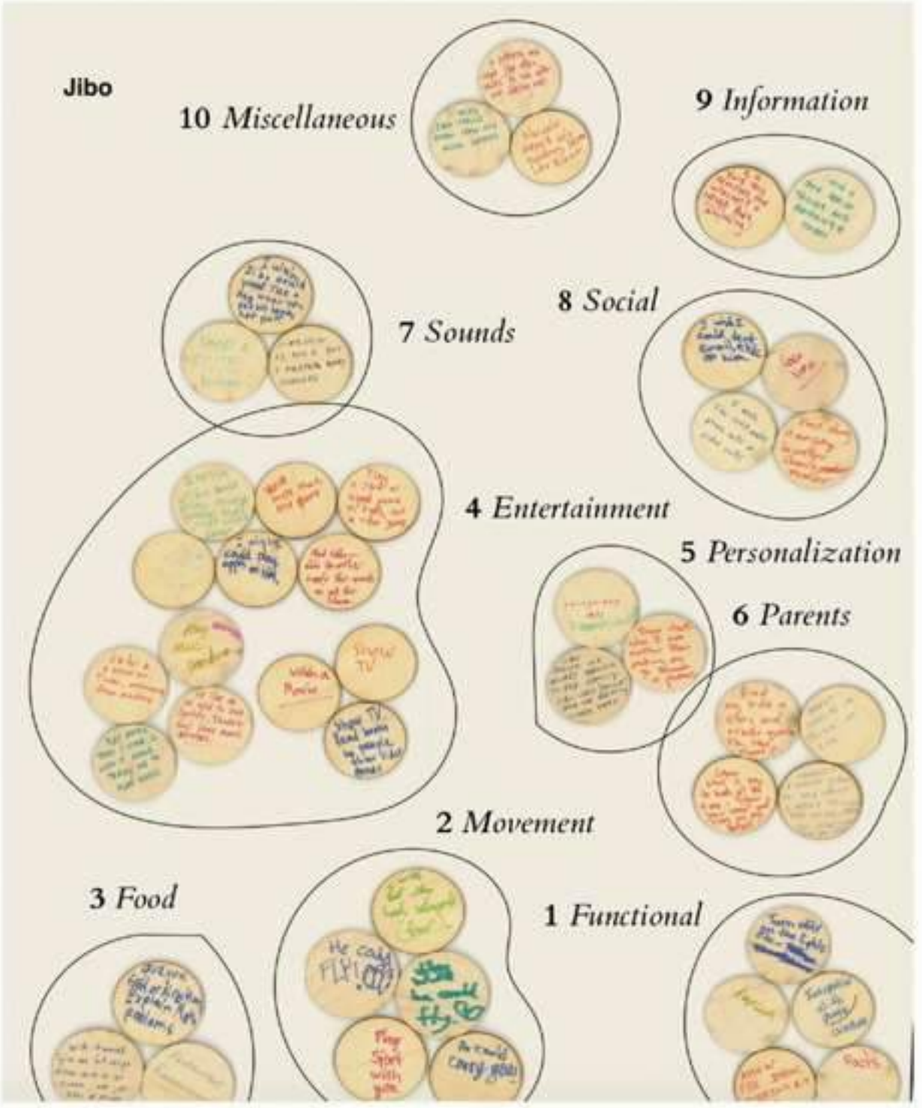
- Preferences of various agent actions were evaluated before & after 1-month study.

- Largest increases occurred in **socially-driven** categories:
  - agent sharing something (e.g. music, art, joke)
  - someone reaching user through the agent (e.g. phone call)
  - someone sharing something through the agent (e.g. photos, video)



Wish Jar: Capturing Aspirations





Democratizing Who
CREATES with AI

Understanding AI by making and coding

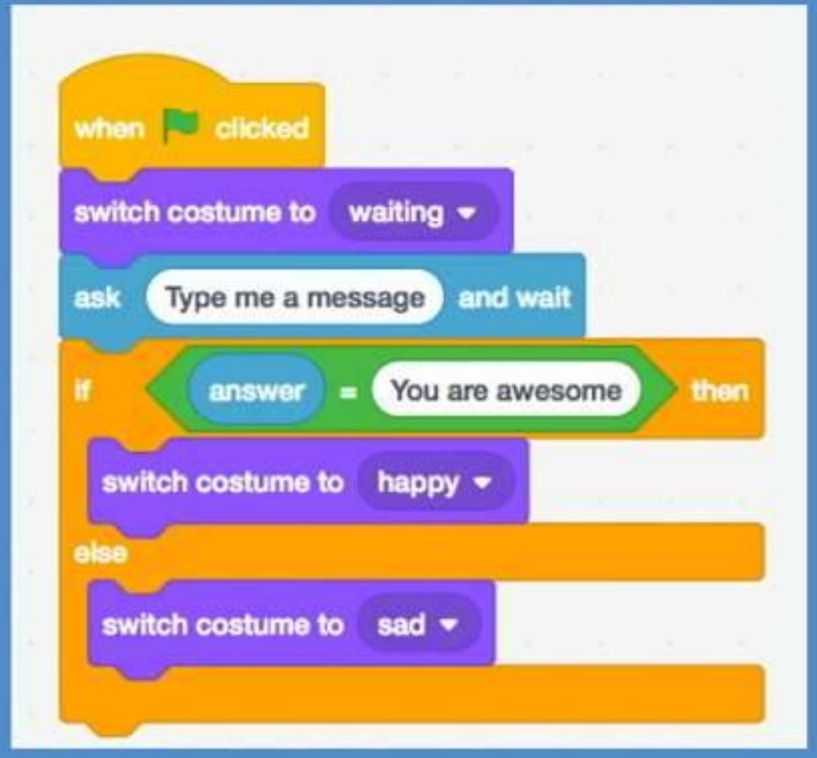
Stefania Druga

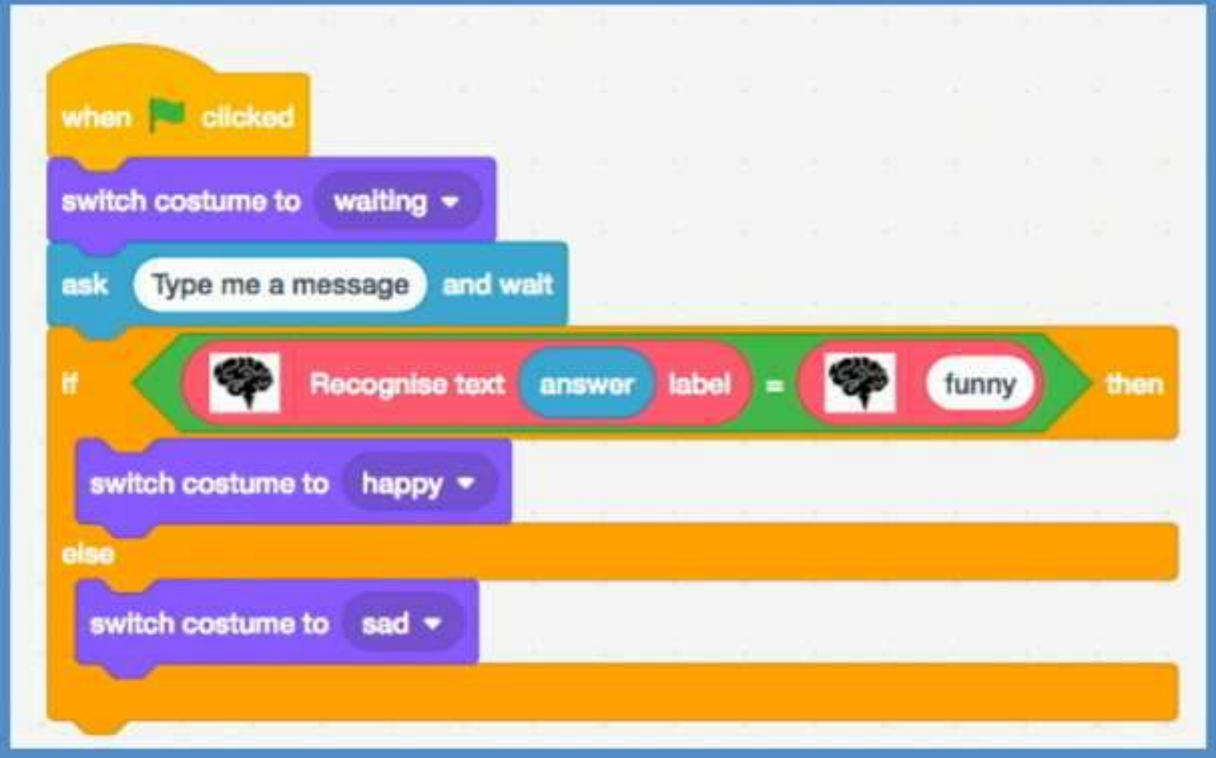
AI + IoT Extension buillt on Scratch Programming Environment

Train AI models and program to create custom AI-enabled experiences and projects

Cognimates

Kids create and train their own models





Recognising **text** as **kind_things, mean_things or backhanded_compliments**

< Back to project

+ Add new label

kind_things

- you are beautiful
- you smell like roses
- you look nice
- you're such an nice person
- it's so kind that you are sharing
- I'm happy to see you
- thank you for calling
- it makes me happy when you share your thoughts…
- it's really cool that you can paint
- I love you

+ Add example

mean_things

- you smell bad
- I hate you
- it's so unkind that you are not sharing
- it makes me sad to see you
- you're not cool
- you suck at rock paper scissors
- you look awful
- i don't like you
- you're not my friend
- you have no talent

+ Add example

backhanded_compliments

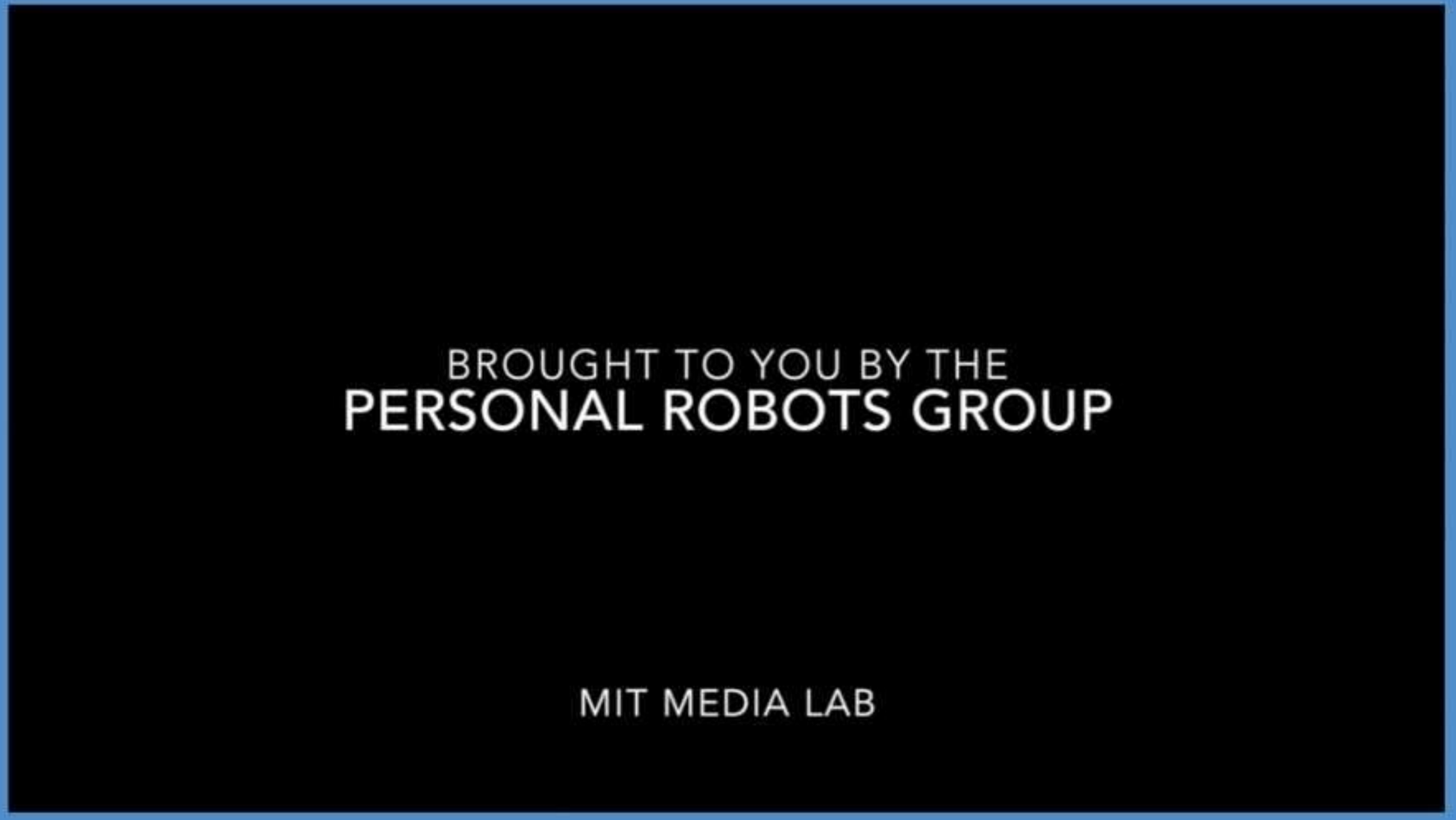
- i didn't recognize you you look beautiful
- you clean up real nice
- wow you're actually smart
- you get better at your job every day
- I love that outfit you're so brave
- you're really photogenic
- is that your hair
- how do you have the energy to talk so much
- you're kind of pretty
- you look so skinny
- you shoes look so comfortable

+ Add example

Understanding + Creating AI Experiences
Making, Coding & Training

- **Cognimates.me**
- Scratch AI + IoT Extension blocks
- Project Ideas + Tutorials
- Teaching Materials

Understanding + Creating AI Experiences
Making, Coding & Training



- **Cognimates.me**
- Scratch AI + IoT Extension blocks
- Project Ideas + Tutorials
- Teaching Materials

A Vision of Humanistic AI

NSF Support

Award 1138986. Expeditions in Computing. **Collaborative Research: Socially Assistive Robots**

Award 1523118. Cyberlearning. **Storyteller Companion to Promote Preschooler Language Skills**

Award 1122886. Cyberlearning. **DIP: Collaborative Research: Social Robots as Mechanisms for Language Instruction, Interaction, and Evaluation in Pre-School Children**

Award 6932321. NICHD**: An autonomous curious social robot with a mindset for long-term interaction**