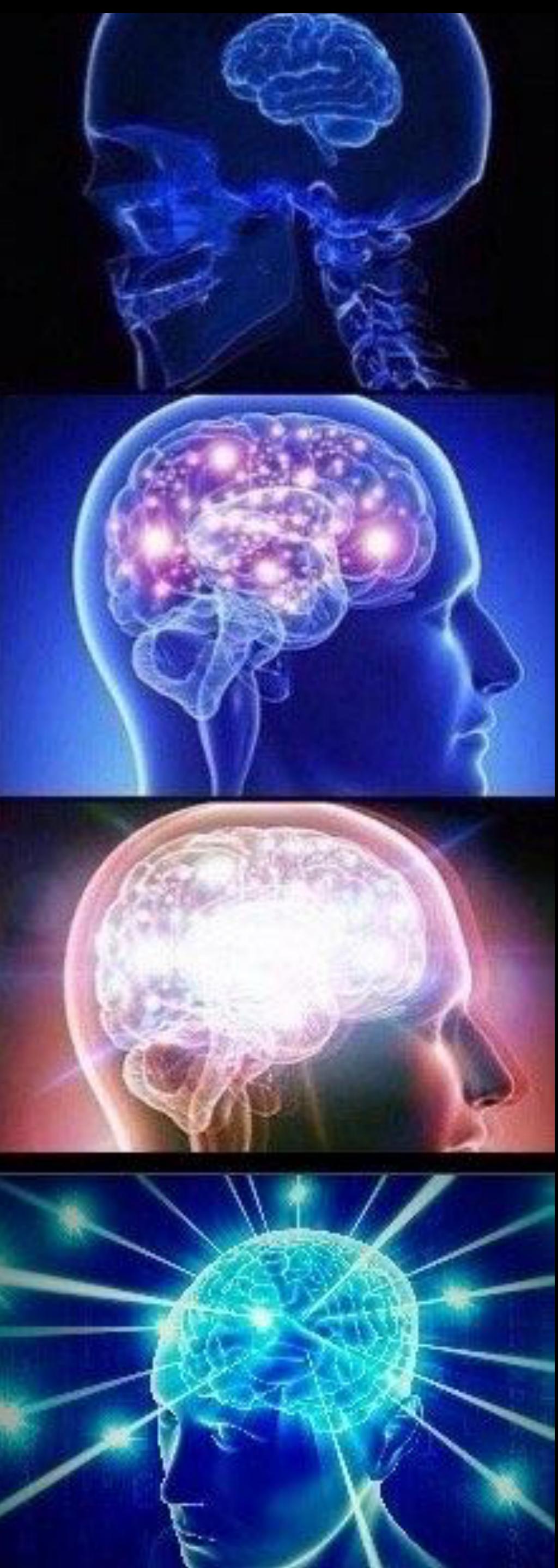


# Cognitive Accessibility



# Coming up

- 1. Today:**  
Cognitive accessibility
- 2. Wednesday:**  
Deaf and hard of hearing  
& FCQ time
- 3. Next Monday:**  
Mini-lecture on collaboration,  
project demo testing
- 4. Next Wednesday:**  
Game demos & the end!

# Cognitive accessibility

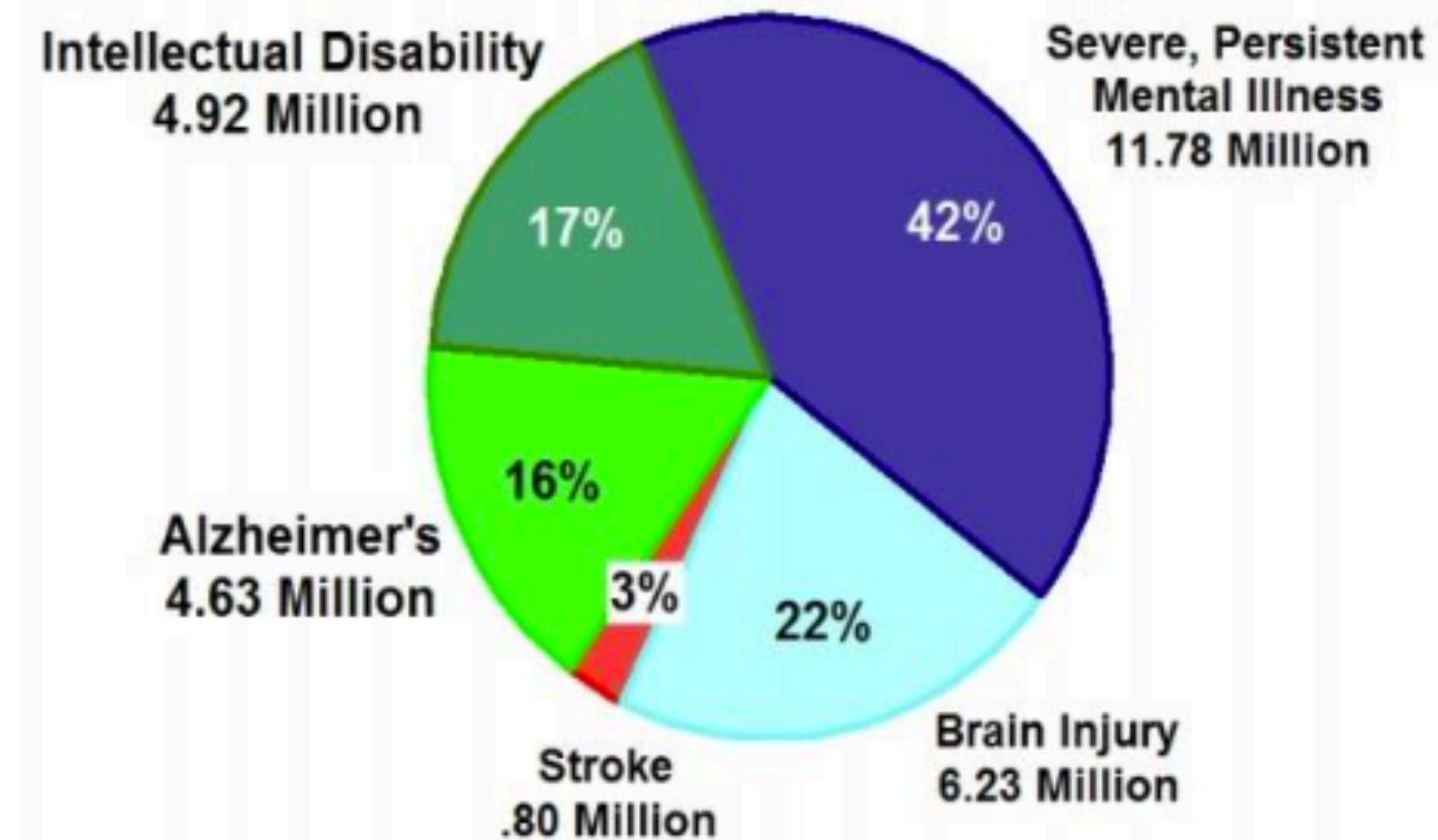
- Types of cognitive disabilities
- Functional aspects
- How technology can help

# Two perspectives

1. Supporting people with diagnosed disabilities
2. Universal design to support **everyone**

# Cognitive disability statistics

PREVALENCE OF COGNITIVE DISABILITY IN THE U.S., 2012



Total: 28.36 Million Persons

Figure 2. Prevalence of Cognitive Disability in the U.S., 2012

# User Groups ([from W3C](#))

- Dyslexia
- Aphasia
- Non-verbal speech & language impairments
- Aging and dementia
- Down Syndrome
- ADHD
- Autism
- Dyscalcula

# What about older adults?

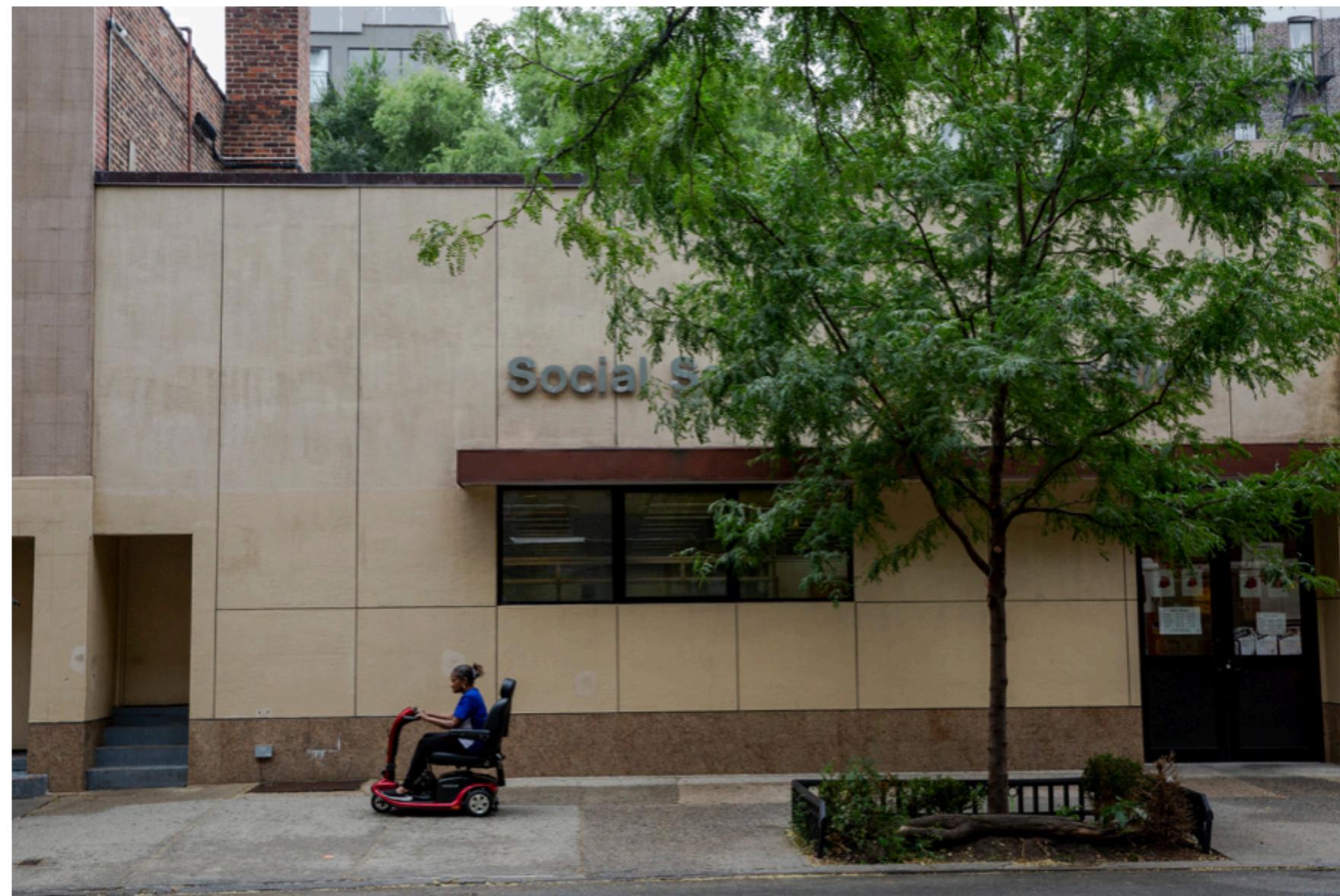
- Does old age count as a disability?
- Not everyone agrees
- Important to consider functional abilities
- Also:
  - Tech resources, context of learning
  - Environmental supports: staff, transportation, etc.

# What counts as a “real” disability?

- Some may not have a diagnosed disability due to lack of resources, fear of stigma, other personal reasons
- Some may have hidden disability, or abilities that are affected by the environment
- There may be personal opinions, formal policies (e.g. academic accommodations)
- Often we can improve usability for all

# Invisible disabilities can create vulnerability

## *On Disability and on Facebook? Uncle Sam Wants to Watch What You Post*



In its budget request to Congress last year, Social Security said it would study whether to expand the use of social media networks in disability determinations, partly to help identify fraud. Mark Abramson for The New York Times

WASHINGTON — If you're on federal disability payments and on social media, be careful what you post. Uncle Sam wants to watch.

The Trump administration has been quietly working on a proposal to use social media like Facebook and Twitter to help identify people who claim Social Security disability benefits without actually being disabled. If, for example, a person claimed benefits because of a back injury but was shown playing golf in a photograph posted on Facebook, that could be used as evidence that the injury was not disabling.

“There is a little bitty chance that Social Security may be snooping on your Facebook or your Twitter account,” Robert A. Crowe, a lawyer from St. Louis who has represented Social Security disability claimants for more than 40 years, said he cautioned new clients. “You don’t want anything on there that shows you out playing Frisbee.”

By Robert Pear

March 10, 2019



# Some issues

- Managing activities of daily living (ADLs)
  - May benefit from timers, schedules, plans
- Access to education and work
- Independence in school, work, social interactions
- Self-advocacy to discuss issues of import
- Social media

# Tech Access as a right

- CU's own Coleman Institute for Cognitive Disabilities introduced a **Declaration on The Rights of People with Cognitive Disabilities to Technology and Information Access**

“Ensuring access to technology and information for the 28 million people with cognitive disabilities in the United States will create new markets and employment opportunities; decrease dependency on public services; reduce healthcare costs; and improve the independence, productivity, and quality of life of people with cognitive disabilities.”

# Taking a functional approach

- What are challenges experienced by these targeted groups?
- What can we do to address these particular issues?
- Addressing these issues can help **everyone**
  - Undiagnosed and “unofficial” disabilities – e.g. older adults
  - Situational impairments – e.g., distracted, on the go
  - Non-native language speakers
  - And everyone else

# Functional challenges

<b>Memory</b>	Working Memory, Short-Term Memory, Long-Term Memory, Visual Memory, Visuo-spatial Memory, Auditory Memory
<b>Executive Functions</b>	Emotional Control and Self-Monitoring, Planning/Organization and Execution, Judgment
<b>Reasoning</b>	Fluid Reasoning (logical reasoning), Mathematical Intelligence, Seriation, Crystallized Intelligence, Abstraction
<b>Attention</b>	Selective Attention, Sustained Attention
<b>Language</b>	Speech Perception, Auditory Discrimination, Naming Skills, Morphosyntax

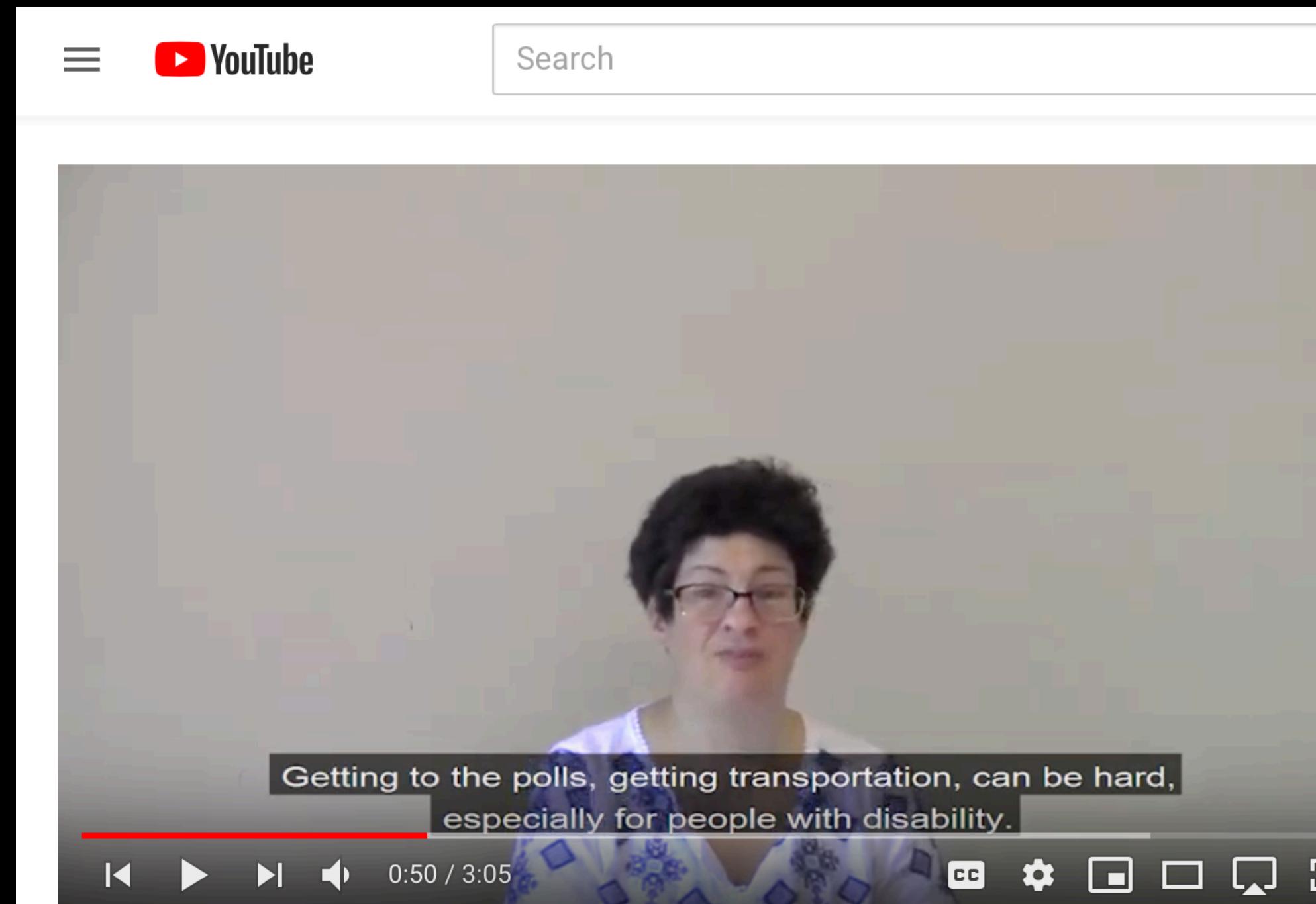
# More functional challenges

<b>Understanding Figurative Language</b>	Including similes, personification, oxymorons, idioms, and puns
<b>Literacy</b>	Speech Perception, Visual Perception, Phoneme Processing, and Cross-Modal Association (association of signs and concepts)
<b>Perception</b>	Motor Perception, Psychomotor Perception
<b>Knowledge</b>	Cultural Knowledge, Jargon, Technology Terms, Metaphors and Idioms, Knowledge of Symbols, Mathematical Knowledge
<b>Behavior</b>	Understanding Social Cues

# How technology can help

- Design guidelines for cognitive disabilities
  - Guides at [WebAIM](#) and [W3C](#)
- Reminders, calendars, timers, scheduling systems can be helpful
- New opportunities for Internet of Things, augmented reality

# Self-advocacy



The video player shows a woman with dark hair and glasses speaking. A subtitle at the bottom of the screen reads: "Getting to the polls, getting transportation, can be hard, especially for people with disability." Below the video are standard YouTube controls: back, forward, volume, and a progress bar indicating 0:50 / 3:05.

**Tuesdays with Liz: Overcoming Voting Barriers**  
100 views

**aucdnetwork**  
Published on Oct 22, 2018

You can VOTE! Learn all about overcoming voting barriers for people with disabilities with Liz. Liz discusses how to get to the polls and how early voting might be the right option for you.

SHOW MORE

**SUBSCRIBED 534**

**Tuesdays with Liz: Disability Policy for All**  
aucdnetwork - 22 / 203

- 1 Tuesdays with Liz: Congressman Chris Smith Discusses Autism CARES Act 4:34 aucdnetwork
- 2 Tuesdays with Liz: Chris Smith Explains the 'Sunset Provision' and aucdnetwork 4:01
- 3 Tuesdays with Liz: Happy Autism Acceptance Month! 1:58 aucdnetwork
- 4 Tuesdays with Liz: Preparing to Meet with Congressional Staffers 3:26 aucdnetwork

**Colbert Gets His Copy Of The Mueller Report**  
The Late Show with Stephen ... ✓ Recommended for you New

**Game of Thrones S8E01 Explained**  
Alt Shift X ✓ Recommended for you New

**Monster Factory: Exploding Shepard's Face Bones in Mass...**  
Polygon



You know why I'm so excited? Voting is coming up, and voting  
is so important for people with disability. I can't say that enough.

# Social media

- Important part of social life for many people, especially young people
- But there are some challenges

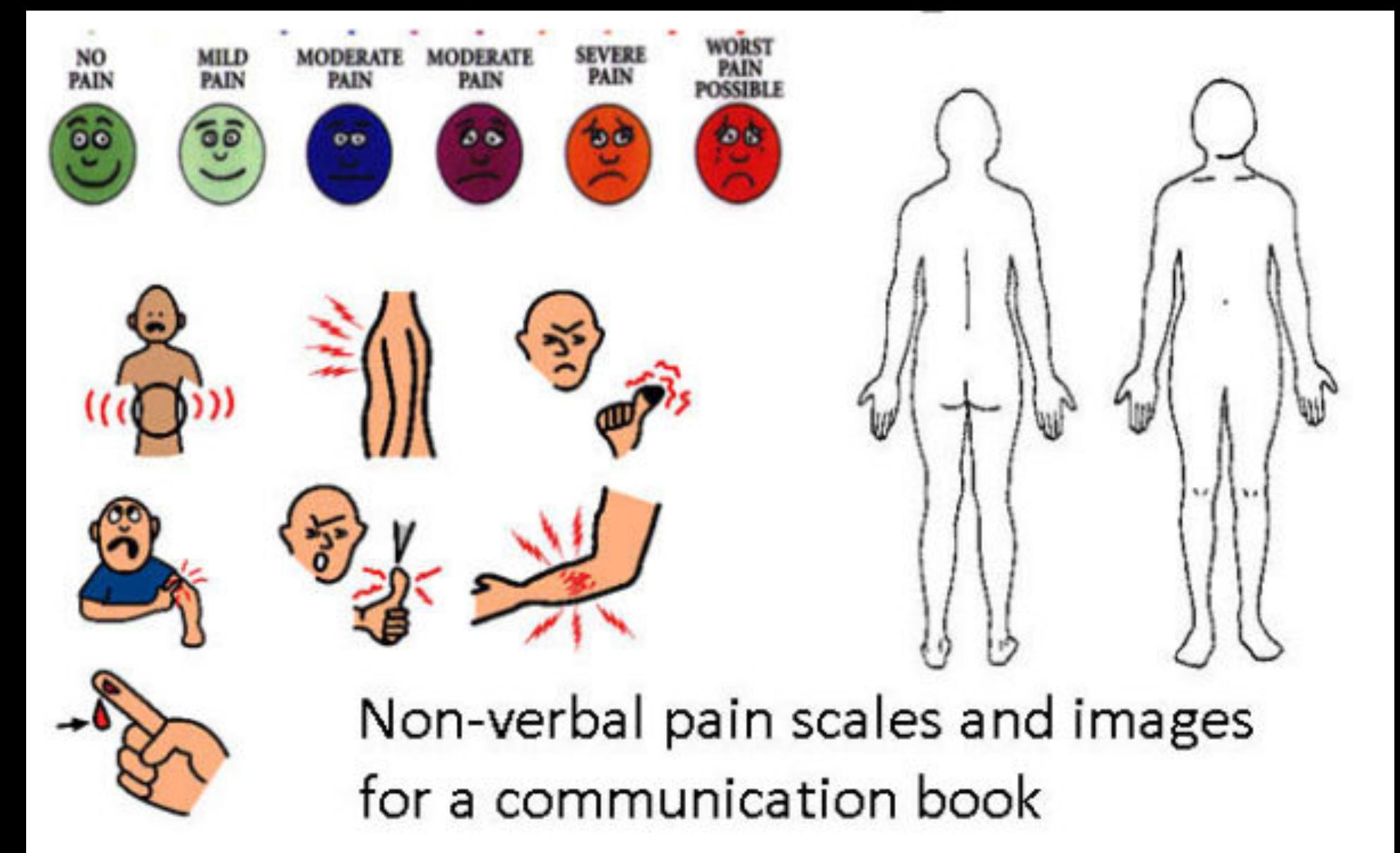
The image shows a screenshot of a Twitter profile page. The header features the Twitter logo and navigation icons. The search bar contains the text "Search Twitter". On the right, there are buttons for "Tweet" and a user profile icon. The main content area displays a large photo of a white dog lying on a wooden floor. To the left of the photo is a circular profile picture of a dog's face. Below the photo, the profile information for "WeRateDogs™" (@dog\_rates) is shown, including a blue verified checkmark. The bio reads: "Your Only Source For Professional Dog Ratings Instagram and Facebook" followed by a link icon. The contact email "partnerships@weratedogs.com" is also listed. Below the bio are links for "DM YOUR DOGS", "weratedogs.com", and the joining date "Joined November 2015". At the bottom of the profile section are buttons for "Tweet to" and "Message".  
  
The timeline below shows a pinned tweet from the account itself. The tweet is dated April 11 and features a photo of a person holding a dog. The text of the tweet is: "This is Cricket. Back in September, you guys raised all the money for his surgery. I finally got to meet him and his friends, and we wanted to thank you for being part of a community that's contributed over \$500k for dogs in need. He insisted all of you receive honorary 15/10s".  
  
To the right of the pinned tweet are two smaller photos: one of a person holding a dog and another of a group of dogs standing outdoors.  
  
At the bottom of the timeline, there are engagement statistics: 337 replies, 8.9K retweets, 108K likes, and a message icon.

# Other issues in research & design

- Collecting user feedback
- Solo vs. group interactions
- Adults using technology for kids

# Collecting feedback

- Can be difficult to collect feedback, especially when there are communications barriers
- Some strategies:
  - Use worksheets, storyboards, multimodal scales

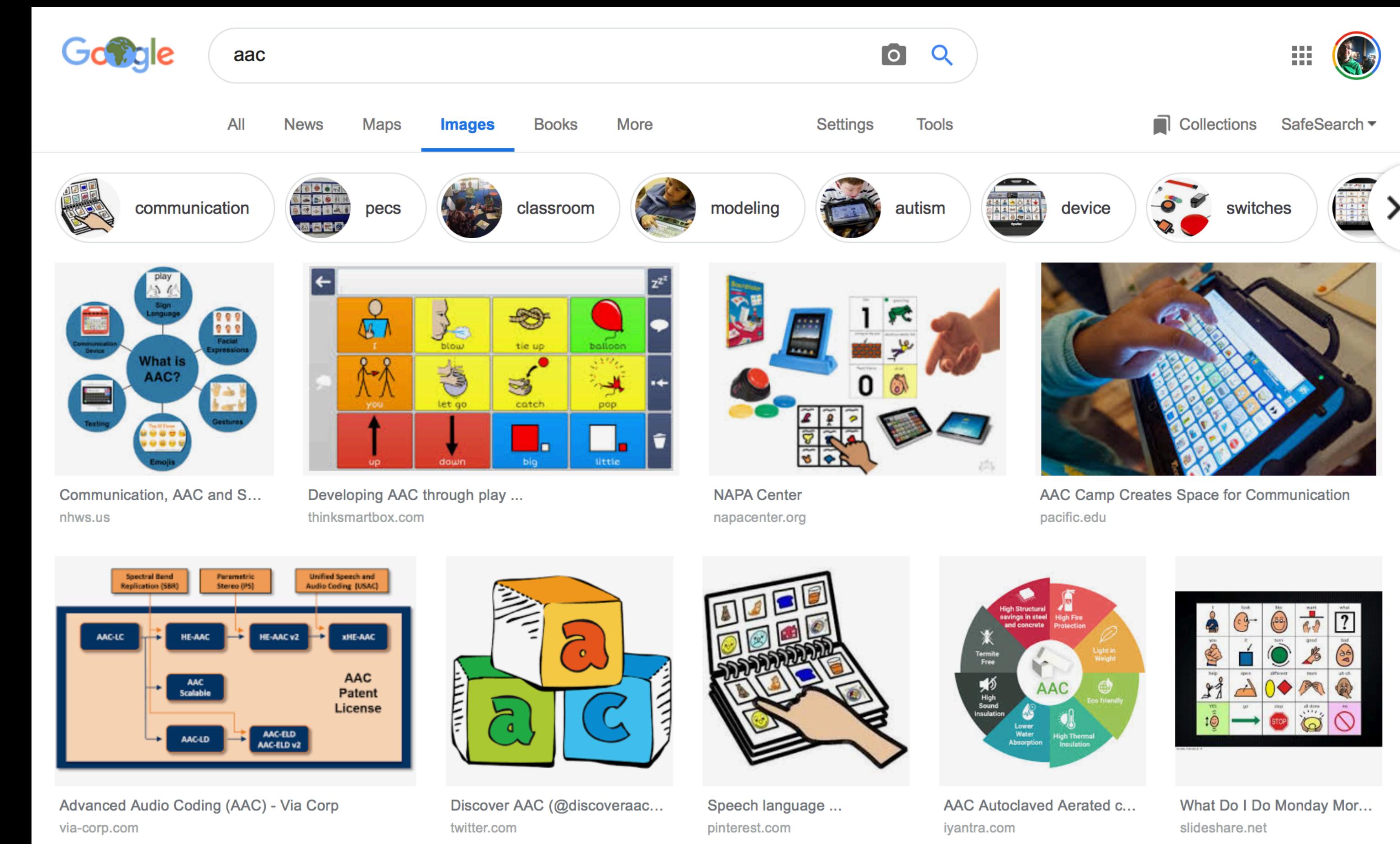


# Solo vs. group interactions

- Many adults with cognitive disabilities may not live independently
  - May not be their own legal guardian, may not live alone
  - In design, we may need to consider how technology affects the entire family
  - Multi-user solutions

# Simple ≠ for kids

- Often simplified technology targets kids
- Looks and feels childlike
- Can be upsetting for adults



# Design & research

# Design guidelines

- Convey information multi-modally; e.g. with text and pictures (but this can be overwhelming)
- Use clear document structure
- Use lists and tables to clearly specify the structure of information

# Examples from research

- Task prompting
- CareNet: monitoring older adults via activity recognition afar
- Using augmented reality to support work

# Research challenges

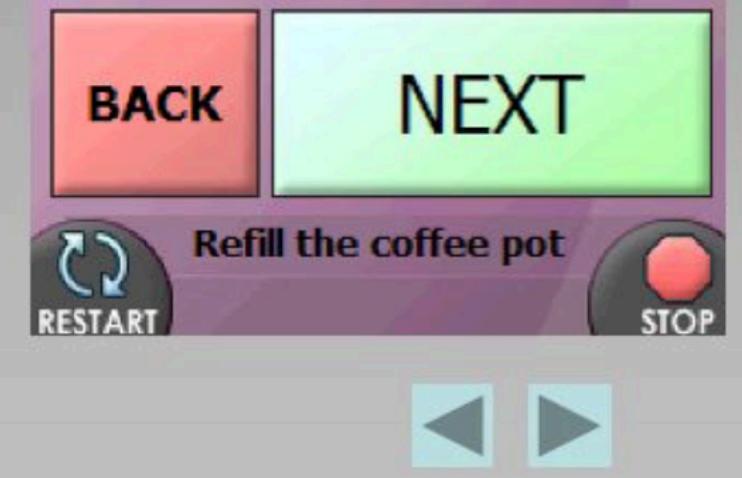
- Significant variations in ability – often difficult to classify people by diagnosis
- Diverse functional effects – two people might have similar linguistic ability, but very different reasoning ability
- Research participants may have difficulty articulating their ideas; require careful research methods

# Task prompting

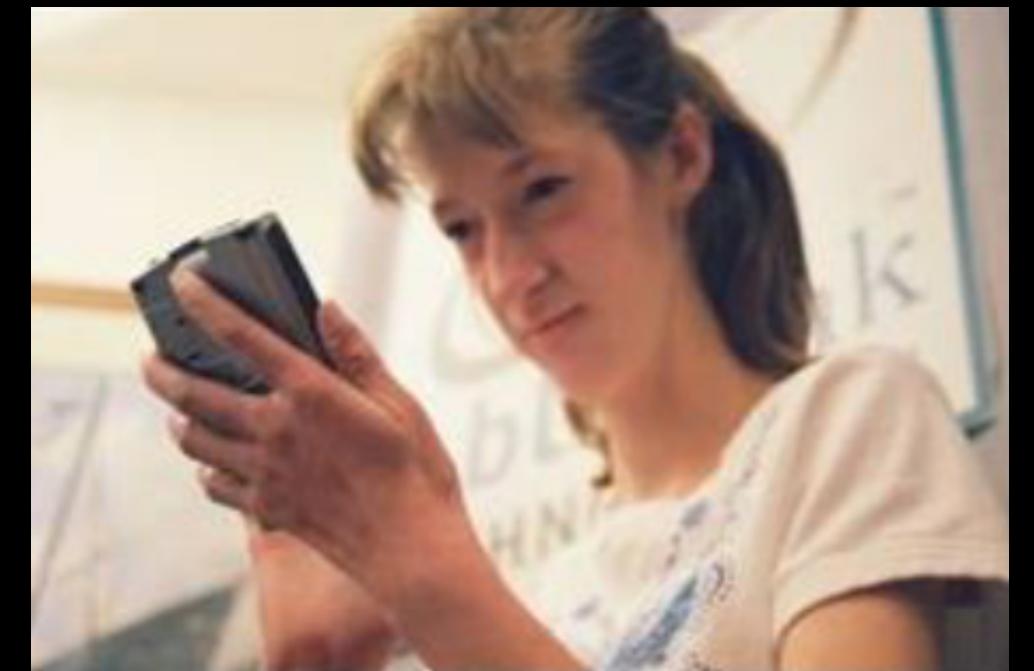
- Much research in this domain focuses on giving instructions
- Recent innovations include: automatically sensing tasks, AR displays

## Audio/visual task prompting

- Here the amounts of coffee and water relate to making two cups of coffee, if another number had been chosen the amounts would be different.



 Halliday James



# CareNet display

- Designed for children of aging adults (but potentially useful for other groups)
- Allow remote monitoring of daily activities—elder wears a smart bracelet in a smart home
- Shows activities as icons—tracks activity without using a camera



Figure 2. The CareNet Display prototype used in the deployments. The prototype uses a touch-screen tablet PC housed in a custom-built beech wood frame

# Primary issues for CareNet display

- How to support independent living for someone who needs a little help
- How to provide monitoring of important issues (did Grandpa take his medicine?) without invading privacy too much
- How to design smart home technology to fit in with existing activities (in this case, as a smart picture frame)

# AR to support work coaching

- Some people with cognitive disabilities work in “sheltered workplaces” – environments designed to support this group
- Perform very simplified tasks designed for them, e.g., twisting a cap onto a tube
- Often follow printed instructions—but it may be difficult to follow complex tasks
- **Potential solution:** Use augmented reality to project instructions into the work area

# Using In-Situ Projection to Support Cognitively Impaired Workers at the Workplace

- Project instructions directly onto the work surface
- Highlight which parts need to be moved, and where
- Dramatically increases the number of steps that can be followed
- But: only tested with a research task (assembling Duplo blocks)

## Using In-Situ Projection to Support Cognitively Impaired Workers at the Workplace

**Markus Funk**  
University of Stuttgart  
Pfaffenwaldring 5a  
70569 Stuttgart  
[markus.funk@vis.uni-stuttgart.de](mailto:markus.funk@vis.uni-stuttgart.de)

**Sven Mayer**  
University of Stuttgart  
Pfaffenwaldring 5a  
70569 Stuttgart  
[sven.mayer@vis.uni-stuttgart.de](mailto:sven.mayer@vis.uni-stuttgart.de)

**Albrecht Schmidt**  
University of Stuttgart  
Pfaffenwaldring 5a  
70569 Stuttgart  
[albrecht.schmidt@vis.uni-stuttgart.de](mailto:albrecht.schmidt@vis.uni-stuttgart.de)

### ABSTRACT

Today's working society tries to integrate more and more impaired workers into everyday working processes. One major scenario for integrating impaired workers is in the assembly of products. However, the tasks that are being assigned to cognitively impaired workers are easy tasks that consist of only a small number of assembly steps. For tasks with a higher number of steps, cognitively impaired workers need instructions to help them with assembly. Although supervisors provide general support and assist new workers while learning new assembly steps, sheltered work organizations often provide additional printed pictorial instructions that actively guide the workers. To further improve continuous instructions, we built a system that uses in-situ projection and a depth camera to provide context-sensitive instructions. To explore the effects of in-situ instructions, we compared them to state-of-the-art pictorial instructions in a user study with 15 cognitively impaired workers at a sheltered work organization. The results show that using in-situ instructions, cognitively impaired workers can assemble more complex products up to 3 times faster and with up to 50% less errors. Further, the workers liked the in-situ instructions provided by our assistive system and would use it for everyday assembly.

### Author Keywords

Augmented Reality; Assistance for Impaired Workers; Assistive System; In-Situ Projection

### ACM Classification Keywords

H.5.m. Information Interfaces and Presentation (e.g. HCI); Miscellaneous

### INTRODUCTION

Projectors are becoming more common and are widely avail-

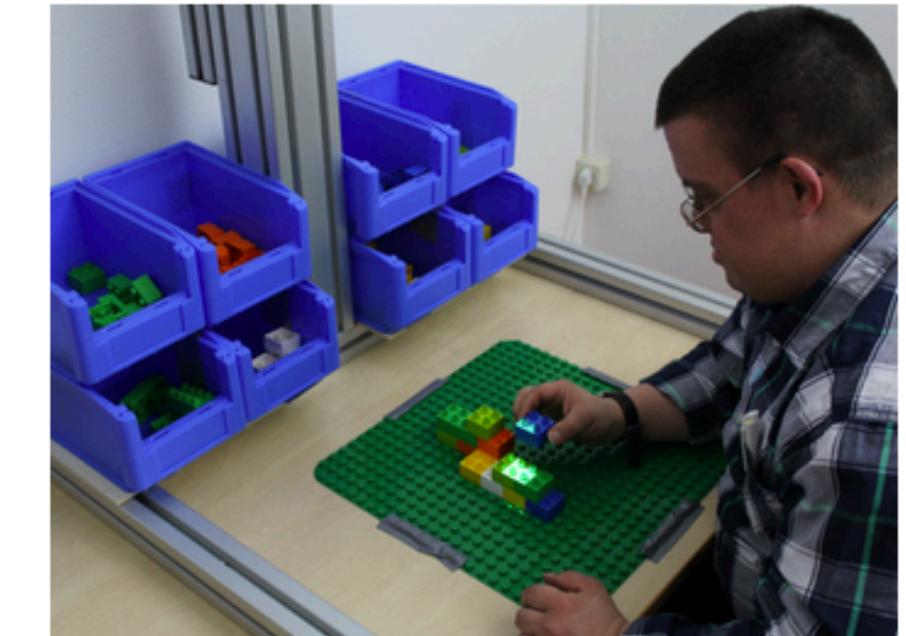
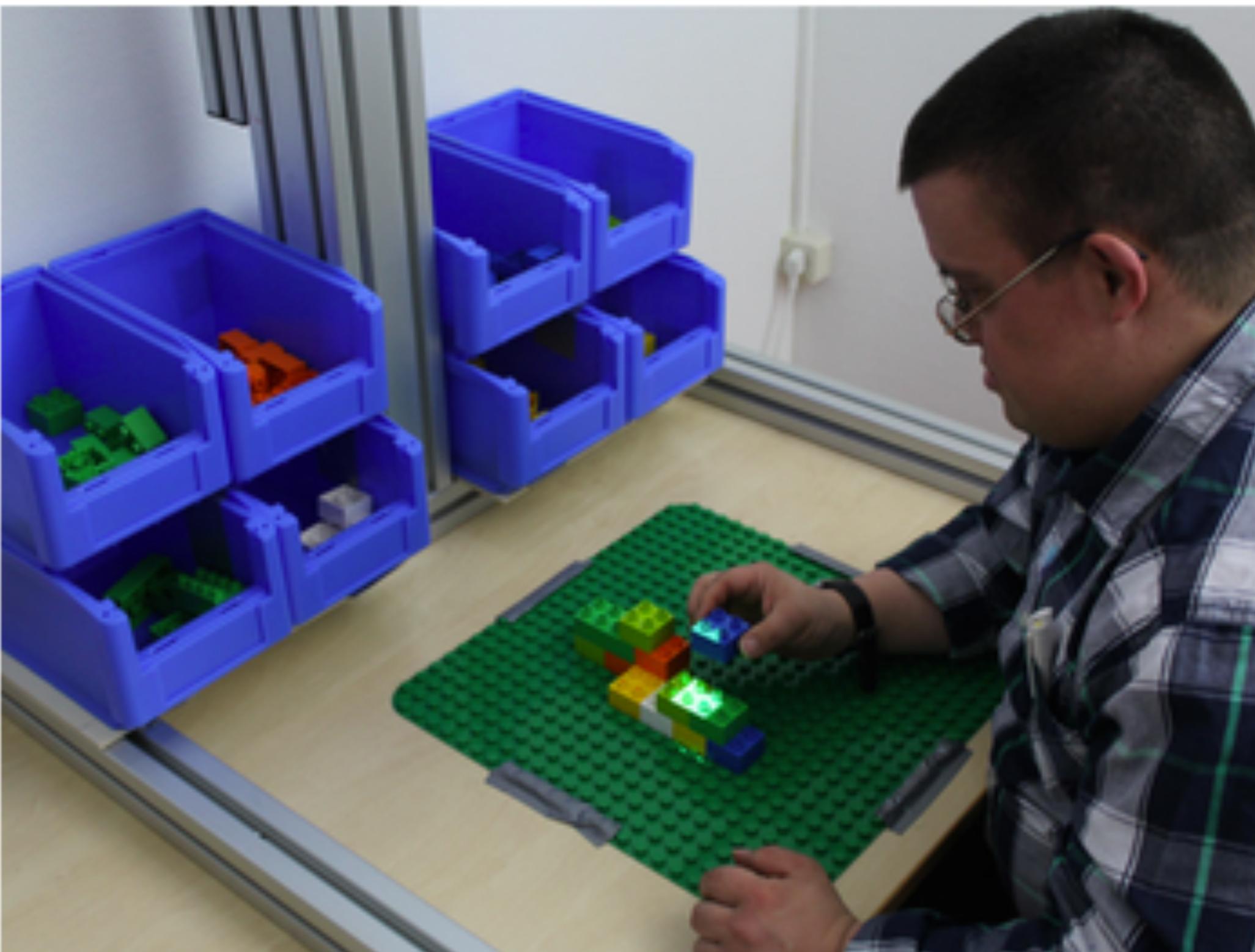
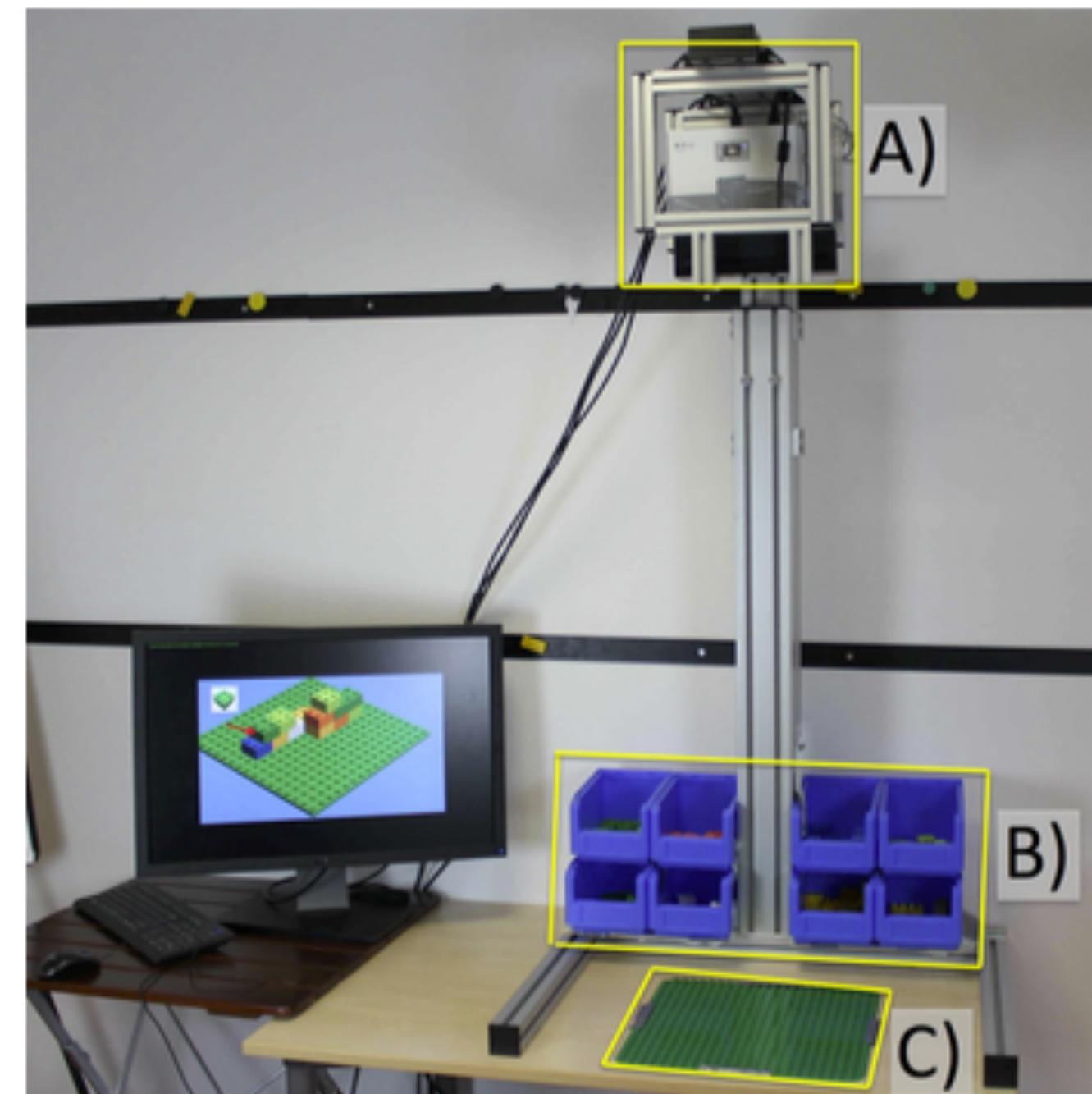


Figure 1. A participant is assembling Duplo bricks using in-situ projected instructions provided by our assistive system.

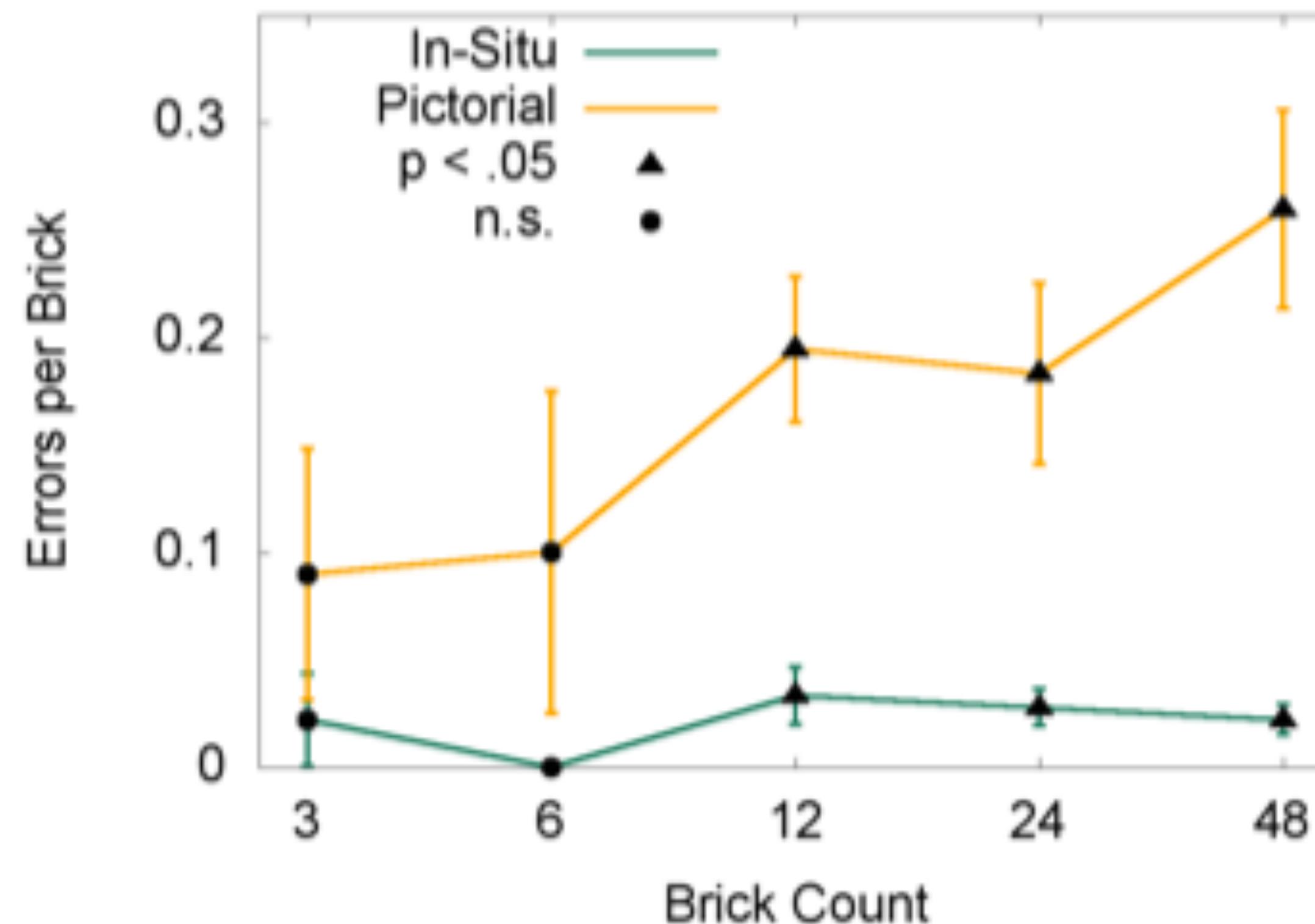
rendering the projection distortion free. This technology can also be applied to provide instructions at the workplace where the instructions can be projected directly onto the workers field of view [7] (see Figure 1). These so-called in-situ instructions do not require the worker to focus on an external screen or on a printed manual anymore and can keep the focus on the task while viewing instructions. The technique of using in-situ projection for instructing workers is already used in some commercial approaches. For example Light Guide Systems<sup>1</sup> use a top-mounted projector to display the next working step. Another commercial system such as the WERKLICHT from Extend3D<sup>2</sup> is using a laser projector to highlight important points for assembly.



**Figure 1.** A participant is assembling Duplo bricks using in-situ projected instructions provided by our assistive system.



**Figure 4.** Our prototypical system for an assistive system providing visual in-situ instructions at the workplace. A) the top-mounted Kinect and the projector B) the boxes containing the spare parts C) the working area which is checked for correct assembly



**Figure 8.** Overview showing the errors made dependent on the complexity of the product to assemble. Error bars depict the standard error. A triangle indicates a significant difference between the conditions.

# Design activity

- Consider social networking / interactions online
- Let's brainstorm challenges to interacting online
- Then, brainstorm potential solutions
- Keep notes at [shaun.cat/cognitive](http://shaun.cat/cognitive)