

Technology for Deaf and Hard of Hearing (DHH) People



Overview

- Challenges
- Current state of the art
- Research and opportunities

Demographics

- About 2 to 4 of every 1,000 (0.2-0.4%) people in the United States are "functionally deaf," though more than half became deaf relatively late in life; fewer than 1 out of every 1,000 people in the United States became deaf before 18 years of age.
- However, if people with a severe hearing impairment are included with those who are deaf, then the number is 4 to 10 times higher. That is, anywhere from 9 to 22 out of every 1,000 people (1-2%) have a severe hearing impairment or are deaf. Again, at least half of these people reported their hearing loss after 64 years of age.
- Finally, if everyone who has any kind of "trouble" with their hearing is included then anywhere from 37 to 140 out of every 1,000 people (3-14%) in the United States have some kind of hearing loss, with a large share being at least 65 years old.

Definitions

- **Deafness** - complete inability to hear
 - Typically communicate using sign language
 - May be addressed by cochlear implants
- **Hard of hearing** - reduced hearing
 - May be limited to certain directions, frequency ranges
 - May be addressed by hearing aids or implants

Sign language

- For people who are born deaf, sign language is typically one's native language
- Sign languages are different across location
 - e.g. American Sign Language ≠ British Sign Language
- Sign languages are distinct from the corresponding written language (ASL ≠ English)
- In the US, English literacy can be quite low for native ASL signers

Profile: Raja

- Computer science professor at Gallaudet University
- PhD in Computer Science; law degrees
- Researches disability policy and assistive technology
- Communicates in ASL, uses interpreters in professional settings



Deaf culture

- Some distinguish between *deaf* (referring to a lack of hearing) and *Deaf* (membership in a specific culture)
- Medical vs. social models of deafness
- Is deafness a disability at all?
- “Oralist” approach (learning to speak and lip read) vs. sign language-first approach
- Implications for technology, e.g., controversy about cochlear implants in children

Deaf gain

- Identifying areas in which deafness provides an advantage



Jay @kiwi_pikachu · Mar 6

I love being Deaf for one huge reason. *takes big breath* I don't have to hear my love of my life snore!!! He he! I love him!! 🤘 #Deafpositive #Deafgain
#blessedtobeDeaf



Claire Dodds @mintyfaglady · Mar 4

Replies to @BookyGeeky

Definitely a #deafgain in this house - both my kids are great readers with excellent vocabularies. #deafaccess #subtitles



DC Deaf Moviegoers @dcdm4oc · Feb 19

A good reason to have #captions on the screen. It can help show names that moviegoers have not heard before. It helps with comprehending more obscure vocabulary too. #DeafGain

Kyle Lawrence @metallikyle

Replies to @metallikyle @_angelica_

In fact, early on in Black Panther I was wishing for captions because of the names. I like to be able to refer to characters by name when discussing afterwards as opposed to "his sister", "the general", "Forrest Whittaker".

Interaction challenges

- Following conversation (can't assume that a deaf person can read lips...)
- Human interpreters are costly, must be recruited in advance
- Inaccessible media
- Peripheral awareness (e.g. horns honking, baby crying)
- Limitations of visual attention (e.g. can't watch ASL interpreter and read slides at the same time)

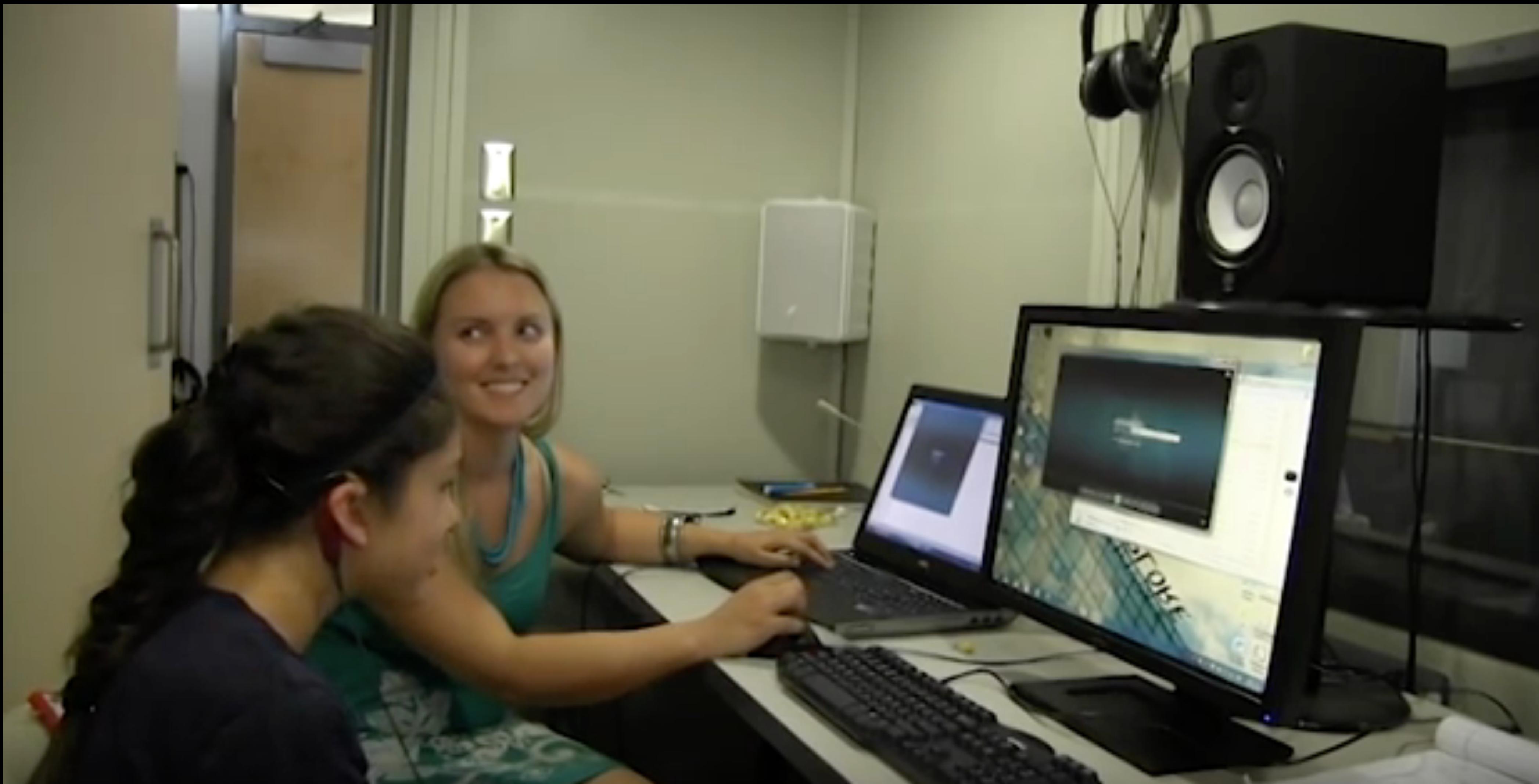
Current technologies

- Hearing aids / cochlear implants
- Captions
- ASL interpreters
- TTY / texting
- Video relay service

Hearing aids & cochlear implants

- **Hearing aids** amplify sounds for people with hearing impairments
 - May be customizable to certain settings (e.g., party, one-on-one conversation)
 - May interface with phones and other devices via Bluetooth
- **Cochlear implants** are surgically placed on the body, directly stimulate nerves
 - Provide limited bandwidth vs. natural hearing capability
 - May require extensive training

What a CI sounds like



Captions

- **Open captions** are “burned into” the video file; can’t be switched off
- **Closed captions** are stored along with the video; can be toggled, formatting can be changed

Automatic captions

- Automatic speech recognition can support auto-captioning (now default on YouTube)
- Accuracy rated at 60-70%
- Lower for technical terms
- Functionally, even worse than you expect, because words may be incorrectly segmented
 - “are you going to the store?”
 - “aria going tooth store?”

Captions in public

- Can provide captions for videos in public, using a personal display
- Or directly connect hearing aid to output
- May be used for movies or stage productions



CART: Communication Access Realtime Translation

- Captioner in the room during a live presentation
- Captions presented on screen
- Captioners typically use a chording stenographer keyboard to rapidly enter text
- Useful for non-signers or as backup to interpreters



ASL interpreters

- Often mandated in the US as a reasonable accommodation by Americans with Disabilities Act
- Demanding task (terps often work in pairs)
- Limitations: spontaneity, field of view



TTY / teletype

- Use standard telephone lines to transmit text
- First appeared in 1960s
- Requires a separate number, and a TTY on the other end



Texting

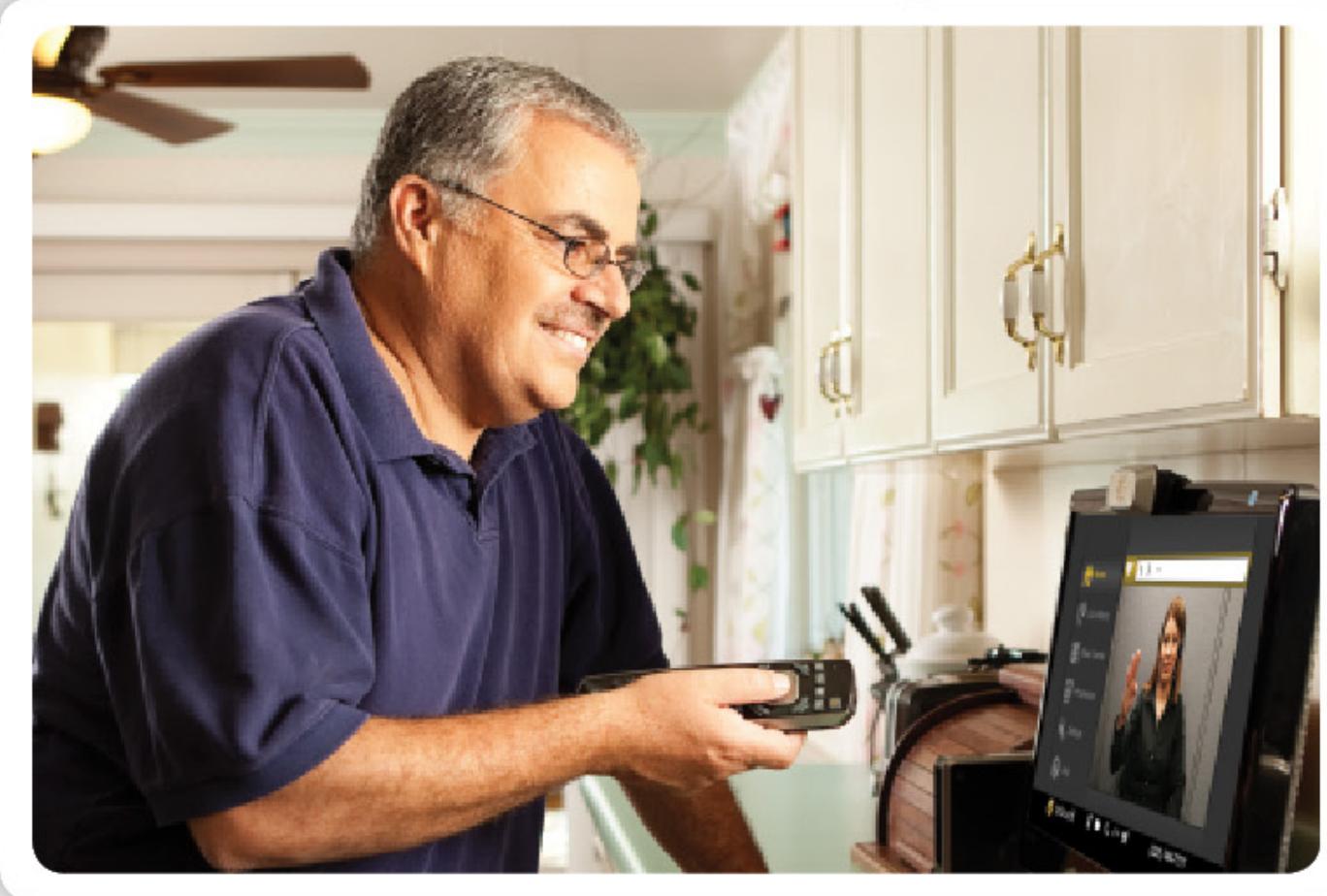
- Deaf people were often early adopters of pagers, Blackberry, other texting devices



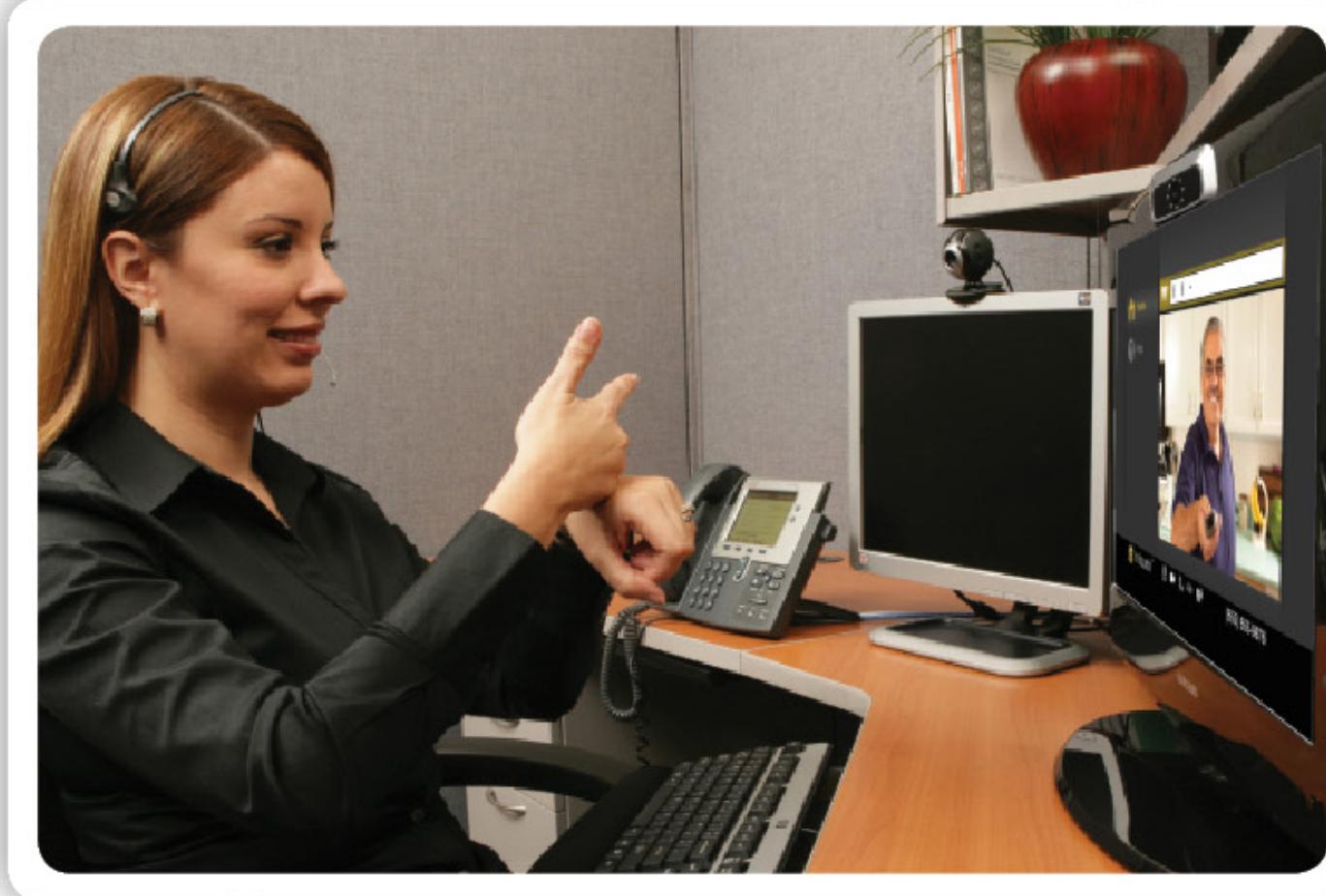
Video Relay Service

- Supports phone calls between a deaf signer and a hearing non-signer
- Supported by **socialism** 😱
- Subsidized by a small fee on everyone's phone bill

1. Deaf user signs to the interpreter



2. Interpreter speaks to the hearing user



2

3. Hearing user speaks to interpreter



3

4. Interpreter signs to deaf user

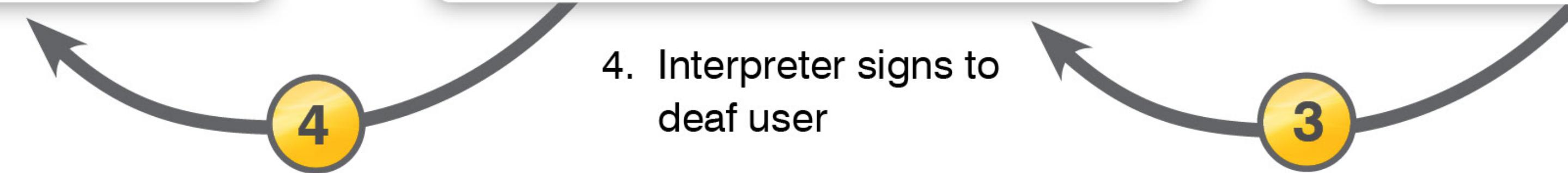


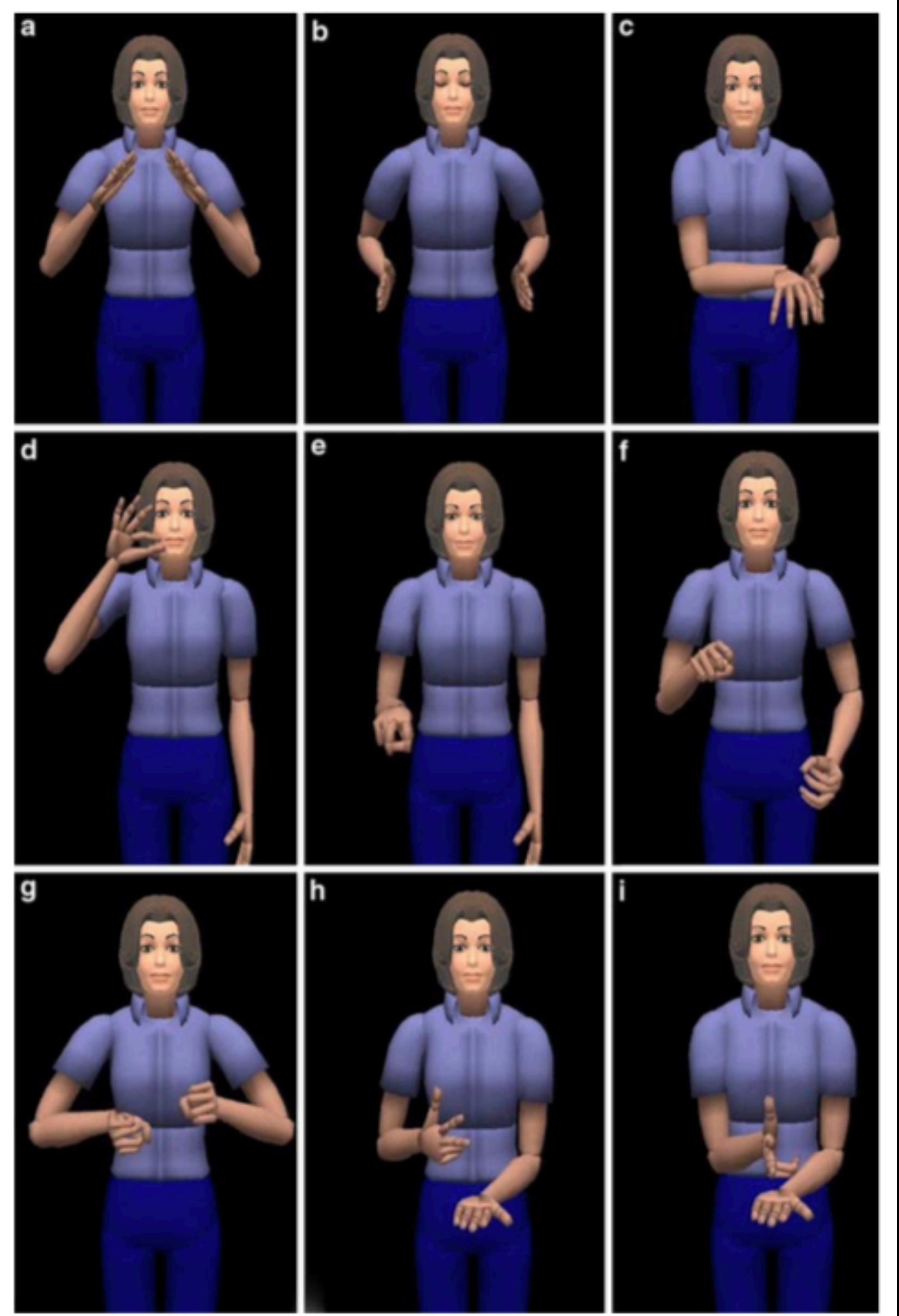
Photo used courtesy Sorenson Communications

Emerging technologies

- ASL and video
- ASL translation
- Environmental awareness
- Hearing aid aesthetics

ASL in the interface

- Goal: augment printed text with ASL, for users who use ASL as their native language
- Example: ASL signing avatars



ASL-STEM Forum

- Supports ASL interactions online
- Supports discovery of new signs

ASL-STEM Forum
Enabling American Sign Language to grow in Science, Technology, Engineering, and Mathematics (STEM)

E-mail: Password: Sign in
Forgot your password? | Register an account

Topics Signs About Help All-topics home Find us on: f

Navigate: Index Search

All

- + Engineering
- + Forum
- + General Stem Terminology^{new}
- + Mathematics
- + Medicine^{new}
- + Science
- + Technology

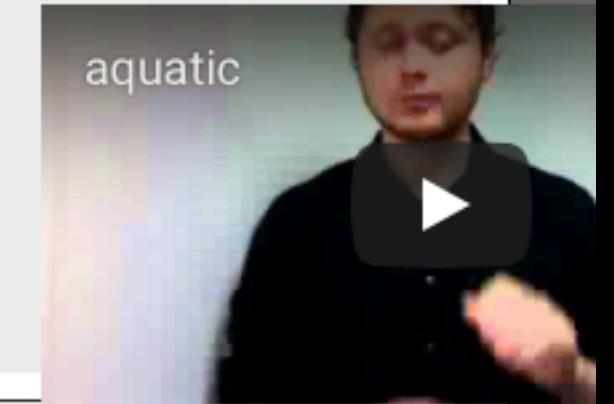
Welcome to the ASL-STEM Forum! The purpose of this online community is to bring educators, interpreters, captioners, students, and others together in order to help build ASL's technical vocabulary from the ground up.

[Sign up for an account and get involved firsthand in the growth of American Sign Language!](#)

Recently active topics: ([more](#))

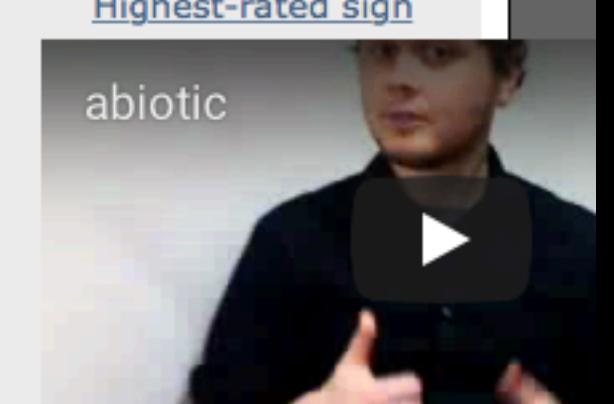
Term: Aquatic

[Signs proposed: 1 \(view signs\)](#)
[Last modified: 3 months ago](#)
[Listed under: ... >> Natural Science >> Biology](#)
[Definition: Growing or living in or frequenting water.](#)

Highest-rated sign

Term: Abiotic

[Signs proposed: 1 \(view signs\)](#)
[Last modified: 3 months ago](#)
[Listed under: ... >> Natural Science >> Biology](#)
[Definition: Of or characterized by the absence of life or living organisms.](#)

Highest-rated sign

Term: Earth

[Signs proposed: 1 \(view signs\)](#)
[Last modified: 3 months ago](#)
[Listed under: ... >> Natural Science >> Biology](#)
[Definition: Courtesy of the NTID Science Signs Project at www.rit.edu/ntid/sciencesigns. Signs are continually improved with evaluation and feedback. Please see the NTID online lexicon for updates on this sign...](#)

Highest-rated sign

MobileASL

- ASL for mobile video chat
- Many interesting computer science problems:
 - Designing user interface
 - Optimizing video compression



ASL music videos: an emerging art form

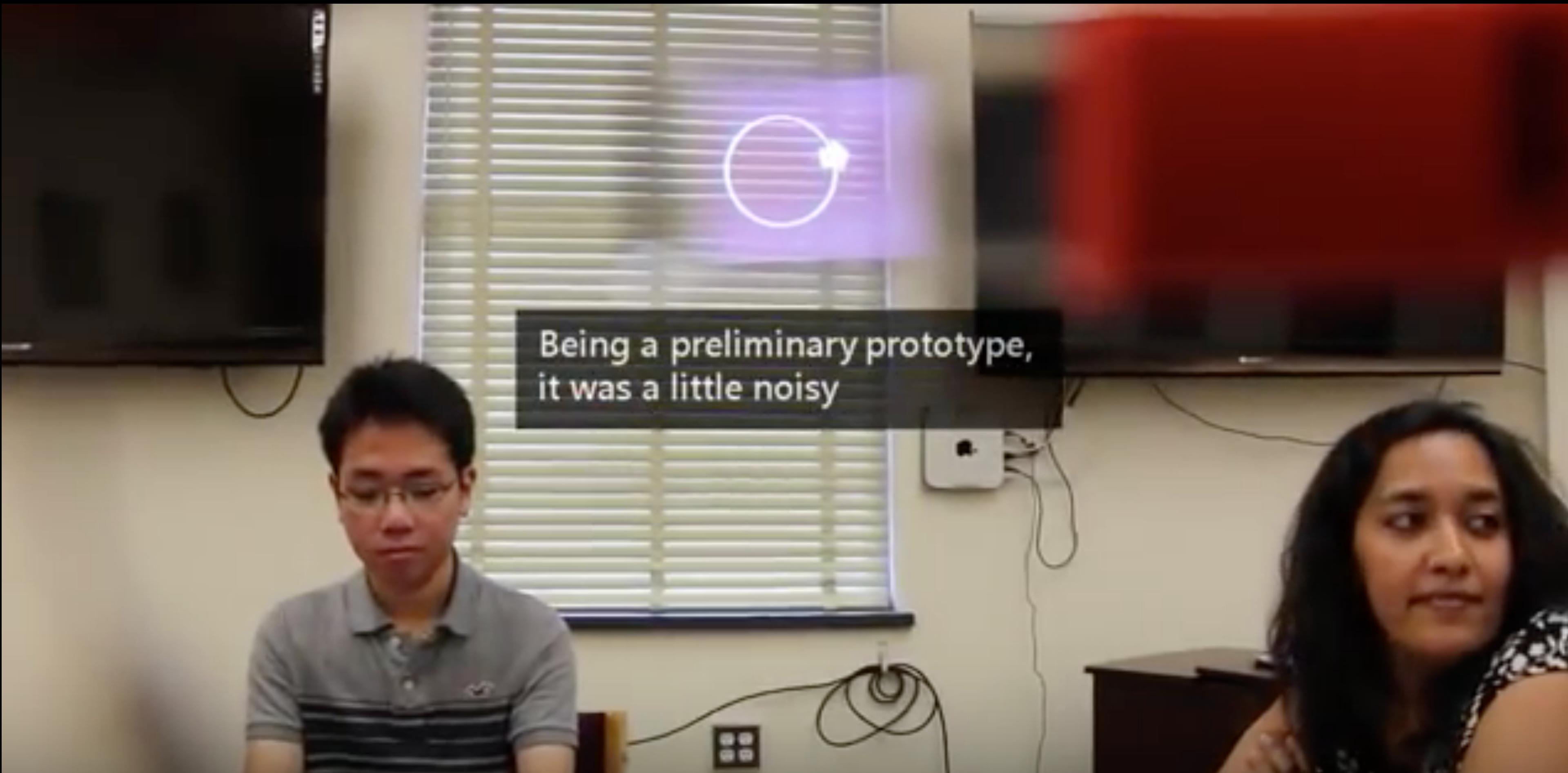


ASL translation

- Can be recognized with many different types of sensors: worn accelerometers, smart gloves, 2D cameras, depth cameras
- ASL involves hand movements, body pose, facial gestures
- Ability to recognize full, natural ASL still limited (and often overstated)



AR to support sound awareness

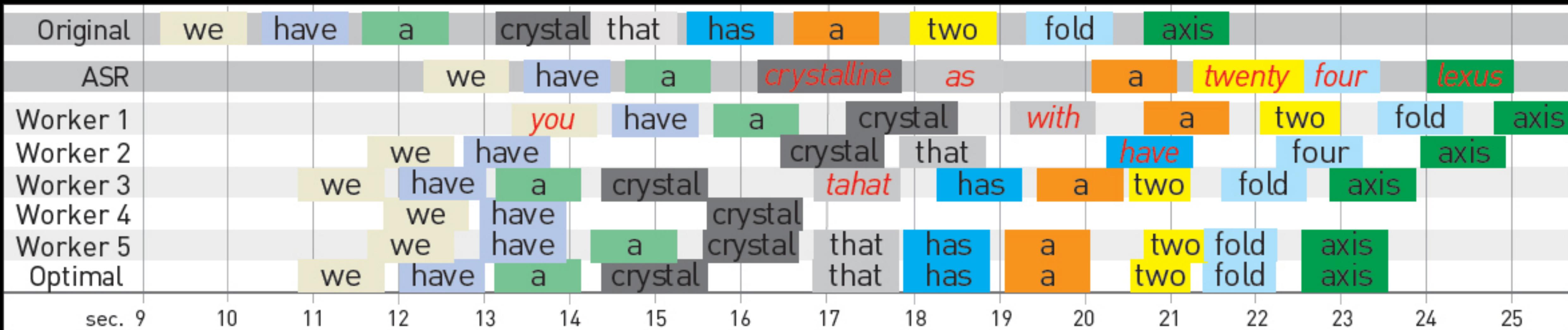


Flutter: sound detecting dress



Legion Scribe

- Use crowd workers on Mechanical Turk to capture audio
- Combine noisy captioning, that doesn't necessarily overlap, to produce accurate captions



Hearing aid adoption

- Many people (especially children) refuse to wear hearing aids, or give them up, even if they are helpful
- This is the **adoption and abandonment** problem
- Many factors: price, quality, social factors

Customized hearing aids

(Halley Profita, Abby Stangl, Shaun Kane)

- Many people now customizing and decorating their hearing aids and cochlear implants
- Often used by parents to encourage their children to use their devices
- People share designs and techniques online
- Can hearing aid hardware be designed to better support this activity?



Takeaways

- Key challenges are **cross-language communication** and **environmental awareness**
- Support diverse modes of communication in person, at a distance, and online
- Some disabilities can lead to strong community formation