Towards Accessible Conversations in a Mobile Context for People who are Deaf or Hard of Hearing

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Prior work have investigated communication challenges of DHH people in **stationary contexts** such as group meetings and lectures.

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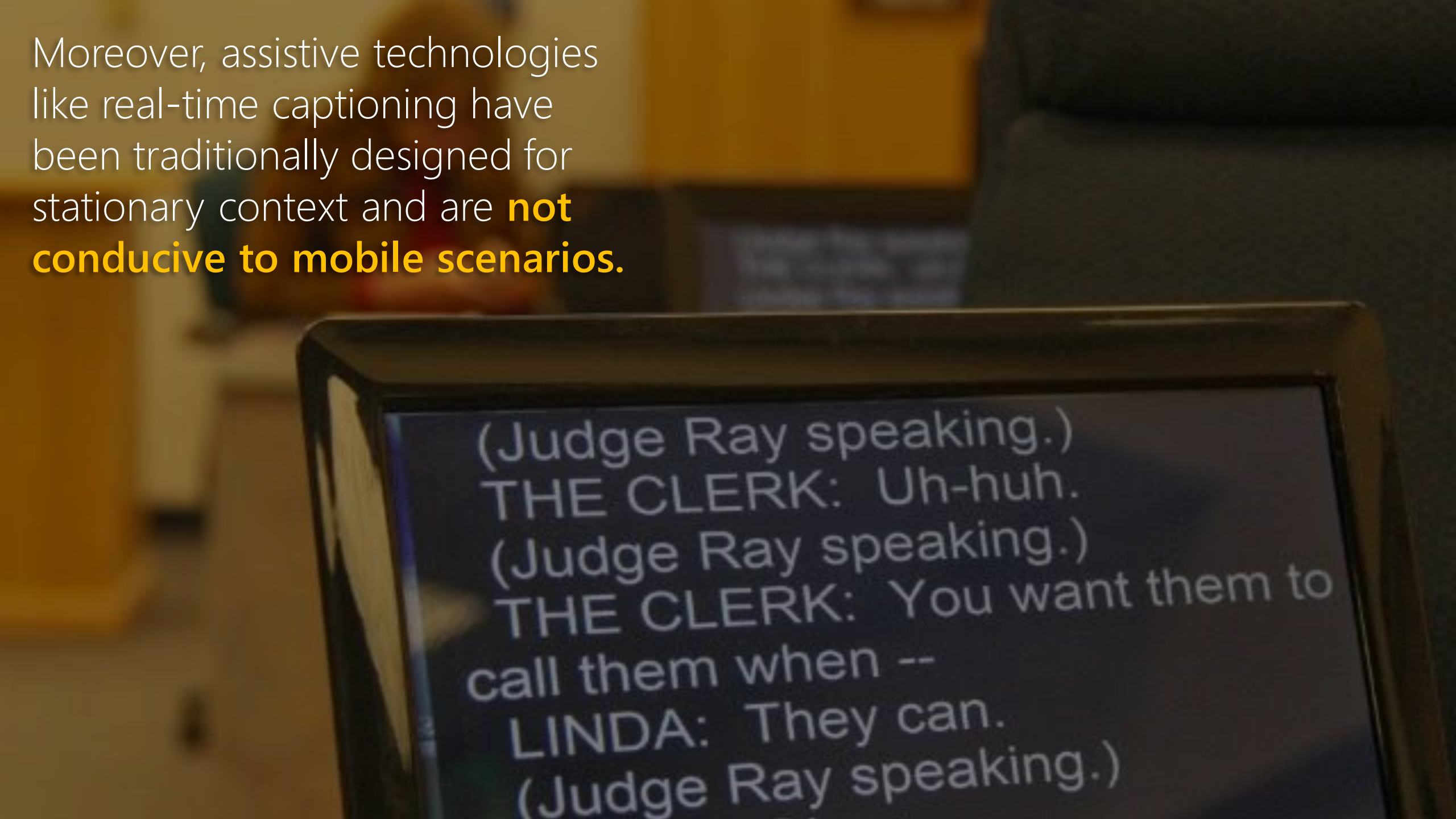
Moving conversations (*e.g.*, walking) could present **new challenges** such as varying background noise and **needing to balance visual attention** between looking at the speakers and looking ahead.

Moreover, assistive technologies like real-time captioning have been traditionally designed for stationary context and are **not conducive to mobile scenarios.**



Aims

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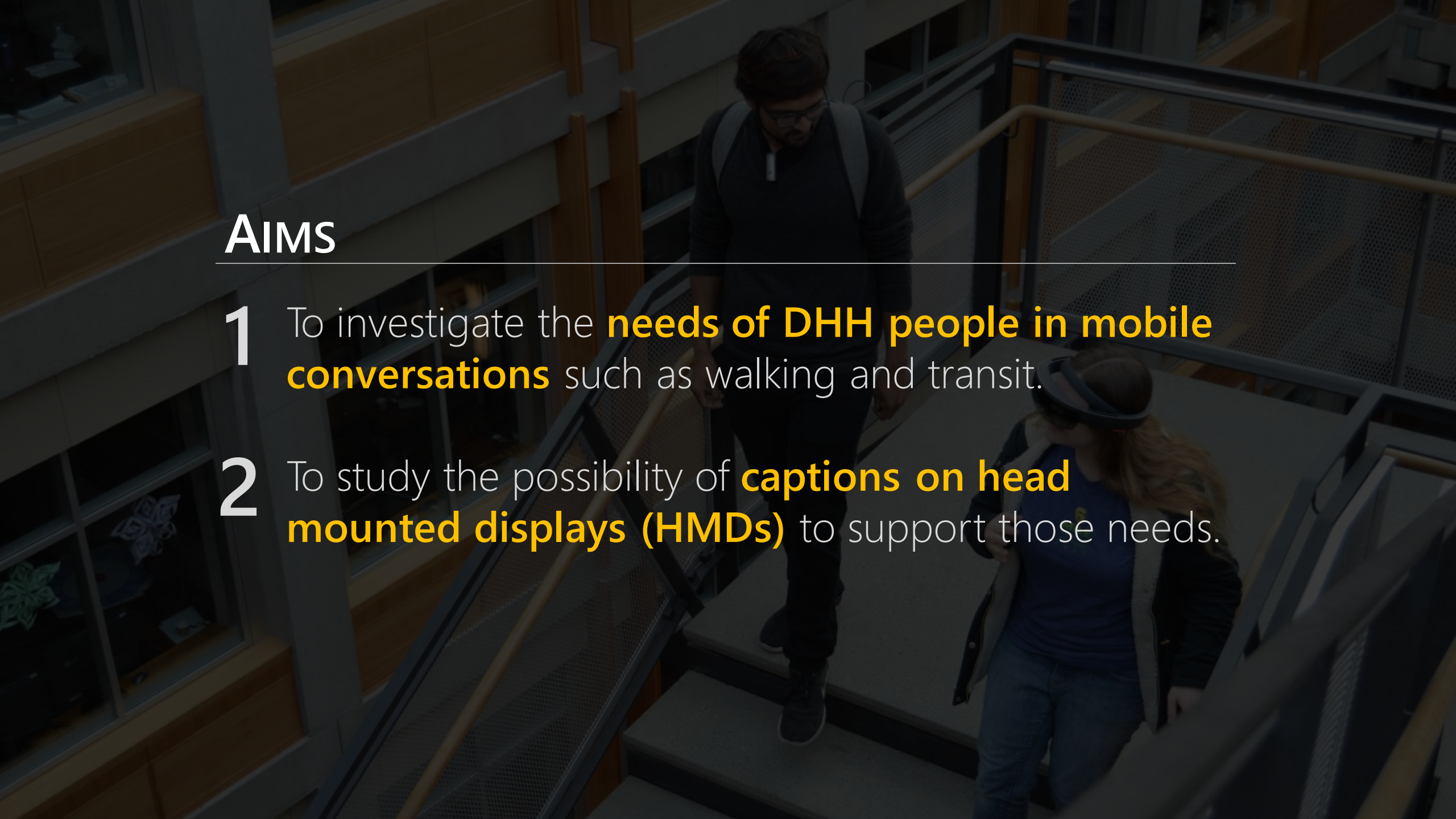
1 To investigate the **needs of DHH people in mobile conversations** such as walking and transit.

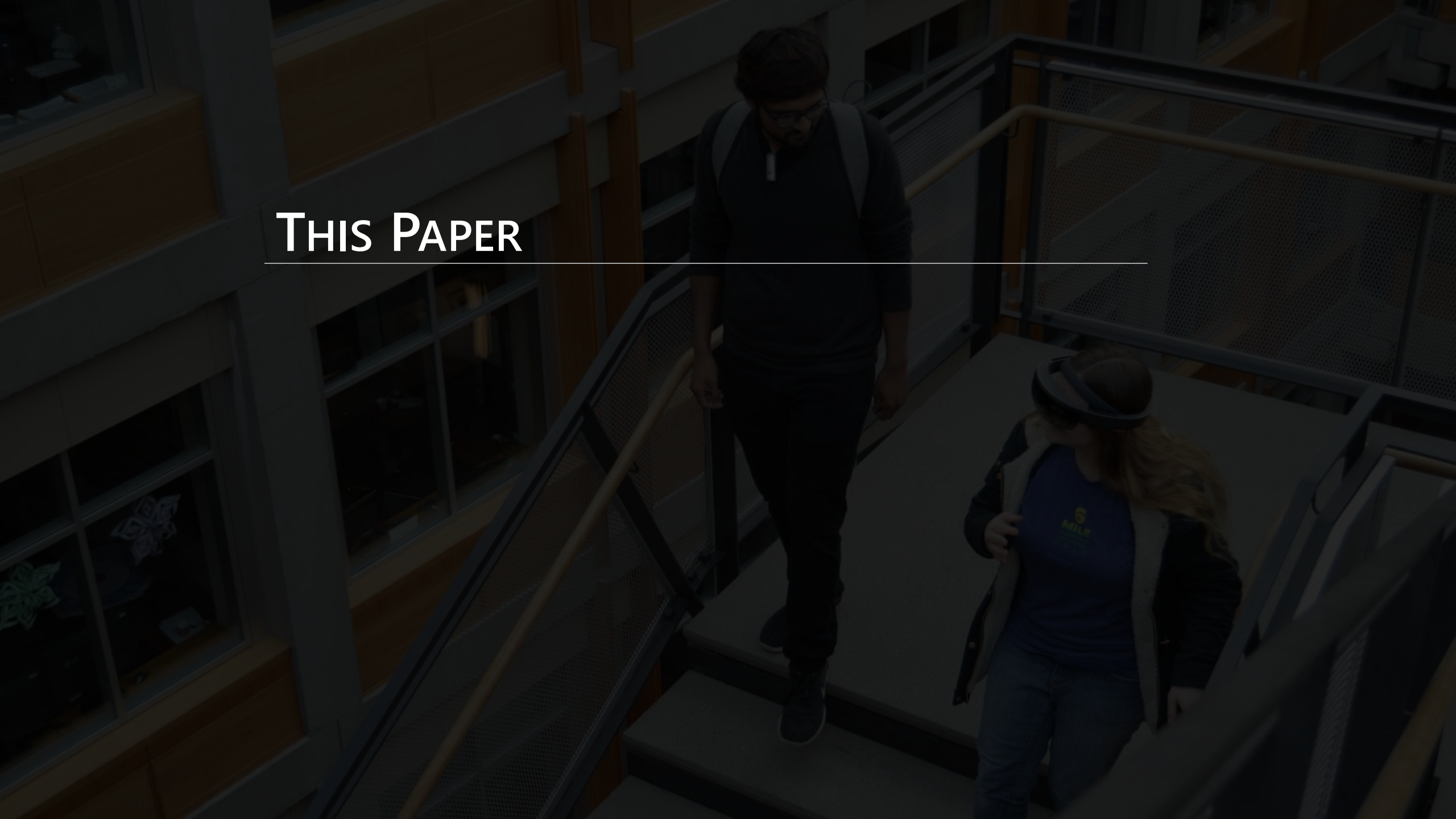


Aims

1. To investigate the **needs of DHH people in mobile conversations** such as walking and transit.

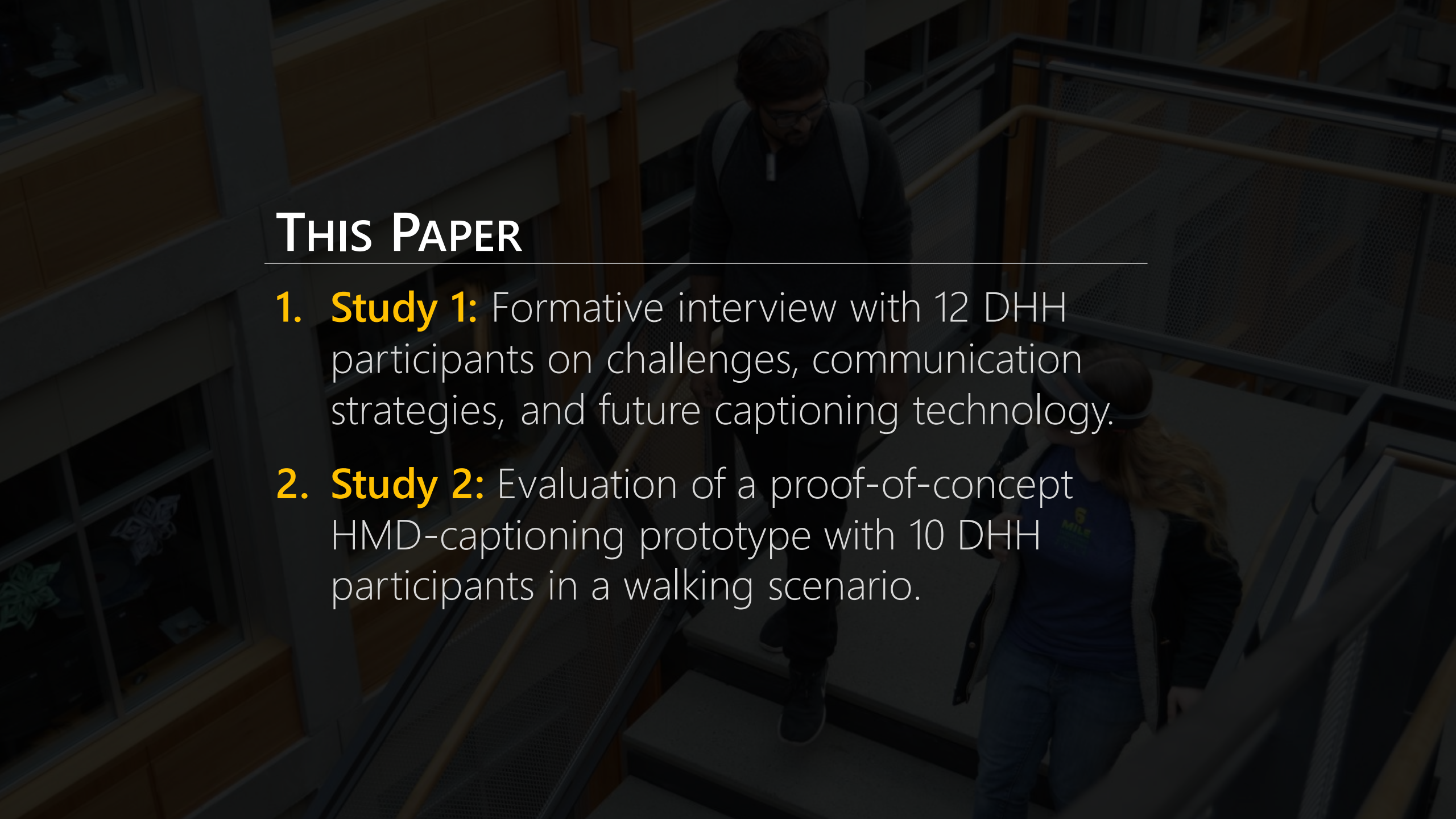
2. To study the possibility of **captions on head mounted displays (HMDs)** to support those needs.

This Paper



This Paper

1. **Study 1:** Formative interview with 12 DHH participants on challenges, communication strategies, and future captioning technology.



This Paper

1. **Study 1:** Formative interview with 12 DHH participants on challenges, communication strategies, and future captioning technology.
2. **Study 2:** Evaluation of a proof-of-concept HMD-captioning prototype with 10 DHH participants in a walking scenario.

Outline

Background
and Past Work

Outline

Background and Past Work → Study 1: Interview

Outline

Background and Past Work → Study 1: Interview → Proof-of-Concept HMD Prototype

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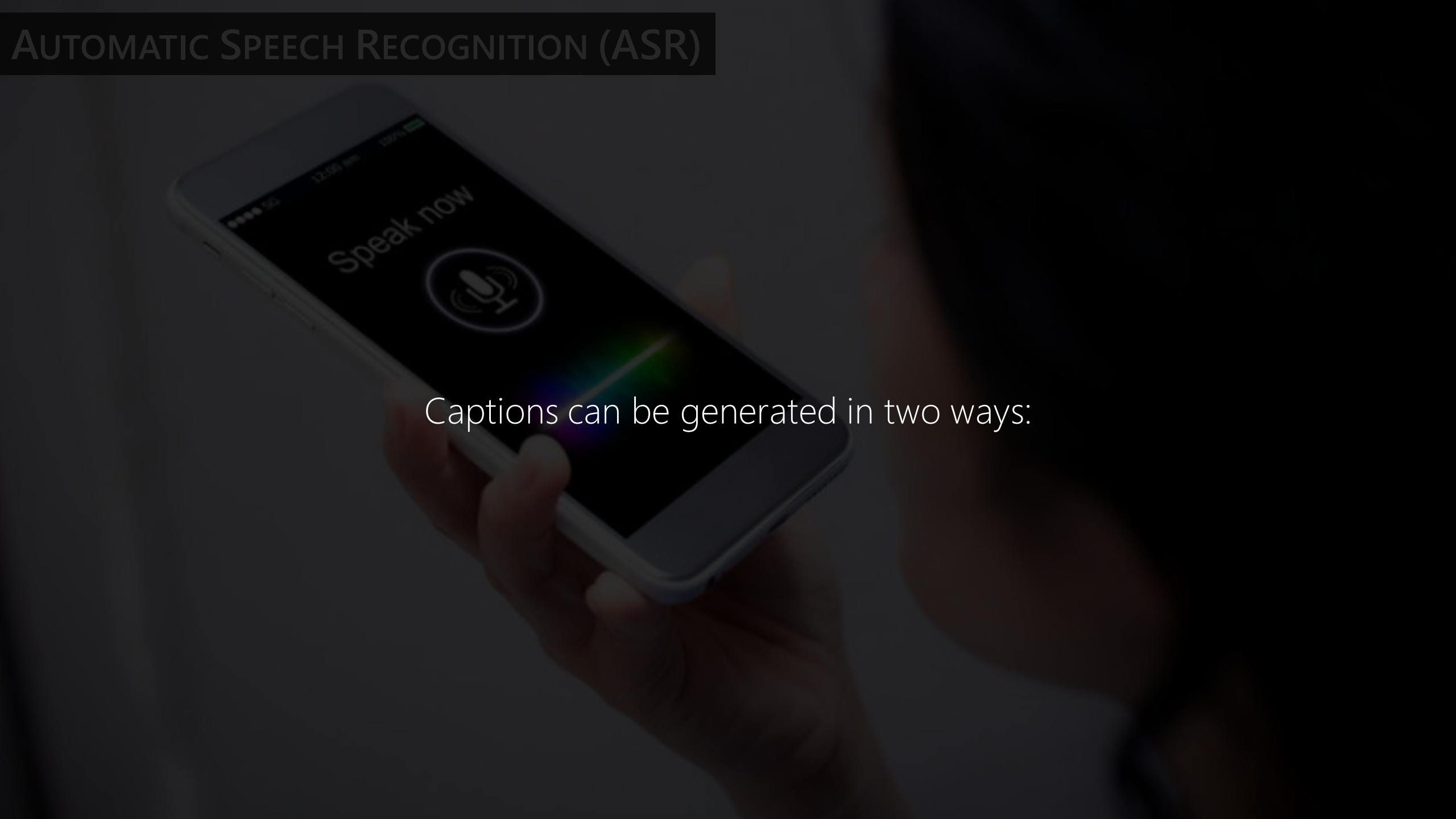
Automatic Speech Recognition (ASR)

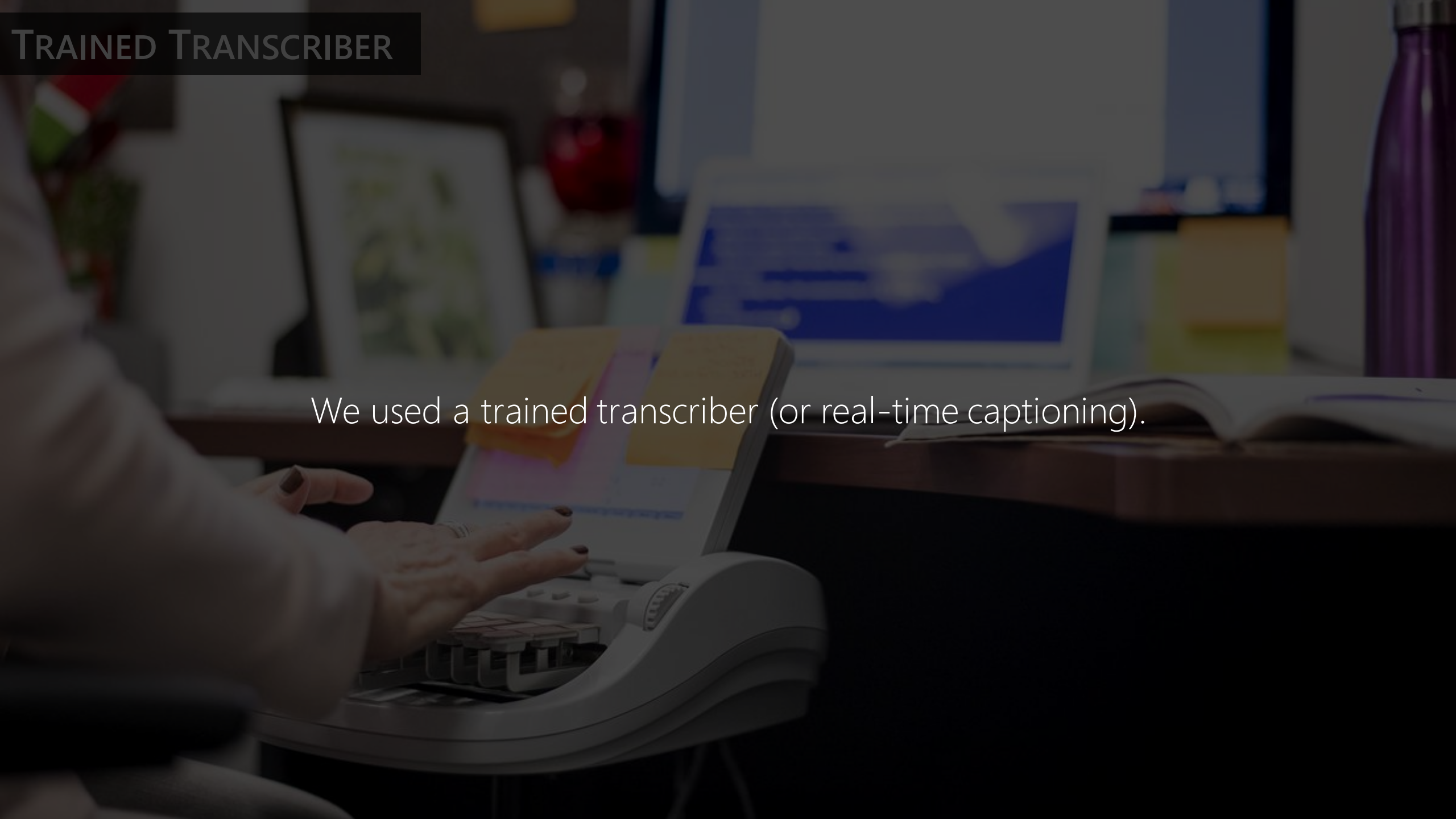


Captions can be generated in two ways:

Automatic Speech Recognition (ASR)

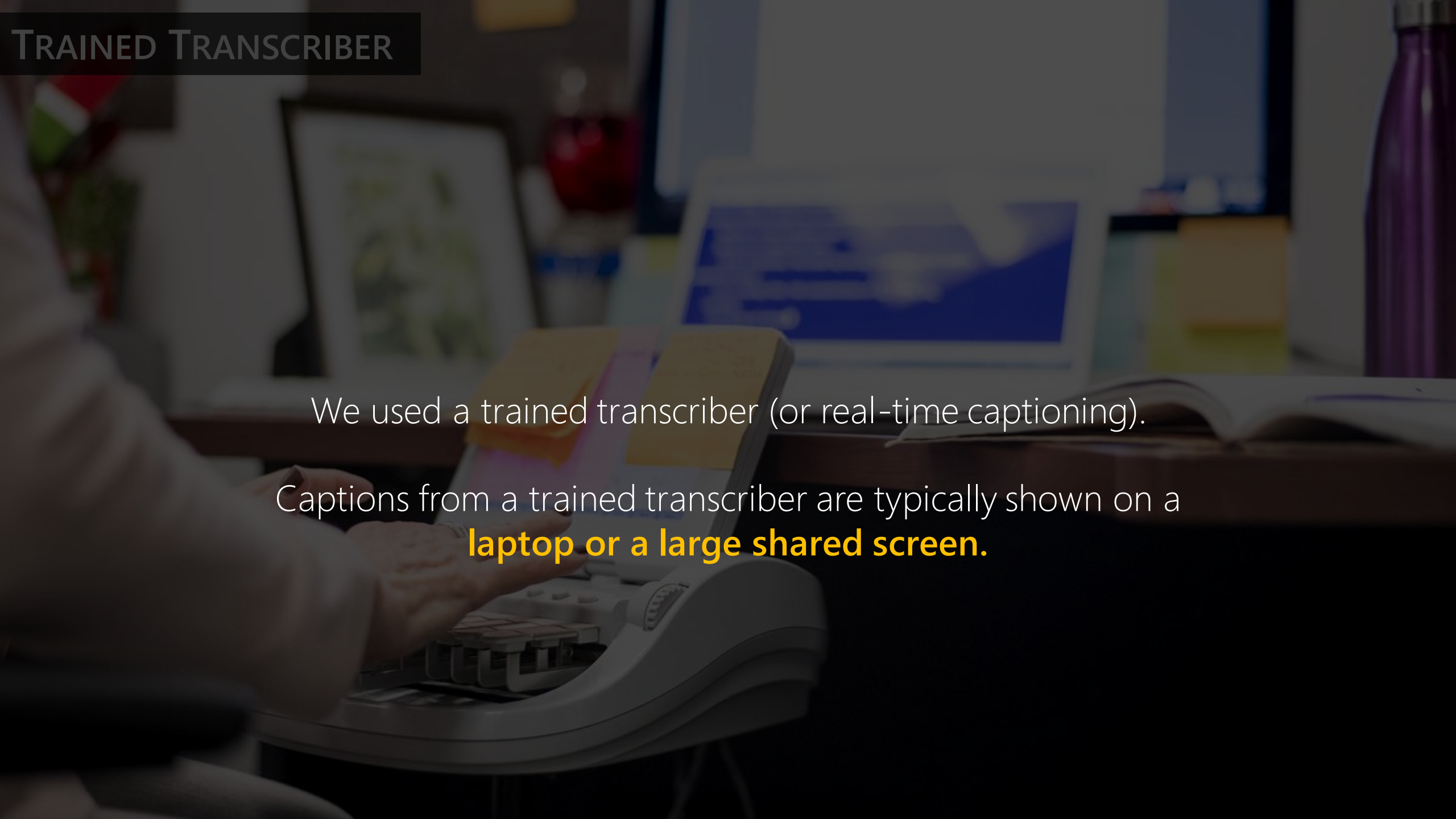
Trained Transcriber

Trained Transcriber



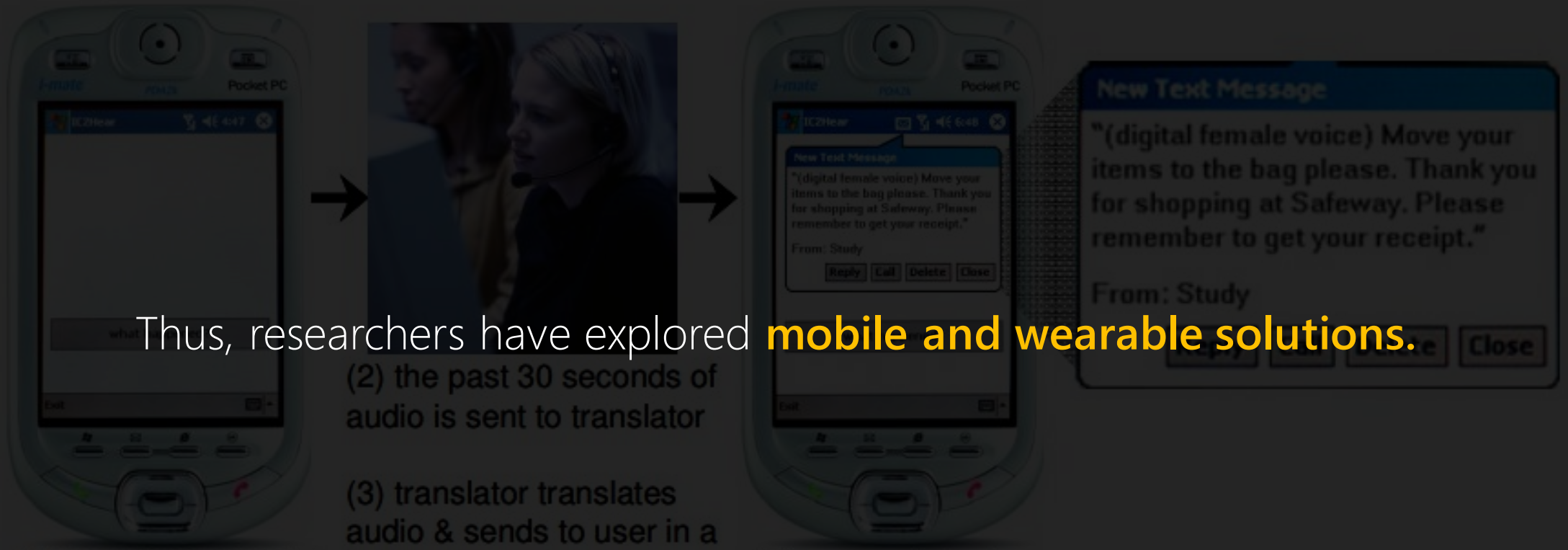
We used a trained transcriber (or real-time captioning).

Trained Transcriber



We used a trained transcriber (or real-time captioning).

Captions from a trained transcriber are typically shown on a **laptop or a large shared screen.**



Thus, researchers have explored **mobile and wearable solutions.**

Matthews *et al.*, UbiComp 2006

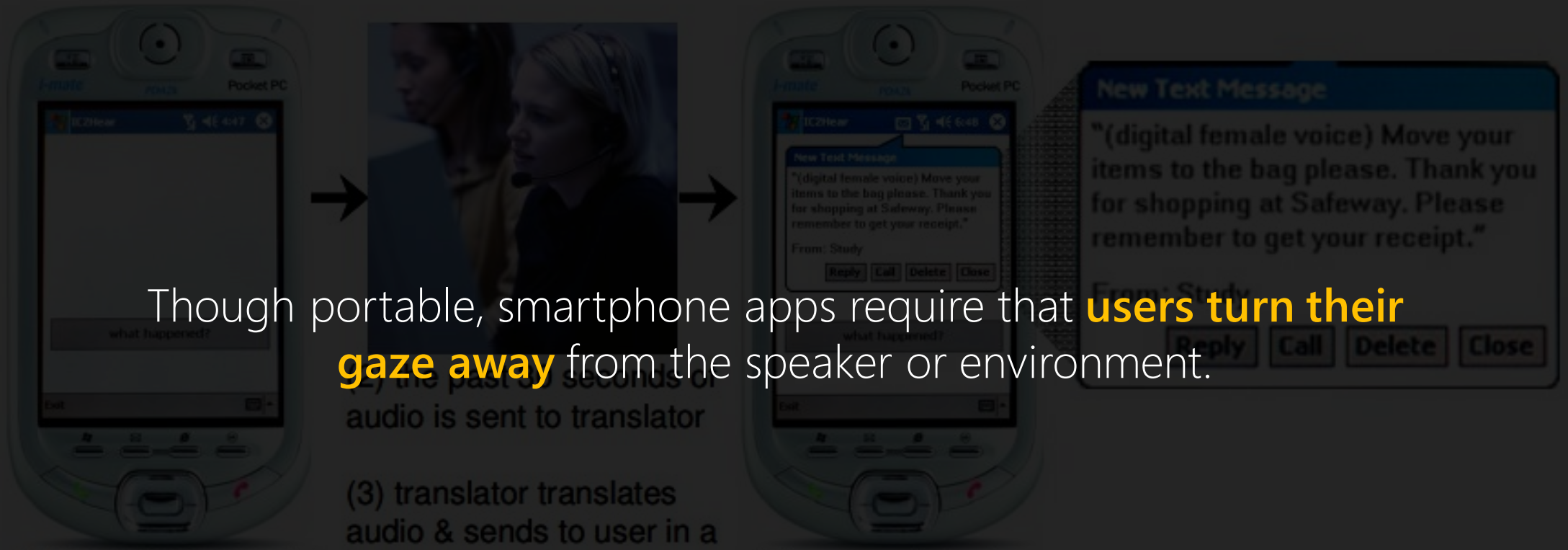
(1) user needs sound info & clicks “what happened?” button

(2) the past 30 seconds of audio is sent to translator

(3) translator translates audio & sends to user in a text message

(4) user gets text message describing sound

Matthews *et al.*, UbiComp 2006



Though portable, smartphone apps require that **users turn their gaze away** from the speaker or environment.

Matthews *et al.*, UbiComp 2006

To reduce this visual split, researchers have used **HMD to show captions.**

Peng *et al.*, CHI 2018

Peng *et al.*, CHI 2018

However, no work has evaluated HMD-based captioning in a

mobile context.

Background and Past Work → Study 1: Interview → Proof-of-Concept HMD Prototype → Study 2: Evaluation

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Study 1

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- To assess the communication needs and potential technologies for DHH people in mobile contexts.

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Study Method

- Two part **semi-structured formative interview in lab-setting**: (i) challenges in a mobile conversation, (ii) ideas for future captioning technology
- Three mobile scenarios were explicitly explored: walking, in transit, and recreational.

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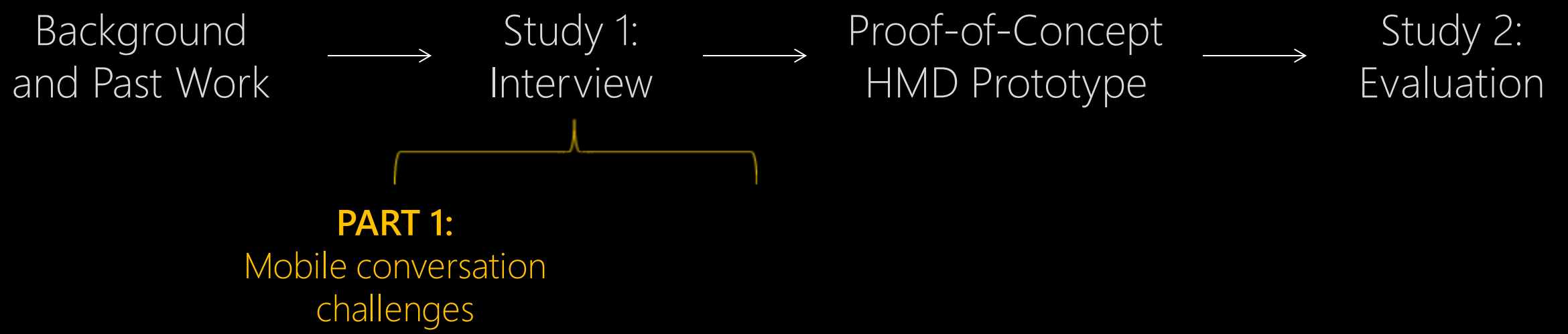
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Study 1: Interview
Proof-of-Concept HMD Prototype
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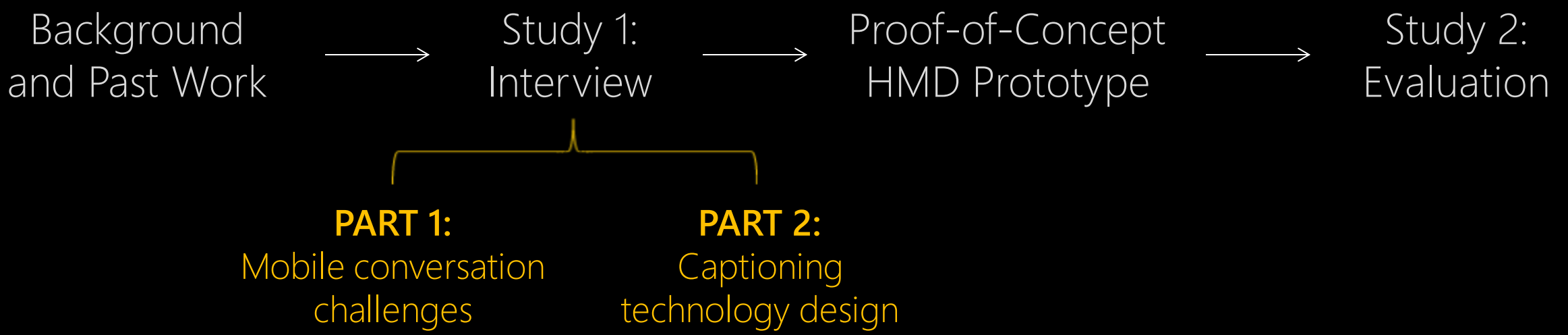
PART 1:
Mobile conversation challenges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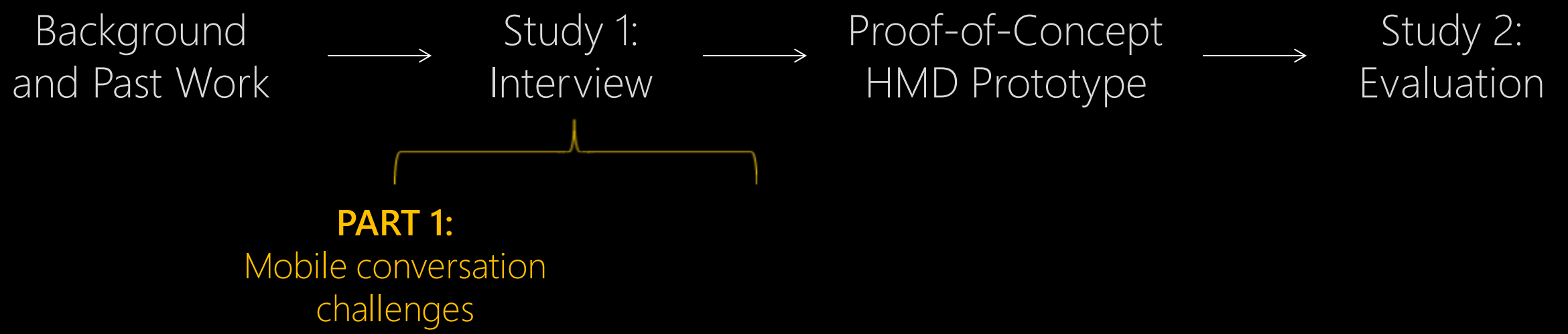
PART 2: Captioning technology design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Mobile conversation challenges

Participants had mobile conversations while **walking** to or from meetings, classes, and social activities as well as on **public transport** and in **cars.**

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Assistive technology use in mobile contexts is **rare.**

“I don't usually use technology other than hearing aids in moving conversations. I will occasionally use my phone to type something if it’s impossible to hear. The [phone] isn't perfect because it demands that I split my attention and [also] have one [hand] holding the phone.”
- P12

Moving Conversation Challenges

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- Conversations are **brief and shallow**

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- **Hearing people** do not understand and accommodate needs

“If I need to look away for some reason, a deaf person will automatically stop talking and resume when I’m ready. A spoken conversation doesn’t have that type of natural stop and start…”

- P10

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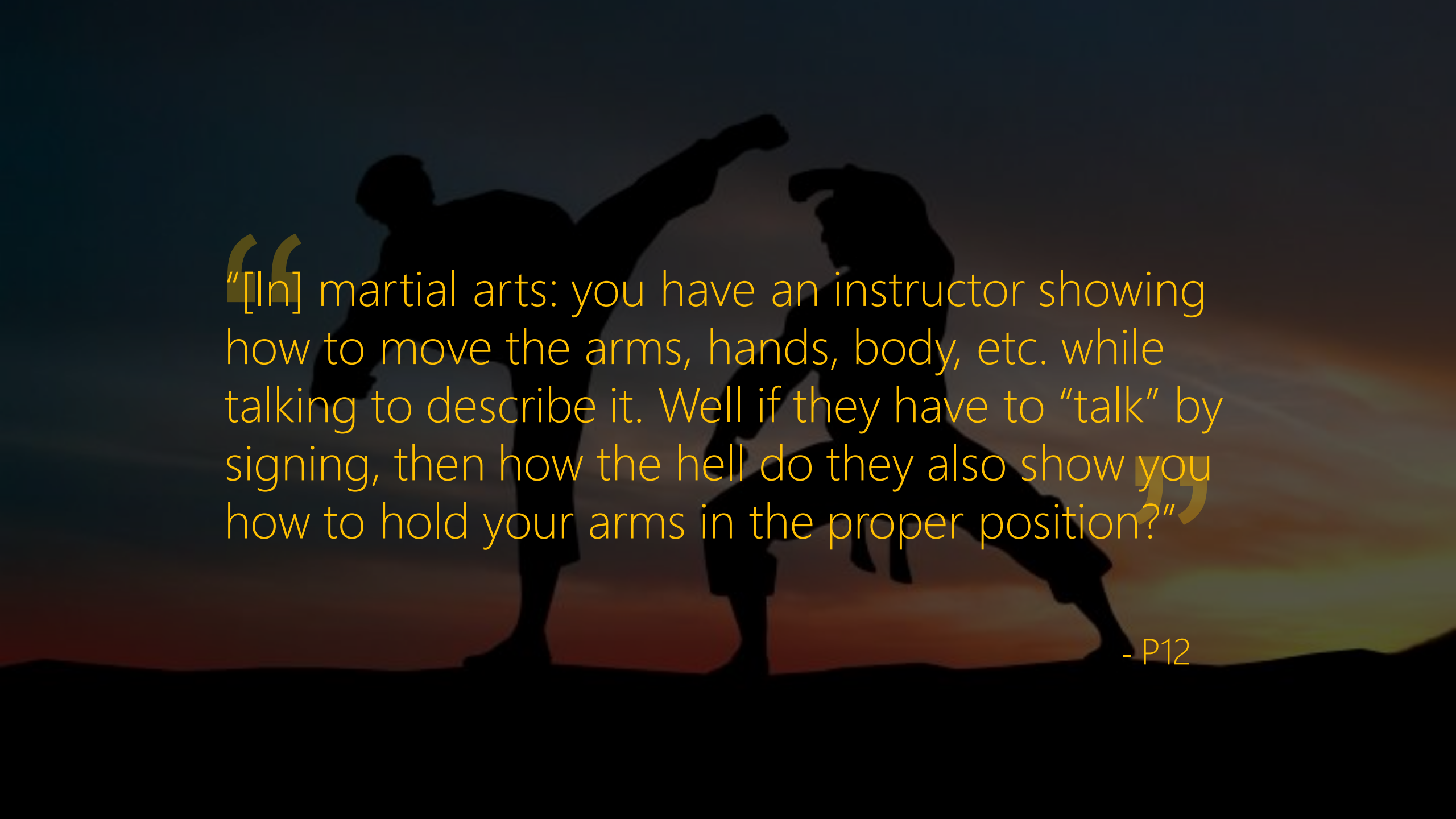
- **Hearing people** do not understand and accommodate needs
- **Recreational activities** are particularly challenging



“[In] martial arts: you have an instructor showing how to move the arms, hands, body, etc. while talking to describe it. Well if they have to “talk” by signing, then how the hell do they also show you how to hold your arms in the proper position?”

- P12

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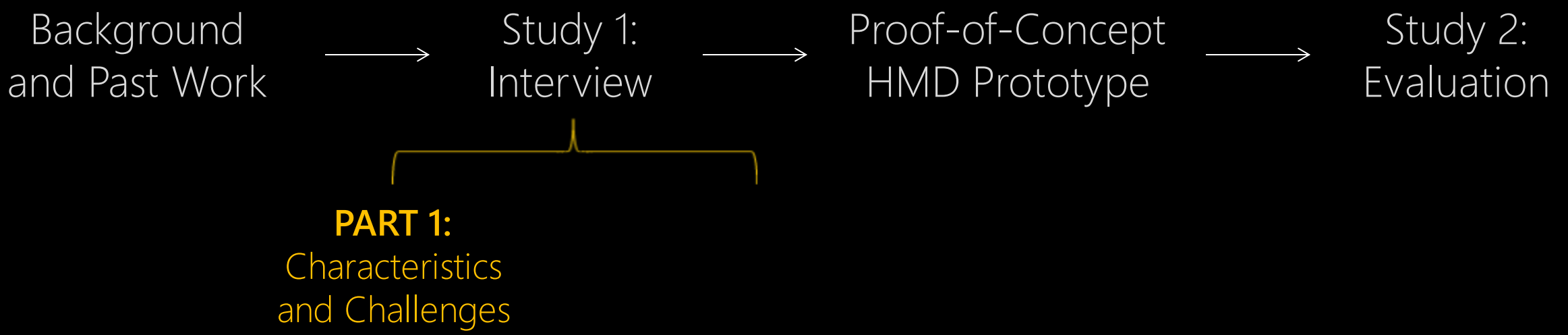
Moving Conversation Challenges

- Conversations are **brief and shallow**
- **Hearing people** do not understand and accommodate needs
- **Recreational activities** are particularly challenging
- Challenges of varying **space, lighting** and **background noise**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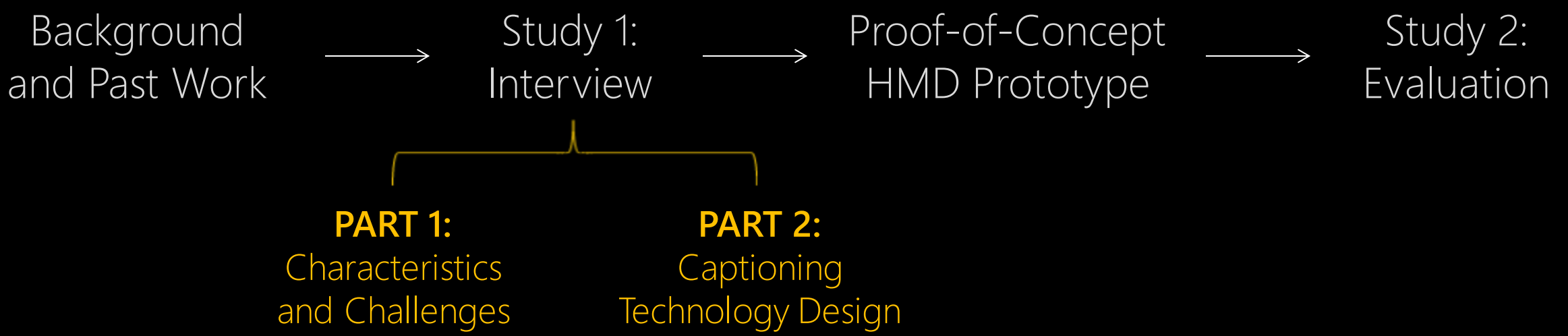
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PART 1: Characteristics and Challenges
PART 2: Captioning Technology Design

All participants said they would use real-time captioning in at least one moving conversation scenario (walking, transit or recreational activity).

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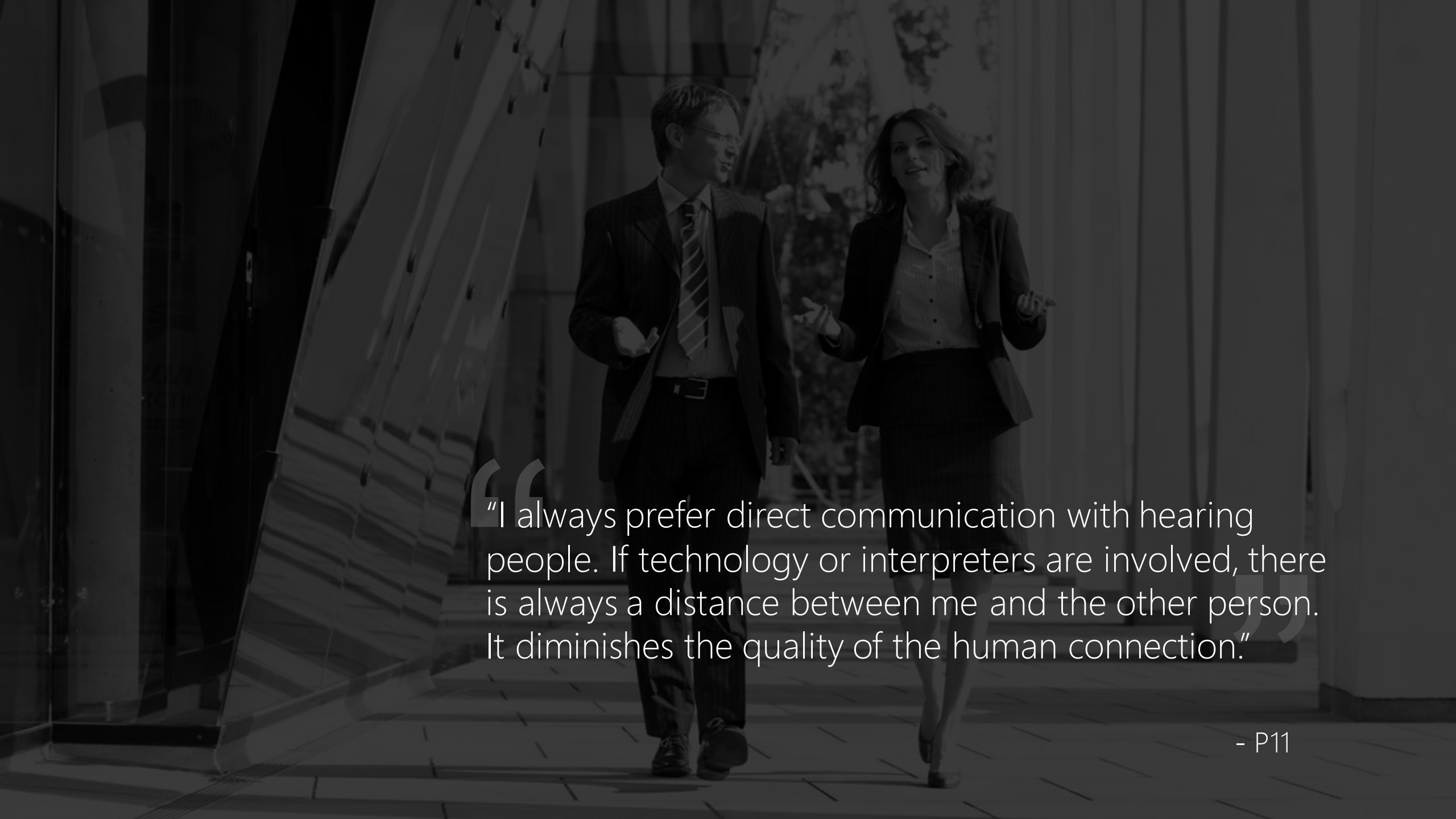
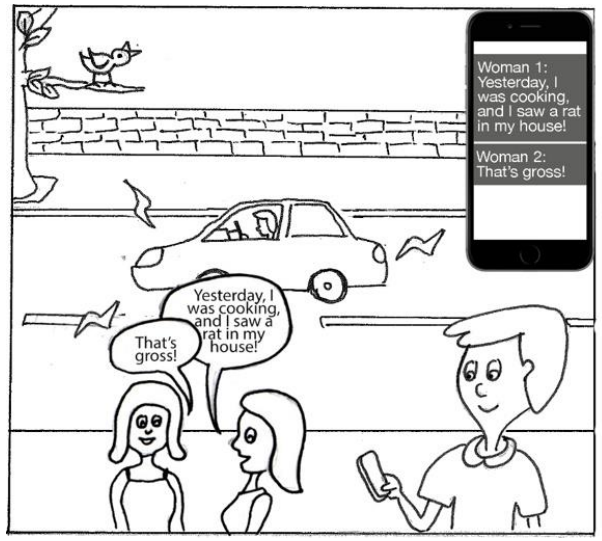
However, some were concerned that **captions may affect conversation quality** (*N*=7).



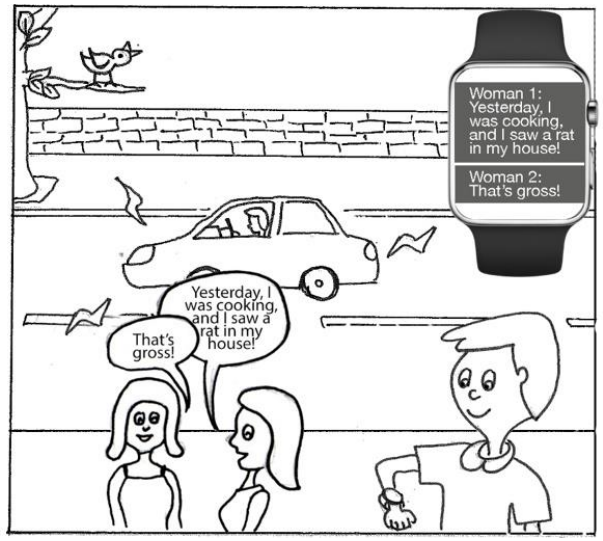
“I always prefer direct communication with hearing people. If technology or interpreters are involved, there is always a distance between me and the other person. It diminishes the quality of the human connection.”

- P11

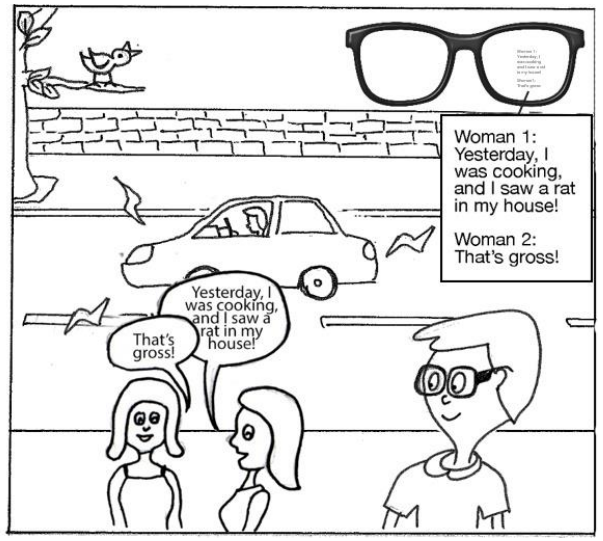
COMPARING DEVICES



SMARTPHONE



SMARTWATCH



HMD

	HMD	Smartphone	Smartwatch
Walking	*N*=11	*N*=1	
Transit (bus, car)	*N*=6	*N*=4	*N*=1
Recreational	*N*=5	*N*=4	

HMD was most preferred because it would **reduce the visual attention split.**

	HMD	Smartphone	Smartwatch
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For high-contact sports, some people wanted smartphone because **HMD could fall off.**

Smartwatch was the least preferred because of the **small display size.**

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Designs Sketched By Participants

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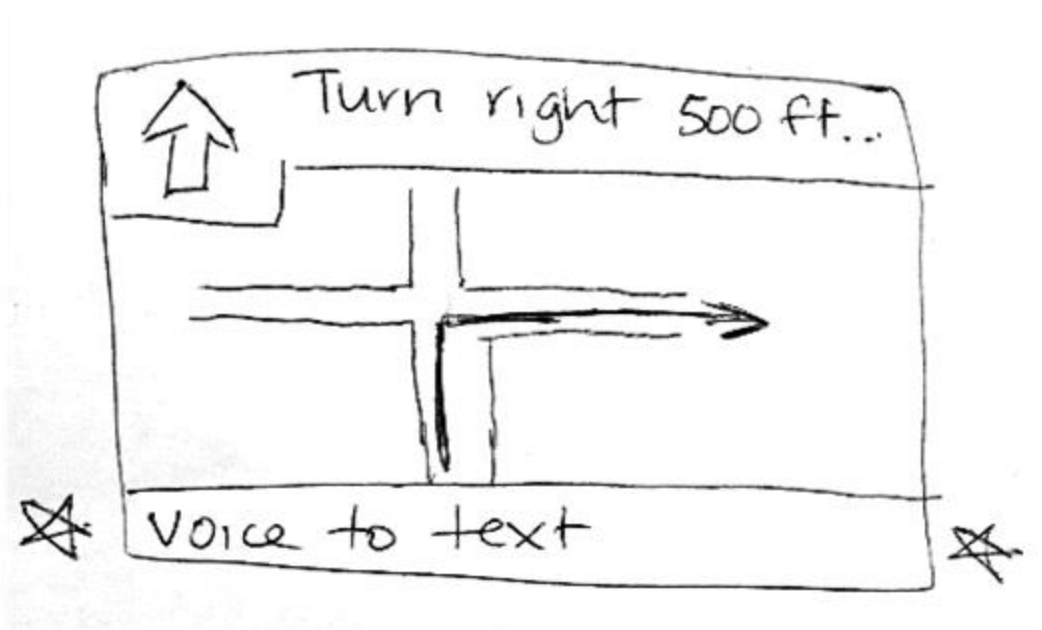

P5: Integrate captioning with car GPS
To reduce having to look at multiple devices

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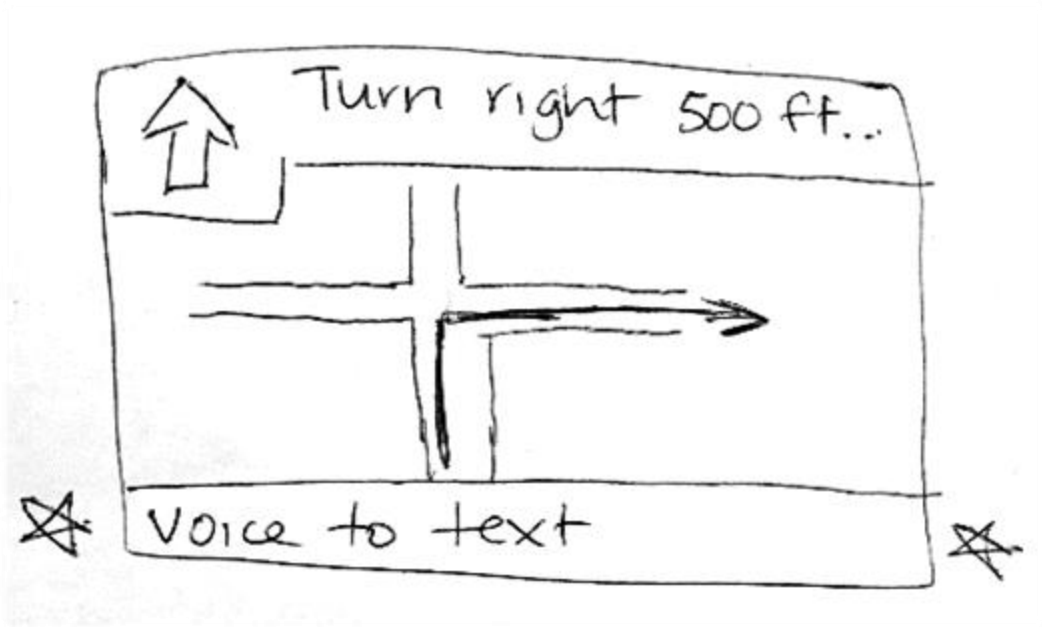

P5: Integrate captioning with car GPS
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P2: A wrist worn device
To display captions

Background and Past Work → Study 1: Interview → Proof-of-Concept HMD Prototype → Study 2: Evaluation

Background and Past Work → Study 1: Interview → **Proof-of-Concept HMD Prototype** → Study 2: Evaluation

"This is third floor of the building.
We have a shop here..."

"This is third floor of the building.
We have a shop here.
Below, there's a restroom. " `

"This is third floor of the building. We have a shop here. "

"This is third floor of the building. We have a shop here. "

>> John: Yes, the weather here is quite nice today.
Design 1: Captions at a fixed distance from the eyes
>> John: Yes, the weather here is quite nice today.
Design 2: Captions projected onto a surface

Background and Past Work → Study 1: Interview → **Proof-of-Concept HMD Prototype** → Study 2: Evaluation

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- To assess whether the use of HMD captions increased conversation accessibility, and decreased attention split for walking conversations

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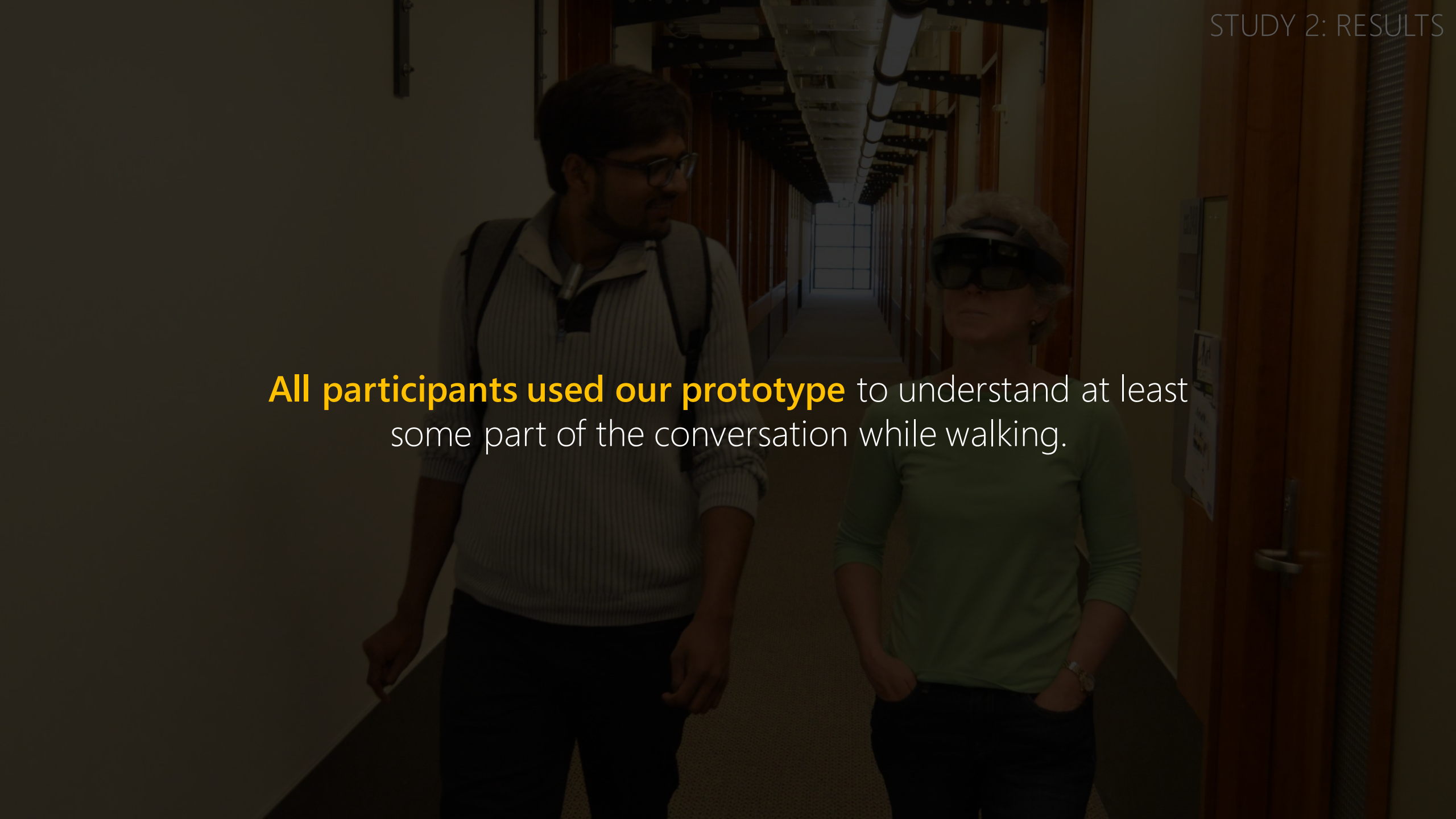
Part 1: Walking Scenario with HMD

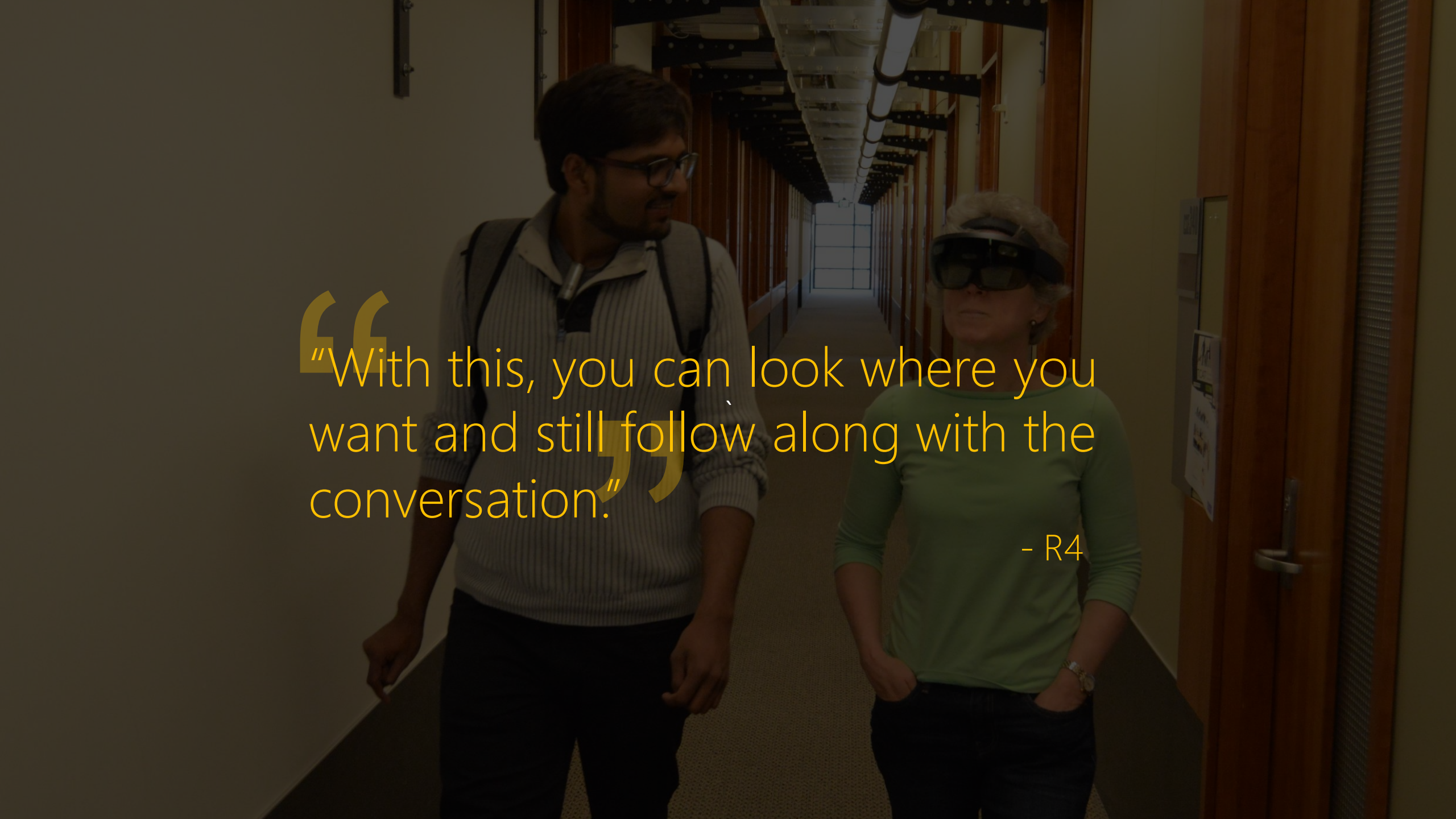
- One researcher conversed with the participant on casual topics
- Another researcher took observational notes
- The first researcher wore a lapel microphone that relayed speech to the on-site transcriber

Part 2: Open-ended Interview

- On the experience any feedback to the prototype



All participants used our prototype to understand at least some part of the conversation while walking.


“With this, you can look where you want and still follow along with the conversation.”
- R4

However, four participants found captions to be **occasionally distracting.**

“When I was trying to formulate my own responses, I would find the captions quite distracting and, in cases like that, I wish [...] that I could look away from [the captions], at my discretion.”

- R5

High-Level **Themes**

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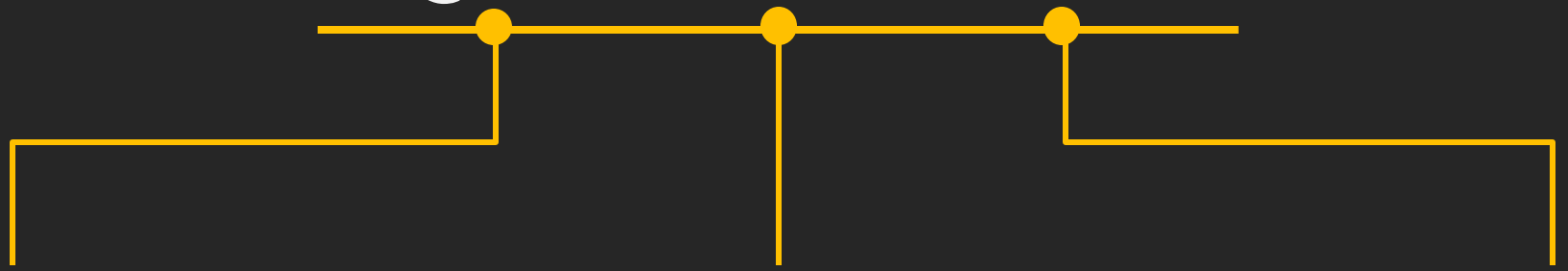

High-Level **Themes**

Visual Split

- Participants used both speechreading and captions.
- Oral speakers looked at speakers more than captions. Sign language users focused on captions more.

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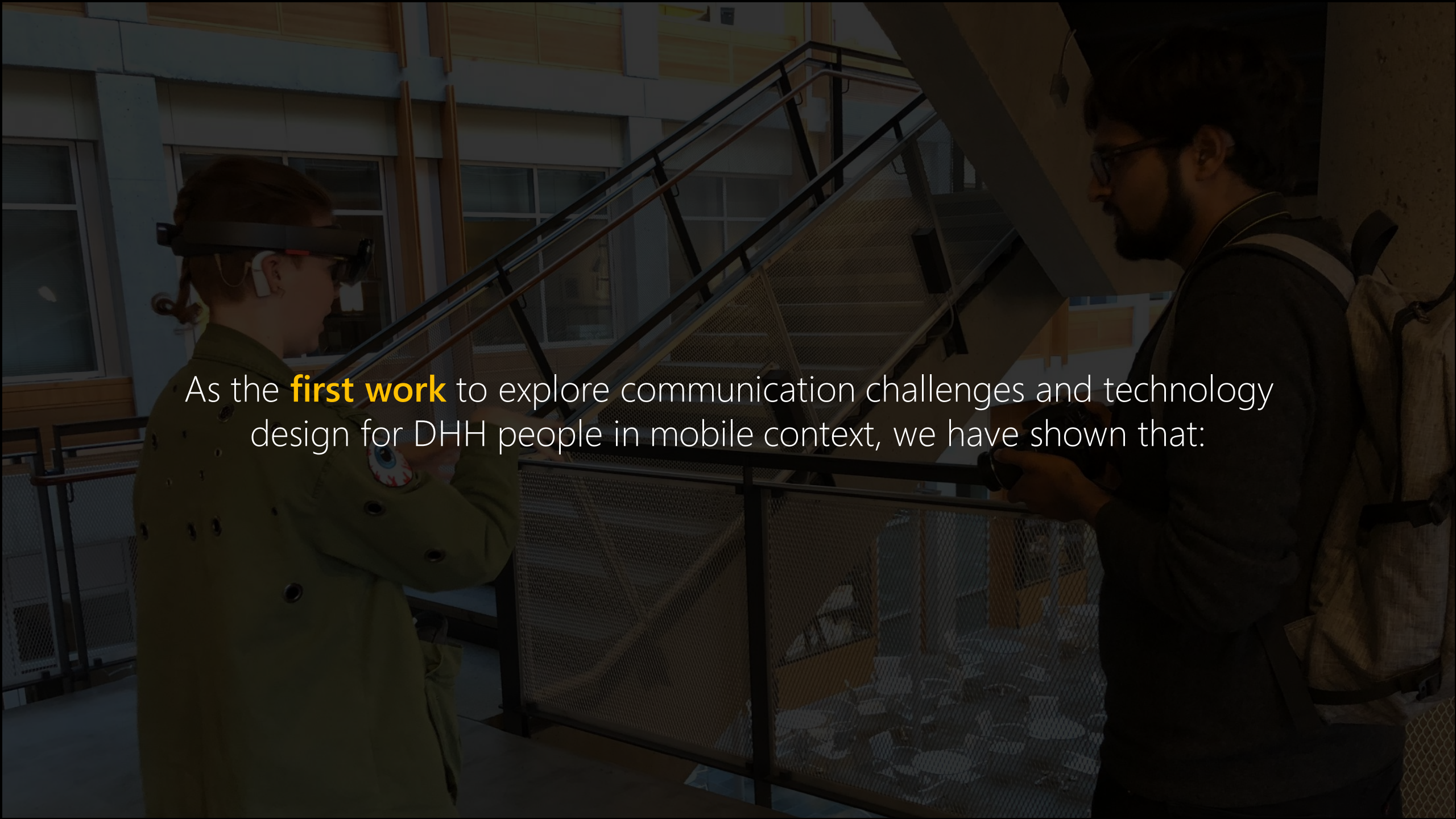
- Split between whether to show captions in the field of view (*N*=6) or above speakers (*N*=4).
- All wanted the ability to turn off the captions when needed.

Design Suggestions

- Display speaker identification cues (*e.g.*, name, location).
- Display environmental sounds (*e.g.*, door opening).
- Display voice tone and volume.

Reflection



As the **first work** to explore communication challenges and technology design for DHH people in mobile context, we have shown that:

1 Mobile context offer **new challenges** and a **new unexplored space** for innovation.

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2 Assistive technology in mobile contexts need to be **carefully designed.**

Design Guidelines
for HMD-Captioning

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Automatic depth alignment

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Adapt to changing context

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Convey **contextual information**

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Automatic depth alignment

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Customizable

The Team

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