Supporting People with Vision Impairments in Automated Vehicles

Dr. Robin Brewer
Dr. Nicole Ellison
Transportation is a huge barrier for ____________.
Enhancing Independence and Safety for Blind and Deaf-Blind Public Transit Riders

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Session: Navigation & Safety

ABSTRACT
Blind and deaf-blind people often rely on public transit for everyday mobility, but using transit can be challenging for them. We conducted semi-structured interviews with 15 blind and deaf-blind people to understand how they use public transit and what human values were important to them in this domain. Two key values were identified: independence and safety. We developed GoBusRide, a real-world application that provides an interface to consent to receive information about buses and bus stops while supporting the key values. GoBusRide is built on MothBraille, a novel framework that enables a Braille display to benefit from many features in a smartphone without knowledge of proprietary, device-specific protocols. Finally, we conducted user studies with blind people to demonstrate that GoBusRide enables people to travel more independently and safely. We also conducted co-designs with a deaf-blind person, finding that a minimalist interface, with short input and output messages, was most effective for this population.

Author Keywords: Blind, deaf-blind, accessibility, Value Sensitive Design, autonomy, safety, public transit usability.

H.5.2 Information interfaces and presentation (e.g., HCI): User Interfaces.

Opinions and Preferences of Blind and Low Vision Consumers Regarding Self-Driving Vehicles: Results of Focus Group Discussions

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ABSTRACT
Fully autonomous vehicles, commonly referred to as self-driving vehicles, are an emerging technology that may hold tremendous promise for individuals who are blind or visually impaired who have been previously disadvantaged by an inability to operate conventional motor vehicles. In a focus group study of 38 participants who are blind and low vision, through the use of a focus group methodology, engaging for emerging self-driving vehicle technology. Participants were overwhelmingly optimistic about the potential for independence and mobility that self-driving vehicles may provide but were concerned that the needs of individuals with visual impairments were not being adequately considered in the development of these vehicles. Participants also raised questions about how the technology would suit their needs for situational awareness, how the technology would enable blind or visually impaired operators to verify their arrival or their desired location, and a host of other issues related to packing, vehicle location and roadside assistance. Participants also expressed a preference for smartphone and speech input capabilities as a primary means of system interaction. These findings suggest that at a minimum more needs to be done to engage individuals with visual impairments in the development of self-driving vehicles and to increase awareness of manufacturer efforts.

error prone human beings from the driving process may potentially eliminate the types of traffic accidents that claim thousands of lives annually and results in costly property damage and loss [13]. Self-driving vehicle technology may render the personal vehicle ownership obsolete as transportation is increasingly consumed as a service [3]. This, in turn, may change the financial models of a host of major industries and the physical designs of cities themselves [5, 23]. To realize these benefits, consumer adoption of such a paradigm shifting technology is critical given the presently high costs of the technology and the potential safety concerns of autonomous driving [4]. While discussions of the impact of self-driving vehicle technology taking place in academic, regulatory bodies and in industry are being accompanied by wide ranging consumer and user research there are still large knowledge gaps as it relates to the needs and preferences of specific groups of users. It has been suggested for instance that mass producing self-driving vehicle technology being developed is not in fact accessible to individuals with visual impairments [18]. This may be an issue that is attributable to a knowledge gap as it relates to the needs and preferences of individuals with visual impairments regarding self-driving vehicle technology.

The present study was designed to contribute to the literature on the exploration and education of concerns and blind and low vision consumers. To the best of our knowledge, no such research has been conducted to date.

Not All Errors Are Created Equal: Factors that Impact Acceptance of an Indoor Navigation Aid for the Blind

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Session: Navigation & Safety

ABSTRACT
Sight-impaired people who have the ability to help a blind person navigate, by coveyed with a device that can detect of lack of knowledge of how person navigators navigate without vision think that the sight-impaired is too a person with a visual aid providing knowledge to blind early assistive technology for naviga the design of a personal personal assistant for blind without the use of a visual aid.

“Just Let the Cane Hit It”:
How the Blind and Sighted See Navigation Differently

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Information Systems and Operations Management
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ABSTRACT
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The introduction of errors due to, for example, insufficient training data or changes in lighting or viewing angle.

Previous research has explored factors that lead to assistive technology (AT) adoption [20] and abandonment [7]. Factors include a lack of confidence for new users, one of device procurement, poor device performance, and changes in needs or priorities. Our goal is to better understand what constitutes poor device performance for indoor navigation AT.

We deployed a survey to 41 blind participants to evaluate their reactions to errors made by an imagined indoor navigation device in different scenarios of use. We found that error type, learning failure for which the error is made, and social-environmental setting vary impact users’ acceptance of the device.

2. SURVEY DESIGN AND ANALYSIS

Before navigation aids that rely on computer vision can make three kinds of errors: object misidentification, false negative (FN); failure to identify a trained object that is actually in view) and false positive (FP; identifying an object that is not in view). To explore how these errors impact device acceptance, we designed a survey that presented an imagined indoor navigation device and error types to participants.

The imagined device was described as a wearable technology with computer vision, capable of recognizing building features in the 3- to 6-clock range. Features included detection of negative signs, the ability to avoid potential obstacles (e.g., Starbucks). Five contextual cues, each with two options, were presented evenly in two scenarios: closed streets (closed side easily visible) and open streets (environment familiar or familiar, context unknown).
“While blind people get around by using mass transit and other things, we don't have the flexibility the autonomous vehicles will present”

John G. Paré Jr., executive director for advocacy and policy at the National Federation of the Blind
1. Designing for barriers of automated vehicles
   DESIGN FOCUS GROUPS

2. Transportation experiences of people with vision impairments
   INTERVIEWS WITH RIDESHARING PASSENGERS AND DRIVERS
“Even though people aren't driving, we know that a sense of control is essential” (Waymo)

Source: Engadget
AUTOMATED DRIVING

LEVELS OF DRIVING AUTOMATION ARE DEFINED IN NEW SAE INTERNATIONAL STANDARD J3016

Source: SAE International
**RQ1: PERCEPTIONS OF CONTROL**

**RQ2: DESIGNING FOR CONTROL**
How can we design accessible systems to support people with vision impairments and differing levels of control in automated vehicles?

Methods

2 focus groups with N=15 people with vision impairments
(7 women, 35-76 years old, mean = 59)
Methods

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(7 women, 35-76 years old, mean = 59)

Experiences driving and with transportation

Automated vehicles

Ideation through design (audio and tactile)
Unexpected autonomy

“I wouldn’t want to be in a vehicle like that [semi-AV] because I know nothing about operating a vehicle anyway so I would have to be in the fully autonomous” – P4

source: verge.com
“if you’ve never drove, then a semi won’t be for you because you have to know how to drive” – P3
Unexpected autonomy

“the ability for you to take over and still have some type of tactile signals given to you and say ‘this is not working. This is not going to work’ and you can still achieve your, you know, independence” – P14

source: verge.com
Identity as a driver

“that’s what I did for a living as a transportation equipment operator for public transportation”

“I warm the car up, the vehicle, for my wife every day...I start it up and pull it out the garage. So, it takes a skill to do that” – P7
Designing for Control

1. Malfunction
2. Misinterpretation
3. Trust
4. Anxiety
“as you’re driving with your hands at 10 and 2, you can use your thumbs ...[you will] get some type of tactile feeling of what’s going on there. So, it’ll work kinda like a Refreshable Braille Display that can move up as vehicles are approaching on the left and right” (P14)
Takeaways:
1. Tension between control and independence
2. Control is a spectrum, adaptive AVs?
Transportation for accessing resources
(Dillahunt and Veinot, 2018)

- education
- jobs
- medical professionals
- healthy food
RQ1: How does the ridesharing ecosystem function for people with vision impairments in the United States? What actors are involved? What are benefits of ridesharing? What are challenges of ridesharing?

RQ2: What assistance behaviors do people with vision impairments employ? Who do they take assistance from? What is the nature/timing of this assistance?

Methods

**Semi-structured interviews**
16 participants in Greater Detroit area
10 male, 6 female, mean 41.6 years

Experiences, challenges and perceptions of other transportation modes
Analyzed using inductive and deductive coding methods
$20 compensation
Findings

1. Role of the driver
2. Role of strong ties
3. Tech driven assistance
"Well, sometimes they can’t always see where you are. They think you can see them and you tell them you can’t... For example, I waited out by my garage before and a guy swore he was at my house. And I said, ‘You’re not at my house ’cause I’m at the garage.’ He goes, ’I’m at the garage.’ I said, ‘No you’re not, ’cause I’m right here’... He drove around, and he finally saw me."
Role of the driver

Need to build trust, difficult in other transportation

"I don’t know anything about the taxi or bus routes. It’s a completely new location, so I have no idea how it works, and it’s not worth the effort for me to look all that up, and it’s potentially unreliable, and I could potentially make a mistake."

"I think there’s an unspoken kind of social contract that plays out in the Lyft. Not always...cause some drivers obviously don’t wanna talk, but generally they do."
Role of strong ties

Mediating mobile app access

"That’s the only way I can get the ride, one of my granddaughters have to text my daughter to do it. Then she’ll do it and she’ll call that, [the driver will] text what color [car]"
Tech driven assistance

BlindSquare, AroundMe and AIRA to mitigate human assistance

“When I order Uber or Lyft, I can order it through my visual interpreter, and then the visual interpreter knows the name and the car, and they know what the car looks like. So now when the car pulls up... the visual interpreter can see what’s in front of me, they can tell me... ‘Walk straight ahead, a little to your left is the back door.’...It limits the third party assistance”
More than transportation

Design experiences to support entry and exit work before/after a trip
Nearby in-person support

Scaffold trust building opportunities in AVs
Co-located “agents” to engage in conversation
Before the ride begins: Drivers’ decision-making process

Kreutz, 2019; Finney and Koury, 2019
Drivers can create inaccessible experiences

Lyft to pay $40,000 fine over claims it denied disabled passengers rides

The move comes after the Justice Department investigated the ride-hailing company for allegedly violating the Americans with Disabilities Act.

Several lawsuits have been filed against Lyft for allegedly discriminating against people with disabilities.
RQ1: What roles do ridesharing drivers play when collaborating with people with vision impairments to support accessible transportation?

RQ2: What expectations do drivers have of passengers with vision impairments? How do drivers assess and manage these expectations?

RQ3: How can ridesharing better support communities of people with vision impairments and other disabilities?
Methods

• Semi-structured interviews with ride-sharing service drivers focusing on their interactions with passengers with vision impairments (n=18)
  • Assistance, collaboration, trust, communication, etc.

• Recruited in Facebook groups and forums for ridesharing drivers

• Audio recorded, transcribed, inductive and deductive codes
  • Perceptions, policies and training, mistrust, negative experiences, etc.
Table 1. Participant Information - average age = 51.67 years old, 6 = female

<table>
<thead>
<tr>
<th>ID</th>
<th>Gender</th>
<th>Age</th>
<th>Driver For</th>
<th>Location</th>
<th>Experience w/Passenger Impairments</th>
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• Above and beyond driving, **what roles did drivers perform** for their visually-impaired passengers?
  • What can this tell us about the design of automated vehicles and the kinds of invisible support services that might be missed?

• When, if at all, in the process should **drivers be informed** about passengers’ vision impairments?
  • How do we give drivers access to information that could enable them to help their vision-impaired passengers while also protecting passengers from potential bias and discrimination?
Drivers performed physical labor roles and found societal value in them.

“I’ve just got a few things to move”. He goes, ‘would you mind helping me?’ I grab boxes... We load them up, take him to his new apartment, and he goes,... ‘would you help me carry these up the steps?’ No problem, I would’ve done it if he wouldn’t have asked, I would’ve offered.

...He goes, ‘would you let me hold onto your arm, and you walk me around the room so that I can memorize where everything is at?’... We walked around and we got to the thermostat for the heating and cooling. And he goes, ‘tell me what each button is for on this’... (P13)
Drivers sometimes performed emotional support roles.

"...you just stop and sit and listen and talk them up for a while so they’re not so depressed. Or, people who are abused by other people and in a bad situation and nobody’s coming to bat for them, and so you sit and try to feed them other points of view and to boost them up so that they can [...] figure out options for themselves. It’s like you bond with people, and you just get to be there for them sometimes" (P12)."
Some drivers formed relationships over time, with positive outcomes for both parties.

“...we just talked on the way and got her to where she was going, [she] was very happy. And then the second time I had her she remembered me and our conversation, whatever we talked about that particular day, being what I used to do for a living and et cetera, just little fun facts that she remembered, and was glad that it was me.”
When in the process should drivers be informed (if at all) about the nature of their passengers’ vision impairment?

“I was a little anxious because I really didn't know what to do...it was really more out of lack of experience more than anything else. It wasn't because I had any kind of angst about having someone who's visually impaired in my car. I just didn't want them to feel uncomfortable riding in my car... (P10)
Drivers expected people to disclose their disability as it helped drivers feel more comfortable in knowing how (much) to assist as a driver it would be nice to know ahead of time. However, I get the fact that they wouldn't want to tell us that ahead of time, also. ... There are predators out here and if somebody knew that that was a visually impaired person, they could plan it ... try to figure out some way to take advantage of them... (P2)
ADA protects people with disabilities

Serving people with different disabilities

Different people have different needs. You can offer great service to your riders by learning the best way to assist them.

Helping people who use wheelchairs or scooters
Knowing how to store wheelchairs and scooters helps people with limited mobility feel welcome and independent in your car.

READ MORE

Helping people who are blind
You can assist people who are blind or have low vision by offering to guide them to your car.

READ MORE

Helping people who are deaf
You can help people who are deaf or have hearing loss by being patient and using visual communication.

READ MORE

Helping people with service animals
You can help people with service animals by welcoming their companions into your car. In most circumstances, it's illegal not to and rejecting one can lead to permanent deactivation.

READ MORE
But some drivers admitted engaging in discriminatory behaviors...

"This can cause drivers to engage in discriminatory behaviors...

"If it's like a pit bull or a crazy looking dog, I probably will skip on that ride and not have that issue... (P11)"

"...because they perceive it to affect future rides"
If we replace the human decision-maker (the driver) with an algorithm, does this problem go away?
For some employment algorithms, disability discrimination by default

Alex Engler • Thursday, October 31, 2019

Last week, *Washington Post*’s Drew Harwell reported that HireVue’s artificial intelligence (AI) software has assessed over a million video job interviews. Its autonomous interview system asks questions of candidates, films their responses, and then uses the resulting video and
“Fairness through awareness”

Overview

Artificial Intelligence (AI) is increasingly being used in decision-making that directly impacts people’s lives. Much has been written about the potential for AI methods to encode, perpetuate, and even amplify discrimination against marginalized groups in society. Like age, gender, and race, disability status is a protected characteristic. Disability status has many dimensions, varies in intensity and impact, and often changes over time; yet, today’s methods for bias testing tend to simply split individuals into members of a protected group and “others.” Disability information is also highly sensitive and not always shared, precisely because of the potential for discrimination; AI systems may not have explicit information about disability that can be used to apply established fairness tests and corrections. Finally, some disabilities have relatively low rates of occurrence; in current algorithmic processes, these individuals can appear as data outliers rather than part of a recognizable subgroup. These are just three examples of how theory and practice of AI require scrutiny to ensure fair treatment of people with disabilities.
Takeaway:

Sometimes drivers do much more than drive

Who will perform this emotional, relational, and physical labor if drivers are replaced by AVs?
Takeaway:

Removing the driver may not remove discriminatory behavior

How can software for AVs be designed in such a way that individuals are supported but biases are not exacerbated?
1. Designing for AV barriers
   DESIGN FOCUS GROUPS
   1. Tension between control and independence
   2. Control is a spectrum, should it be a choice?

2. Understanding transportation
   INTERVIEWS w/ RIDESHARING PASSENGERS AND DRIVERS
   1. Drivers play a critical role
   2. Bias may still be a concern, even without drivers (people) making decisions
Thank you!

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Vaishnav Kameswaran
Amy Austin

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Thanks!

Questions?

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