

Voice Assistant Strategies and Opportunities for People with Tetraplegia

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ABSTRACT

To help both designers and people with tetraplegia fully realize the benefits of voice assistant technology, we conducted interviews with five people with tetraplegia in the home to understand how this population currently uses voice-based interfaces as well as other technologies in their everyday tasks. We found that people with tetraplegia use voice assistants in specific places, such as in their beds, or when traveling in their wheelchair. In addition, we note the inefficiencies for people with tetraplegia when using voice assistance.

Author Keywords

Tetraplegia, design research, voice user interfaces, voice agents, assistive technology

CCS Concepts

•Human-centered computing → Accessibility design and evaluation methods;

INTRODUCTION

Voice assistants—"software agents that interpret human speech and respond via synthesized voices" [11]—have promise as a general purpose interface to provide access to information and services for people with limited use of their hands [17, 5]. Researchers have developed approaches to help people with motor impairments to use technology, such as voice user interfaces (The Vocal Joystick [10]) and brain-computer interfaces [16]. However, these are dedicated to a single-task. Natural language speech interaction could bring the goals of seamlessness and invisibility-in-use into reach [19, 12, 14].

Recent research suggests that existing voice assistant tasks (i.e., requesting music or information) are accessible to people with tetraplegia, who have paralysis of all four limbs [1]. In this paper, we explore what new opportunities voice assistance can offer people with tetraplegia, and to understand what constraints, if any, might need to be addressed so that they can



Figure 1. Voice can be a powerful tool for people with tetraplegia

fully realize the benefits of this technology. We present findings and opportunities from five home-based study sessions to understand current uses of voice technologies.

RELATED WORK

For people with tetraplegia, what challenges limit the adoption of voice assistance? Past research indicates that these interfaces are sub-optimally adapted to this population: interfaces have difficulty recognizing soft voices or distorted speech [18], which sometimes occur when people with tetraplegia use a respirator [3]. This indicates that people with tetraplegia need longer to execute voice commands [4].

The cost of specialized solutions once limited the possibility of adapting speech interfaces to special populations [15]. More recently, the mass consumerization of voice assistance devices and the advent of downloadable “apps” for general purpose platforms makes it easier to respond to the specific needs of people with tetraplegia. We hope to help designers clearly identify those needs.

In our work, we use *needfinding methods* to help us better understand users. This process of finding needs, or *needfinding*, comprises various thoughtful activities to help designers explore and understand people in relation to the design of new products. Here, some methods include conducting personal observations of users [9, 13], contextual inquiry around products [2], and semi-structured interviews inspired by Curtis & Tang’s “Needfinding for Assistive Technologies” [6].

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STUDY DESIGN

Participants

For this study, we recruited $N = 5$ participants who have tetraplegia. This population includes those who have spinal cord injuries, who use power wheelchairs, and who have limited motor ability in their legs and arms.

Participants were recruited through the clinical research program at Weill Cornell and through local contacts in the community. All participants were screened by an occupational therapist at Weill Cornell to verify medical suitability. Participants were ages 29-64, primarily male (4M;1F), 2 Caucasian, 1 Asian American, 1 African American, and 1 Hispanic. The levels of their spinal cord injuries were C5, C7, C5-C6-C7, C4. Participants in study had varied etiologies of their spinal cord injuries, including prior polio, motor vehicle accidents, a gun-shot wound to the neck, and a fall down the stairs.

Method

We performed contextual needfinding activities with the participants with tetraplegia, mostly in their own homes. We conducted semi-structured interviews [8, 6] along with wizard-of-oz prototyping [7] or a contextual inquiry [2]. Example activities included enactment activities where a researcher acted as a voice activated chair or drone, or contextual observation activities, where we had participants demonstrate the use of technologies in their house that they mentioned in the interview. The interviews and design activities were video-recorded and transcribed for subsequent analysis.

RESULTS

We found that our participants use voice assistant technology to address accessibility challenges.

Existing Use of Voice Interfaces

Participants generally had a preference for physical, specific-use interfaces when available (i.e. joystick, or phone), but in some contexts, voice was their only option. Four out of the five participants expressed that they used voice features when they were laying down, sitting, or when in transit, situations which put physical controls out of reach. When laying down, two participants use voice activation for playing music, emergencies, or for phone calls. P6 uses his Echo to get directions to prepare for trips.

Participant 1 explained, *“And I wanted to play some music, because I can’t when I’m laying down flat on the bed, I can’t grab the phone. I can’t control the phone at all when I’m laying down. If I’m not sitting up in the bed, or if I’m not sitting up in the chair, I can’t use the phone at all. The phone will be next to me sometimes... it may be charging on the windowsill, and I’ll tell the phone, um, “okay Google”...play some music. ...And it’ll work, or... I tell it to text and it’ll text.”*

P1 also reports that when he is sitting down for too long, he calls someone via Alexa so they can move him from his seat.

P3 explains that when the function stopped working:

“I could be in bed and I’d say, ‘Alexa, call [friend]’ and she would do it. Now, I have to say, girls, can you come here? So,

it’s annoying.” This indicates a preference for voice assistants to aide assistance for this kind of task.

Inefficiencies in Voice-Assisted Services

In several cases, we found make-shift uses of voice assistance technology in ways that suggest unmet needs.

P2 calls rooms in his house through an Echo Dot in order to ask his family members to come help him with using his iPhone. His daughter explained, *“He’ll just say ‘Call Kitchen’, and then it will just beep [in the kitchen]. And then, someone will go answer for him...It’s like a bell....Using his voice.”*

This anecdote illustrates a “last inch” problem. The services needed by P2 are right under his fingers on his iPhone. Still, he is using current-day voice assistance to solicit help from the next room to make use of services, including asking to change the temperature, making a call (Siri doesn’t understand his voice), or asking what is for dinner. He is not able to use voice commands to access those services directly.

Agency in Voice-Assisted Action

We wondered if people with tetraplegia would draw a distinction between the assistance received from technology vs. other people, but found that they regarded being able to command voice assistance as “doing things themselves.”

P2, for instance, expressed a desire to recline the chair without help from a health aide: *“recline the chair... I cannot do it myself. It is no good for control here, even. My aide will do it for me. That’s when I’ve been sitting too long, when she’ll do it- she’ll do it for me.....Um ... I’d like to do it myself, if I could do it myself.”*

P1 described using voice assistance to split a manual task: *“And I can hold the phone, because I can’t hold the phone and take the picture at the same time. So if you hold the phone and you tell the phone to capture, then that works best for me.”*

These anecdotes suggest that voice assistants have the opportunity to raise the self-efficacy of people with tetraplegia, if they are designed properly.

DISCUSSION

From these semi-structured interviews, we have identified the following needs. People with tetraplegia use voice activation when lying down on their bed, when on the floor, or while in transit. We suggest a physical convenience approach, distributing microphones on the bed frame, on the floor and even in the bathroom (with caution about privacy, and permission) in order to accommodate for the locations that the people will want to use the voice assistant technology.

In future work, we plan to examine novel uses of the wizarded voice-activated drone or chair (i.e., scratching the nose, checking who is at the door, picking up mail). Additionally, we plan to extend this work to include more participants.

We hope to empower users with tetraplegia to achieve daily tasks with voice assistance. We hope these current user strategies provide designers with insights and opportunities that help to create a seamless human-computer interaction for people with tetraplegia.

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