The Impact of Digital Voice Assistants on the Everyday Life of Physically Disabled Users: Barriers, Drivers and Potential for Improvement

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Abstract

To date, there is little research literature on the adoption and use of smart technology, like digital voice assistants by vulnerable user groups, such as physically disabled users. In particular, physically disabled users face different everyday obstacles that can be overcome by using digital voice assistants. Therefore, 18 interviews with users having physical disabilities (all wheelchair users) are conducted and evaluated by means of qualitative content analysis to identify the barriers and drivers of use, but above all the potential for improvement especially for this user group. The results show the potential for facilitating everyday tasks and increasing individual mobility offered by digital voice assistants, but also that financial barriers, lack of necessity, and the desire to maintain independence inhibit their use. To minimize these barriers for users with physical disabilities, financial support, better education, and improved functionality of the devices should be ensured.

Keywords: Digital voice assistants, physically disabled users, smart technology, user autonomy

1. Introduction

Smart environments offer the potential to assist users in their living and consumption habits and make related tasks more convenient and/or efficient (Ahmed et al., 2016). Currently, as part of this development, the use of digital voice assistants is in particular focus. Global players such as Amazon, Google, Apple, Microsoft, and Samsung play a significant role as leading players and develop and distribute digital voice assistants (e.g., Fota, 2022). Typically, digital voice assistants are provided in two different forms: As a function preinstalled voice application in mobile devices such as smartphones and tablets, e.g., Apple's Siri. Or, they are increasingly being integrated into hardware solutions manufactured specifically for this purpose, such as so-called smart speakers, e.g., Amazon's Alexa or Google Home (Wagner & Schramm-Klein, 2019).

The goal is to have natural conversations with users exclusively by voice, eliminating the need for manual input such as typing or clicking to complete tasks (Hauswald et al., 2015). While it is estimated that around 4.2 billion voice assistance systems were in use worldwide in 2020, the forecast for 2024 shows a doubling to up to 8.4 billion voice assistants in use worldwide (Juniper Research, 2020), bringing the number of voice assistants to more than the world's population.

Various researchers already focus on the general relevance of digital voice assistants, mostly in terms of the acceptance and use of these smart voice systems (e.g., Chen & Wang, 2018), such as by humanizing them (Han & Yang, 2018) or by making digital voice assistants easy to use and interact with (Burbach et al., 2019). However, research is also looking at these smart systems in terms of their potential risks, such as lack of trust, technical problems, or limited privacy and security (e.g., Klein et al., 2020). While there are some research studies on the use and acceptance of digital voice assistants by vulnerable user groups, such as older users (e.g., Kowalski et al., 2019), there are only a few scientific studies (e.g., Volochtchuk et al., 2023) on how digital voice assistants are (or can be) used by users with physical disabilities and what specific barriers using digital voice assistants arise for this user group.

Proponents of voice assistants argue that digital voice assistants offer numerous possibilities, especially for disabled, sick, or elderly people, e.g., by facilitating communication for people with dementia (Wolters et al. 2016). Therefore, in addition to technical aids to increase mobility, technologies are also increasingly taking over everyday tasks or requests for users with a (physical) disability. They can be an enormous relief for the lives of these disabled users, minimize or even eliminate barriers

URI: https://hdl.handle.net/10125/106822
978-0-9981331-7-1

and thus enable a whole new access to social participation. New technologies, e.g., intelligent wheelchairs, consequently, have enormous potential for handicapped users (Gomi & Griffith, 2006). But also voice assistants enable physically disabled users, with the help of other interfaces, to switch the light on and off, operate the heating or doorbell, or place an order, therefore promoting their independence and autonomy.

However, in addition to the obvious potential that voice assistants offer for physically disabled users, potential barriers and obstacles also exist. These go beyond the usual challenges in the acceptance and use of innovative technologies and manifest themselves even more explicitly in the case of users with disabilities and limitations. Such barriers and obstacles can arise due to a lack of consumers' knowledge and abilities (Shultz and Holbrook, 2009). When using digital voice assistants, most users have not yet gained any experience and therefore do not have the knowledge about processes, possible risks and opportunities or do not yet have the skills to integrate them smoothly into their everyday lives.

In addition to the personal characteristics and situational circumstances of the users (Baker, et al., 2005), the quality of usability in the use of digital voice assistants can therefore also be decisive for how easy or difficult it is for users to successfully implement them in their everyday lives. Therefore, if usability is poor when using digital voice assistants, users may feel overwhelmed, and the usage process will not run faultless (Fota, 2022). This is even more fatal for users with physical disabilities, when they are more dependent on a smooth process to complete certain tasks, in contrast to users without physical disabilities.

However, it has not yet been proven which influencing factors are decisive and what impact voice assistants have on the everyday lives of this user group. For this reason, the goal of this work is to use a qualitative study to identify initial factors and their relevance for use by physically disabled users, from which success factors for the use of digital voice assistants for this specific user group can be derived later. Thus, the research questions are as follows:

(1) How do physically disabled users experience and use digital voice assistants? (2) What drivers and barriers of digital voice assistants are perceived by physically disabled users? (3) What potential for improvement of digital voice assistants can be identified for physically disabled users?

In the following, the background of the paper is presented in the form of a literature review, in which the theoretical basis of the study is also introduced. After that, the methodology is described, which is followed by the analysis of the qualitative research study. Finally, the results are discussed in the light of relevant literature, implications are developed, and limitations and a further outlook are presented in the context of this study.

2. Background

Especially in an international context, disability is discussed controversially and defined diversely. The World Health Organization (WHO) attempts a rough outline and distinguishes the term disability between "impairment", "disability" and "handicap" (World Health Organization, 1976). The United Nations Convention on the Rights of Persons with Disabilities, in turn, characterizes people with a disability as users who have long-term physical, mental, intellectual, or sensory impairments which, in interaction with various barriers, may prevent them from participating fully, effectively and on an equal basis with others in society (United Nations, 2006).

In addition to the various definitions of disability, different perspectives and theoretical frameworks on the concept of disability have formed over time, e.g., the Social Models of Disability (Olkin, 2002). This model shifts the focus from the individual's impairment to the social and environmental barriers that limit their full participation in society. According to this model, disability is not inherent in the individual but arises from the interaction between the individual and the physical, attitudinal, and social barriers they encounter. The emphasis is on removing these barriers, promoting inclusivity, and enabling equal opportunities for individuals with disabilities (Olkin, 2002).

It is therefore insufficient to look at disability only from the medical perspective. Disability also represents a social phenomenon when, for example, stigmatization and exclusion as well as social circumstances make social participation difficult (Forstner, 2022). The Social Model thus targets less the impaired user himself or herself and much more his or her environment. Therefore, it is the social processes or circumstances, such as a lack of orientation aids for blind people or workplaces that are not suitable for people with disabilities, that lead to a disability in the first place.

There is an increasing attempt to understand people with a physical disability beyond their medical condition as users within the context of consumer research (e.g., Menzel Baker et al., 2007). In this context, users with physical restrictions and disabilities can be categorized as vulnerable consumers (Basu et al., 2023, Hill & Sharma 2020), who have problems coping with traditional and new

challenges of everyday and life economies (Baker et al., 2005). Thus, there is a risk of social and economic exclusion. Particularly in the digital realm, this danger may be fueled by rapid technology development and the associated need to acquire skills to use these technologies.

According to Baker et al., (2005), the cause of user vulnerability is the lack of individual skills, for example due to illness or insufficient communication capabilities. Physically disabled users exhibit a high level of user vulnerability due to the immense hurdles they face in coping with everyday life. They often find themselves in a situation of perceived powerlessness due to a lack of behavioral control and may have difficulty using given resources in a targeted manner (Dietrich et al., 2017). Simply identifying them just as users does not do them justice, as they have special needs regarding products and services compared to people without disabilities. After all, users' consumption behavior and decisions depend primarily on their personal situation, including physical health (O'Mahony & Hall, 2011).

There has been a consensus among researchers for many years that technology holds tremendous potential for positively impacting the lives of users with disabilities (e.g., Newman et al., 2001). Consequently, relating to the Social Models of Disability (Olkin, 2002) to technology use, technology represents means of restoring users with disabilities to a state of normalcy and enabling them to perform certain everyday activities (Gregor et al., 2005). Thus, the improvement of the individual circumstances of the users concerned is closely linked to technological progress and the adequate use of technology. Moreover, technology acts as an inclusion driver for participation in society (Warschauer, 2004), especially for users with disabilities (e.g., Manzoor & Vimarlund 2018).

Such technologies developed specifically for handicapped users are also called assistive technologies. They represent aids that are developed for personal use, so that individuals gain more independence in different environments and their disability-specific characteristics become less prominent (Nicolson et al., 2012; Coleman, 2011). They are therefore intended to change the subjective conditions of affected users in such a way that social inclusion can be facilitated. However, with regard to assistive technologies, it is also clear that many challenges and barriers exist. Often, access to such advanced technologies is associated with hurdles, whereby it is usually the financial cost that prevents disabled users from using them (Harris, 2010).

A contrast to the individual approach of assistive technologies is universal design. The design concept describes the design of products, devices, environments, and systems in terms of the most possible inclusive usability, regardless of aspects such as age and individual abilities of the users (Story et al., 1998). By implementing universal design, the participation of users with disabilities should be promoted from the ground up, without the need for the use of assistive technologies. It can therefore be stated that products and systems in the sense of universal design have the potential for social participation and facilitation of everyday life in many areas of life without creating financial barriers as in the case of assistive technologies.

In particular, voice search and voice assistance, which can make processes much easier and more efficient (Hauswald et al., 2015), can be included in many other everyday devices in the form of universal design. Particularly in conjunction with applications from the smart home sector, there is enormous potential for users with physical disabilities. For users in wheelchairs, it is easier to control lights, heaters, or blinds via voice, since not every living environment is designed to be barrier-free, which means that some wheelchair users cannot even reach certain places, such as radiators. In addition, partners, family members or assistants can be permanently relieved by using a voice assistant for the completion of tasks that they would otherwise perform (Pradhan et al., 2018).

The way in which interaction with voice assistants takes place depends to a large extent on two aspects: the system itself (or the manufacturer) and the context of use. For example, smart speakers, like Google Home or Alexa, are mainly used for serious inquiries, for example to complete certain tasks in a goal-oriented manner while applications in mobile devices, like Siri, were more used for entertaining purposes, such as telling a joke (Luger & Sellen, 2016). Cowan et al. (2017) highlight in their study that "social embarrassment" and "cultural context" act as barriers to public use. Chen and Wang (2018) report that individual understanding of voice assistants, which is often limited by low transparency of how they work, also influences the nature of interaction and can inhibit widespread usage.

As an important component of interaction quality, simulating human-like characteristics and behavior has a positive effect on the acceptance of these systems (Nasirian et al., 2017). For example, Han and Yang (2018) have shown that human-like characteristics of voice assistants have a positive impact on satisfaction as well as further intention to use, while other studies focus primarily on the usability of digital voice assistants, which serves as a basic requirement for using these systems (e.g., Dutsinma et al., 2022; Zwakman et al., 2021). In their survey, Liao et al.

(2019) shed light on the role of privacy as well as trust in the decision to use voice assistants. They find that privacy compliance, in particular, is important to users of voice assistants and is a key driver of its adoption. Furthermore, if user expectations are met in this regard, this strengthens trust in the manufacturing company (Liao et al., 2019).

In the context of users without disabilities, voice assistants have therefore already been studied more or less extensively. However, relatively little research literature exists up to date on users with special needs. Some scholars have made initial research efforts on voice assistants and the elderly. For example, Fota et al. (2020) found that voice assistants played only a minor role in the everyday lives of the older users (60+ years old), due to a lack of availability, a lack of technical interest and due to concerns about data security. At the same time, the potential for elderly and mobility-impaired users is discussed, as digital voice assistants offer significant advantages and act as "a kind of independence aid" for "motor-impaired persons" in order not to lose their autonomy completely. Kowalski et al. (2019) conclude that there are both, technological and psychological barriers for older users, like too much time spent learning the technology, lack of a screen for context and feedback, fear of dependency, and system malfunction.

In addition, people with a wide range of disabilities already use voice assistants, but difficulties with speech recognition and processing are identified, and therefore the desire for more voice assistant features is expressed (Pradhan et al., 2018). Regarding physically impaired users, some research merely suggests design changes (Isyanto et al., 2020). Questions regarding the acceptance and use and thus the influence of digital voice assistants on the everyday life of physically disabled users remains to be clarified. It is precisely this research gap that the present study aims to address by focusing on Olkins' (2002) Social Model of Disability.

3. Method

In order to investigate the influence of digital voice assistants on the everyday life of physically disabled users as holistically and true-to-life as possible, a qualitative research method was selected. The interview guide used consists of five question blocks, "Introductory questions," "Drivers of digital voice assistant use," "Barriers of digital voice assistants," "Prerequisites and factors for digital voice assistant use," "Potential for improvement of digital voice assistants," and "Social factors and characteristics of the interviewee," which were derived from literature. The participants of the study were informed that the purpose of the study was to find out whether and if so, how digital voice assistants can make their everyday life easier, without giving them concrete specifications, possible fields of application, or assumptions resulting from the literature. The aim was to let the interviewees answer as independently as possible without influencing them in their answering behavior beforehand.

For the analysis of the transcribed interviews, the qualitative content analysis according to Mayring (2015) was applied. Based on this, four upper categories (UC) were deductively developed to categorize the interview transcripts, which in turn are further subdivided into eight, inductively developed, subcategories (SC) (see Table 1).

Table 2 provides an overview of all 18 interviewed participants. 11 female and 7 male users were interviewed independently via telephone conversation in the period from July 2022 to September 2022. All conversations were recorded by a recording device and transcribed afterwards. The average age of the interviewees in the sample is 45.61 (SD=12,84) years and all interview participants are German citizens. In the search for participants, priority was given to different Facebook groups that primarily focus on users with physical disabilities, such as "Wheelchair User Forum", in which a total of more than 5,000 members are registered and can share their experiences. In addition, various wheelchair sports clubs, including the Wheelchair Club Cologne e.V., were contacted.

All interviewed participants have a degree of disability of at least 70%. In addition to users who are paraplegic as a result of an accident, various disease patterns are also represented, including muscular dystrophy (hereditary disease in which muscle tissue gradually degenerates), multiple sclerosis (chronic inflame-amatory neurological disease affecting the central nervous system) or spastic diplegia (birth defect usually affecting the legs). Some of the participants interviewed may also experience increasingly drastic health consequences or associated limitations in the future, depending on the further course of their disease.

Table 1. Category system			
Upper Categories		**Subcategories**	
UC1	Experience with digital voice assistants		
UC2	Main drivers of digital voice assistants for physically disabled users	SC 2.1 SC 2.2	Everyday facilitation Increased mobility and time saving
UC3	Main barriers of digital voice assistants for physically disabled users	SC 3.1 SC 3.2 SC 3.3	Financial barriers Lack of necessity Preservation of independence
UC4	Main potential for improvement for physically disabled users	SC 4.1 SC 4.2 SC 4.3	Financial support Better education Functionality

Table 2. Overview of interview participants

No.	Gender	Age	Type of Physical Disability	Degree of Disability	Use of a Digital Voice Assistant
1	Male	55	Spinal Paralysis	100	No
2	Female	30	Spinal Paralysis	80	Yes
3	Female	21	Spinal Paralysis, Autoimmune disorder	100	No
4	Female	39	Paresis	90	No
5	Male	48	Spinal Paralysis	100	Yes
6	Male	42	Muscular dystrophy	100	Yes
7	Female	55	Proximal Myotonic Myopathy	80	Yes
8	Male	61	Multiple sclerosis	80	Yes
9	Female	62	Muscular dystrophy	100	No
10	Female	53	Somatoform pain disorder	100	No
11	Male	48	Spastic diplegia	80	Yes
12	Female	53	chronic pain syndrome	100	Yes
13	Female	52	Multiple sclerosis	80	No
14	Female	45	Multiple sclerosis	80	Yes
15	Female	39	Functional Neurological Disorder	70	Yes
16	Female	42	Spinal Paralysis	100	No
17	Male	59	Polyneuropathy	100	No
18	Male	17	Tetraspastic	100	No

4. Results

The interviews will be used to elaborate the influence of digital voice assistants on the everyday life of physically disabled users, including drivers, barriers and potentials for improvement. The presentation of results is oriented along the main categories of the category system, whereby "IP" stands for interview partner.

UC1: Experience with digital voice assistants

The knowledge about functionality can vary from participant to participant and sometimes there is even a great lack of knowledge about the access and the integration of these devices (IP4, IP9, IP16). However, all of the interview participants without exception are convinced of the possible everyday life facilitation through technologies and artificial intelligences in general and of the enormous potential of digital voice assistants for physically disabled users in particular. E.g., IP9 states: "Well, I see a very big future there for physically disabled users [...] So the person can stay sitting or lying down all day, doesn't have to move anywhere and the assistant does everything." By using digital voice assistants, which are integrated on the smartphone, interview participants can, for example, control music playback while driving a wheelchair (IP2) or answer a call while driving a car (IP5). However, some participants assign digital voice assistants primarily to entertainment purposes, while a combination with other smart devices is seen as a way to solve functional tasks (e.g., IP18). Hence, many of the participants also already use digital voice assistants in everyday life to make household tasks easier to perform, which, for some participants, would require a lot of effort, e.g., opening doors and windows, controlling radiators, lights or blinds (e.g., IP2, IP5, IP6).

UC2: Main drivers of digital voice assistants for physically disabled users

The second main category describes what motivates the interviewees to use a digital voice assistant and what advantages arise from its usage for users with physical disabilities.

SC 2.1: Everyday facilitation

First of all, the aspect of convenience is mentioned (e.g., IP5, IP3, IP15). With digital voice assistants, the specific situation can be made more comfortable for the respective user. In addition, the

interviewees stated that a language assistant basically makes everyday life easier for them: “Well, I still know the situation as a pedestrian. You lie in bed: "Oh, the light is on." Then I have to get out of bed, turn on the light switch, and go back to bed. And now, even if I forget to turn off the light somewhere or to look if the radiator is on in winter, I can basically control everything from my bed.” (IP2). The form of everyday relief ranges from relatively banal activities in the areas of entertainment and organization, such as having books read aloud to users, switching on the television and creating shopping lists, to complex processes of controlling the living environment through the combination of digital voice assistants and smart home products. Furthermore, digital voice assistants can not only simplify the life of physically disabled people, but also enable certain activities: "[...] control technical devices that I would otherwise not be able to access. For example, the heating in the living room, which I would otherwise could not use." (IP3). Communication can also be made easier, since it is no longer necessary to laboriously type a message, which could already be an obstacle for some participants due to additional handicaps of the fingers, but instead messages can be written with the voice (IP11, IP15). In addition, people in the social environment of the physically disabled users can be relieved (IP6), for example by creating digital shopping lists for family, friends, or assistants who go grocery shopping for the participants (IP7).

SC 2.2: Increased mobility and time saving

Since physically impaired people rely on hand throttle and brake when driving, operating a smartphone by hand would pose an increased safety risk. When driving, however, the digital voice assistant gives participants constant control over the means of transportation, thus increasing mobility and safety (IP1). Since some participants have difficulties in moving around (e.g., in a wheelchair), which can take a lot of time, also multitasking can be more complicated to realize for users with physical disabilities if, for example, a wheelchair has to be controlled simultaneously. However, these users can regain this possibility for multitasking through digital voice assistants (IP8), therefore, the use of digital voice assistants represents additional time savings for many, as they are able to complete different tasks at the same time (IP12). IP1 also describes the potential time savings if he wants to open the door for someone: At the moment he has to use a wheelchair and the elevator to get to the ground floor. This could change with the use of a digital voice assistant in connection with smart home devices such as a camera to observe the entrance area combined with an electrical opening option for the door. In addition, digital voice assistants make it easier and faster to obtain information, since, e.g., a wheelchair user, does not have to drive to a computer or laptop first (IP14).

UC3: Main barriers of digital voice assistants for physically disabled users

The third main category describes which aspects hinder the acceptance and usage of digital voice assistants for users with physical disabilities.

SC 3.1: Financial barriers

Financial barriers play a central role in the usage of digital voice assistants. The reason for this can be traced back to the professional situation of the interviewees. Often, physically disabled users are not employed due to their handicap and the resulting consequences. This is also reflected in the sample: 13 of the 18 interviewees are not employed and receive financial aid from the government. They therefore have limited financial resources at their disposal, see financial hurdles when purchasing digital voice assistants (e.g., IP6, IP11, IP12), but are also not exactly informed about the price of a purchase (IP18). “Well, when I think about using smart home, which is sometimes the case, I balk at the cost right now. It's really expensive." (IP11). In addition, when using a smart home, some constructional adaptations would have to be carried out, which entail additional financial and time expenditures (IP17). Since financial support is often strictly regulated by health insurance companies and financial approvals are very cumbersome, there are also physically disabled users who have only been able to purchase digital voice assistants through fundraising efforts (e.g., IP1).

SC 3.2: Lack of necessity

Some participants lack information about the possible areas of application, and some have not yet dealt intensively with digital voice assistants (IP10). This information deficit and the still lacking knowledge led some participants to consider the acquisition of digital voice assistants as not yet necessary (IP16). Therefore, some of the non-users interviewed would not yet use digital voice assistants because they do not see an urgent need for them (at the moment): "So far I haven't really recognized the need. However, I'm also lucky that I live in an apartment that doesn't have a fire door. If I'm moving and then can't open a door like that myself, it would of course be interesting if you could open the door by voice control or cell phone" (IP10). A further reason for this attitude is the personal situation of the people interviewed, i.e., how they are able to cope with their everyday life (IP1, IP4, IP9). Nevertheless, they consider using digital voice assistants if their personal situation changes or if the disability becomes more extreme (IP8).

SC 3.3: Preservation of independence

Some of the interviewee's clinical pictures are progressive and, depending on their course, can lead to the person concerned becoming bedridden and dependent on comprehensive help with very basic activities. In order to prevent this and to maintain a certain degree of independence for as long as possible, some interviewees consciously refrain from using voice assistants "[...] and I should still do as much as possible that I can still do alone and not become comfortable. That is, I consciously do without all these supportive things." (IP7). The urge to be independent therefore only manifests itself as a barrier to use because the person consciously and voluntarily, i.e., intrinsically motivated, decides against using it in order to maintain his or her independence. Since the aforementioned financial barriers are often due to decisions made by external parties and the physically disabled consumers have little or no ability to counteract them, they would like to retain at least autonomy over their own usage decisions (IP1).

UC4: Main potential for improvement for physically disabled users

The fourth main category describes possible potential for improvement in connection with digital voice assistants for users with physical disabilities.

SC 4.1: Financial support

While financial requests from physically disabled users are often denied (IP12), many of the interview participants would like financial support to be able to afford a digital voice assistant (e.g., IP7, IP9). The interviewees plead for digital voice assistants to be officially recognized as a tool for coping with their everyday lives, so that financial access is made easier for them (e.g., IP13, IP15). Also, IP6 describes the tremendous importance of financial provision of assistive devices since it is directly related to his mobility. However, the procurement of aid is associated with a high level of bureaucracy, which can pose major problems for physically disabled users in particular, who are already confronted with immense hurdles in coping with everyday life.

SC 4.2: Better education

Better education about the possible uses of digital voice assistants in everyday life for physically disabled users was also discussed. It is striking that both users and non-users consider increased provision of information to be useful. For example, it is suggested that disability organizations become active in providing information about ways in which physically disabled people can adequately use digital voice assistants (e.g., IP17). Individual interviewees even demand personal instructions from an expert (e.g., IP4). Another option would be to provide it on a trial basis for a certain period of time: “That you can first try it out [...], I'm talking about a few weeks. And then you can always decide for or against it, since everyone is also very different in terms of their limitations” (IP3). In addition, it is not always entirely clear to the participants which smart home devices can be used with the digital voice assistants. Here, clearer compatibility classifications could help to make a usage decision (IP3).

SC 4.3: Functionality

Some criticize the range of functions. For example, it is important to the interview participants that further relevant functions are added to those that already exist (IP12). In this context, for example, the desire is expressed to be able to connect digital voice assistants with the electronic wheelchair: "The optimum would of course be voice control, something like that for the wheelchair." (IP17). In connection with mobility, IP18 also cites autonomous driving, for example, as an important future technology for physically impaired users. Driving a car is difficult or even impossible for many people with a physical limitation, which is why autonomous driving with the help of integrated digital voice assistants would bring an improvement in the self-esteem of the user. IP5 sees further opportunities for improvement in the field of augmented reality. Based on this technology, severely physically disabled users could operate certain devices with the help of specially made glasses and eye-tracking technology by only using their voice.

5. Discussion and Conclusion

With regard to the first research question "How do people with physical disabilities experience and use digital voice assistants?" it was determined that most of the interviewees have already come into contact with the technology and have a basic idea of the functionality of digital voice assistants. Also, in connection with interfaces and smart home products, half of the users use digital voice assistants, for example to control blinds, radiators, television, or light. In addition, there is a positive attitude towards the technology and agreement that it has constantly improved in recent years. Moreover, the interviewees trust the technology and see enormous potential for the future, especially for physically disabled users. Some interviewees plan either to upgrade their existing smart device or to purchase a digital voice assistant, especially in cases where a progressive illness is the cause of the physical disability, and it is expected that it will become even more severe.

In contrast to the existing literature (e.g., Klein et al., 2020), concerns or skepticism are expressed only very occasionally by users with physical disabilities. This positive attitude toward digital voice assistants

also stems from their positive influence on the interaction with other people when using them. The resulting relief of people from the social environment is accompanied by increased autonomy and independence of the physically disabled user. Also, digital voice assistants allow users with physical disabilities to overcome certain limitations in everyday life, which in turn is extremely important for social participation (Warschauer, 2004).

Regarding the second research question "Which drivers and barriers are perceived by people with physical disabilities?" it turns out that whether participants see a need to use digital voice assistants is highly situation dependent. In many cases, physically disabled users live in barrier-free housing conditions and are supported by partners, family, or friends in coping with everyday life. Others deliberately refrain from using a digital voice assistant in order to maintain their remaining independence as far as possible. The necessary connection to the Internet represents a particularly vulnerable point in the voice assistant ecosystem (Lit et al., 2021). For example, users with physical disabilities need to be able to ensure a constant internet connection. Otherwise, the associated malfunction of the digital voice assistant could mean that certain tasks that the digital voice assistant has been relied upon to perform would no longer be guaranteed, putting them in a vulnerable, sometimes even dangerous, situation, compared to users without physical challenges.

In addition, financial barriers prevent many participants from purchasing such a device or expanding its use. Due to the often-precarious financial circumstances of those surveyed, digital voice assistants are still of secondary priority, also because additional devices and possibly even conversions in the living environment may be necessary for complete smart home integration. Moreover, it becomes clear that not every participant is informed about the price range of digital voice assistants and that there are some information deficits existing.

The interviewees see a very central advantage in time saving. If they need a relatively long time for certain activities due to their physical limitations, they can effectively save time by using a digital voice assistant. The most important driver for the interviewees is the facilitation of everyday life. Similar to users without disabilities, comfort and energy savings are perceived as motivating factors among those surveyed. Interview participants with motor impairments state that they have books read to them or write messages using digital voice assistants. Compatible devices in the living environment can also be controlled by voice input. In this way, everyday tasks are not only simplified, but also partly made accessible by it in the first place. In this context, the digital voice assistant can only act smartly and intelligently through "context-awareness," i.e., the identification, processing, and use of context-specific information (Knote et al., 2018). The more context-specific information is captured, such as temperature, humidity, location, or sounds, the more accurately digital voice assistants can perform their function and respond to specific changes. A trade-off thus arises between the disclosure of personal user data and the most effective and comprehensive possible use of the voice assistants.

Although the security of the systems has been repeatedly questioned in literature (Yan et al., 2022; Lit et al., 2021), data protection does not play a role at all for the interviewees. Except for three participants, nobody sees a problem in the way digital voice assistants handle private data. In contrast to studies with users having no physical challenges (Knote et al., 2018), in some cases it is even requested to relaxed data protection to expand the functionality of the digital voice assistants for physical disabled users. However, the physical disabilities of participants pose the risk of increased user vulnerability, making user education and literacy interventions particularly important for this user group (Baker et al., 2005).

With regard to the third research question, "What potential for improvement of digital voice assistants can be identified for physically disabled users?", many of the interviewees primarily expressed a desire for financial support. Due to their mostly limited purchasing power, the participants are in many cases dependent on external (financial) help, such as by health insurances. The participants see further potential for improvement in terms of functionality. They would like to see improved compatibility with other aids such as wheelchairs. These demands are understandable but given the current state of the art and the primary commercial focus of the technology, it remains unclear whether this will find practical implementation in the near future.

Furthermore, implications for politics, user protection and manufacturers can be derived from the interviews. Policymakers could introduce legislations that make it financially easier for physically disabled users to obtain digital voice assistants and smart devices that are compatible with digital voice assistants. In addition, policy could promote research and development in the field of smart technologies, such as the digital compatibility or special development of universal designs for physically impaired users (Branham & Mukkath Rox, 2019), such as smart wheelchairs.

Speech systems specially adapted for wheelchair users could also be developed to meet their needs and suitability for physically disabled users. To optimize user knowledge and handling, additional free training and education could be provided on topics such as the use of digital voice assistants in the everyday lives of physically disabled users. For example, these users could be offered training that includes a demonstration of the possibilities of such assistants as everyday aids. By implementing improvement measures, users' performance expectations of digital voice assistants may increase, possibly leading to a higher acceptance, positive attitude of usage, but also to a greater inclusion of physical disabled users in society (Olkin, 2002). Thus, the results of the study specifically tie into Olkin's Social Model of Disability (2002) and emphasize the importance of creating an environment through information and communication technology that allows the inclusion of all members of a society.

Although a qualitative approach offers the possibility of gaining an insight into subjective views, the statistical power remains relatively low in the context of this study. To counteract this, care was taken when selecting the study population to ensure that people of different genders, ages and educational backgrounds were interviewed. However, quantitative studies should also be conducted, e.g., whether the severity of the physical limitation and the associated degree of independence act as influencing factors for the acceptance and use of digital voice assistants.

Future studies could also compare users with physical disabilities in different country markets (Hallikainen & Laukkanen, 2018), since only a German sample is considered here, as well as examine cultural differences, such as those according to Hofstede (2009). For example, the acceptance of the use of digital voice assistants may not only differ between cultures but may additionally be characterized by different integrations of users with physical disabilities into societies. Furthermore, there are further types of physical disabilities, such as limitations in vision or hearing, which are not taken into account in this study. Some of the surveyed non-users of digital voice assistants did also express the wish to be able to test the technology once. An observational study could therefore record and analyze possible difficulties, but also advantages, for this user group when applying the technology in practice.

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