Disability and Rehabilitation: Assistive Technology

ISSN: 1748-3107 (Print) 1748-3115 (Online) Journal homepage: https://www.tandfonline.com/loi/iidt20

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To cite this article: Aline Darc Piculo dos Santos, Ana Lya Moya Ferrari, Fausto Orsi Medola & Frode Eika Sandnes (2020): Aesthetics and the perceived stigma of assistive technology for visual impairment, Disability and Rehabilitation: Assistive Technology, DOI: 10.1080/17483107.2020.1768308

To link to this article: https://doi.org/10.1080/17483107.2020.1768308

Published online: 05 Jun 2020.

DISABILITY AND REHABILITATION: ASSISTIVE TECHNOLOGY
https://doi.org/10.1080/17483107.2020.1768308

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ORIGINAL RESEARCH

Aesthetics and the perceived stigma of assistive technology for visual impairment

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ABSTRACT

Purpose: The aim of this study was to identify factors that influence the perceived stigma of two assistive devices for visual impairment, namely the white cane and smart glasses.

Method: Face-to-face semi-structured interviews with eight European students were conducted to probe their experiences and knowledge related to disability, assistive technology, visual impairment, as well as handheld and wearable devices.

Results: Close relationships with disabled people seems to have a positive influence on participants perceptions about stigma, disability, and assistive technology. Academic background seems to not have any influence. The aesthetics of assistive devices was observed as an important factor that influences the adoption or abandonment of the device.

Conclusion: Device without negative symbolism but with modern aesthetics (smart glasses) were positively accepted by the participants than the device with traditional aesthetics and symbolisms of visual impairment (white cane). Designers should, therefore, consider aesthetics in addition to functionality in order to avoid the perceived stigma, thereby reducing the chances of device abandonment.

➤ IMPLICATIONS FOR REHABILITATION

- Understanding the factors that influence the perceived stigma associated with assistive technology can help designers and developers to reduce assistive technology abandonment and perceived stigma.
- Designers need to consider both functionality and aesthetics. While functionality is crucial for the users' adaptation, aesthetics is important for the users' positive perceptions.

ARTICLE HISTORY
Received 17 September 2019
Accepted 8 May 2020

KEYWORDS
Stigma; assistive technology; visual impairment; white cane; smart glasses

Introduction

People with disabilities often experience challenges such as physical and functional barriers that restrict participation. Moreover, the social factor is also highly important for effective inclusion. It is claimed that 15% of the world's population has some type of disability [1]. Disabled individuals are often associated with negative perceptions and are thus too often experiencing discrimination [2].

People with disabilities are believed to go through processes of acceptance that depends as much on personal factors such as age, gender, psychological and emotional conditions, as well as socio-cultural factors [3]. These social and cultural factors are related to stigma. According to Shinohara and Wobbrock [4], stigma and disability are socially constructed phenomenon because it is the environment and attitudes of others that results in discriminating inaccessibility and barriers.

People with disabilities often use assistive technologies to compensate for reduced functionality. In addition to the functionality of assistive devices, their aesthetics can also influence the relationship between product and user. According to Soderstrom and Ytterhus [5], technologies have symbolic meanings in contemporary societies and the way people use them can confirm and reinforce certain values. This is also the case with assistive technology devices.

Users' acceptance of assistive technology is an important factor that contributes to satisfaction and engaged use, thus reducing the risks of product abandonment. According to Shinohara and Wobbrock [4], assistive technology users can feel stigmatized due to device aesthetics and social acceptance. Therefore, the design of an assistive device should not interfere negatively with the process of acceptance. Faucett et al. [6] pointed out that the stigma of assistive technology can threaten individuals' lifestyle, because they may feel exposed or fear facing barriers. Consequently, disabled individuals may abandon assistive technologies [6].

Discrimination and judgement are also influenced by the type of disability. According to Louvet [2], mental and sensory impairments, such as visual impairment, are more frequently associated with negative perception than physical disabilities. Faucett et al. [6] explained that observers will often only know that a person is disabled due to the visibility of an assistive device. Although such devices are designed with all the best intentions to increase human function, they can also make disabilities more visible.

Visually impaired people cannot easily surrender their assistive technologies without reducing independence. Assistive

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technologies need to meet the functional needs of users without causing social embarrassment. According to Hersh [7], the white cane is a mobility aid that detects obstacles but it is also a symbol that communicates the blindness of the user. Hersh [7] explained that visually impaired people often avoid using white canes to prevent being stigmatized, attracting unwanted attention and thereby limiting contact with people who are not blind.

According to Shinohara and Wobbrock [8], wearable technologies such as smartwatches and glasses are becoming increasingly popular and, are also used for self-expression of users' identity. Whether using an assistive device or a mainstream technology in a social environment influences how individuals feel about themselves in terms of self-efficacy and self-consciousness. Mainstream technologies may help improve user acceptance by providing the necessary functionality while preventing stigma.

Several studies have addressed assistive technology abandonment [5,9–12], including how aesthetics relates to stigma, how the assistive technology users are perceived in society and how this affects device abandonment [3,13].

In order to identify factors that influence the perception of stigma, this study conducted semi-structured interviews with eight European students. An interview guide was designed to address whether design background and personal experience with a disability affect the perception towards visual impairment and assistive devices. The study also explored the perception of stigma regarding assistive technology aesthetics, comparing a traditional device (white cane) with a modern device (smart glasses). Understanding the factors that lead to stigmatization can help designers develop more desirable technologies, consequently reducing device abandonment.

Method

A qualitative research design based on semi-structured interviews was chosen. Eight European students were recruited (including six Norwegians, one German and one Dutch), students aged between 24 and 33. The sample was divided into two groups of four participants: product design students (one female and three male) and non-design students (three female and one male) from different areas including biology and storytelling. The rationale for this division was to evaluate whether the formal design background would influence the perception of stigma.

The interviews were semi-structured and conducted in face-to-face meetings, using English. Each session lasted approximately 30 min and was conducted by the two first authors. The interviews took place in the cities of Oslo and Lillestrøm, in Norway, during the months of September and October, 2018.

The questions were divided into four groups, namely disability, assistive technology, visually impaired people and assistive technology, and wearable versus handheld devices.

Ethics

All participants received and reviewed an informed consent form with a brief explanation about the research objectives and methods, and ensuring that their participation was anonymous.

While one of the researchers conducted the interview, the other researcher took notes of all verbal responses and meta-communication such as pauses and body language. Audio and video recordings were not used to preserve the anonymity of the participants.

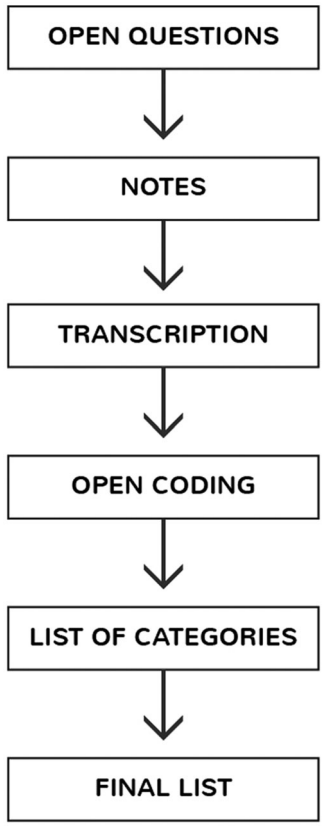

Figure 1. Data analysis.

Data analysis

The interviews were transcribed verbatim. The transcripts were analyzed by means of open codes that were freely generated and later organized into a list of categories representing relevant topics. These topics were used to detect major issues and to identify relations between these (Figure 1).

Results

All participants claimed knowing someone with a disability. Three participants reported having a relative with a disability that regularly uses assistive technology. The other five participants had either a friend or colleague with a disability, but the relationship was not close.

Negative perceptions of disability

Overall, negative perceptions of disability were observed. Five participants associated the term "disability" with the word "problem" (as in "having problems or difficulties to do something"). We observed that this association was more frequent among participants without disabled relatives. We also noticed from pauses during the answers, repetition of the questions, and body language (face turning red, hands in the face) that two participants felt uncomfortable and insecure on the topic of disability.

Another term that was mentioned a few times to describe disability was "wheelchair", showing that this assistive device is seen as a symbol of disability. We also observed a connection between assistive technology and the words "help" and "easy". None of the participants were aware of the term assistive technology as a formal concept, that is, they did not know how to define what assistive technology is. However, almost all the participants gave

consistent responses, and only one participant was unable to explain the term assistive technology but offered correct examples of assistive technology devices. In general, most answers described an assistive technology as assistance to do or to improve daily activity, or to help to accomplish a task in an easier manner. Three participants mentioned the terms "disability" or "disabled" to describe assistive technologies as devices for special groups. On the other hand, two participants pointed out that assistive technologies are devices that can be used for people with or without disabilities. Even though they did not know assistive technology as a formal concept, the majority (five participants) have already used at least one type of assistive technology, which included: eyeglasses (five), orthotic insoles (two), crutches (two), and wheelchairs (one). Regarding their experience as assistive technology users, most of them claimed to be satisfied with their devices, with only one participant saying that he did not adapt well to eyeglasses and preferred contact lenses instead. The student who used crutches also complained about discomfort during use. In addition, non-adaptation with assistive technology was also mentioned by one participant as the main reason why his grandmother did not use a hearing aid.

When asked to describe a disabled person four participants associated a disabled person to someone that has problems or difficulties to do something that a person considered as "normal" or everybody else does. Three interviewees described a disabled person as someone with a mental or physical disability such as the amputation of a leg. Most participants described a non-disabled person as someone that does not face difficulties or problems in conducting tasks. The words "normal", "fully functional" and "capable" were used two times each to answer this question. The participants that chose to use these words did not have relatives with disabilities. Two participants, whose parents have a disability, described a non-disabled person as someone that has the freedom to move and the ability to choose how to move.

The interviewees were also asked about their perception regarding a person using a white cane. Only one person did not associate the device with a blind person, but rather an elderly individual. Four participants claimed they would give space to persons when they are walking. Three interviewees were neutral in their answers and did not manifest any judgment in their responses. Other responses included feeling sorry for the person using the device, being empathetic towards the blind person, and being more careful around the person using a white cane.

Regarding participants' knowledge about assistive technologies, specifically for visually impaired people, the most frequent responses included eyeglasses, contact lenses, and white canes. Other answers included guide dogs, tactile floors, traffic lights, and Braille language. Three interviewees also mentioned surgery, which is not classified as assistive technology.

Visual impairment and navigation

The participants were instructed to think from the perspective of a visually impaired person and to identify situations that could be difficult in their daily routine. Most responses were related to navigation outdoors or in unknown environments. Other responses included "finding things", "being safe in traffic", "crowded places", "public transportation", and "missing the body language when speaking to someone". One participant mentioned "information displays and small text" from personal experience.

The interviewees also talked about how they envisage technology can help people with visual impairment. Most participants mentioned that emitting sound warnings could be helpful. Another idea mentioned four times was the creation of a device that could interpret the environment and function as the visual sensory system for the user. Apps that could provide navigation systems, helping to identify the environment (both indoors and outdoors) were also mentioned four times. In addition, navigating outdoors was an issue identified by the participants, with three interviewees suggesting services as potentially helpful and two mentioning the white cane.

Wearable devices vs. handheld devices

The interviewees were also asked to imagine the use of smart glasses in the future. The responses revealed an association between the device and something usual or common. Five participants imagined that smart glasses will be a common product, similar to the current smartphone, that any person can use. Four participants described smart glasses as a desirable device, capable of arousing interest and desire among people. One participant raised the concern that this device would create "social pressure", meaning that people would feel the need to acquire smart glasses to be part of the community and not feeling being left out. This is similar to what is experienced with current mainstream technologies such as smartphones [14]. One participant mentioned that he would be envious of someone with this type of device. On the positive side, two participants associated smart glasses users with modern and pioneering people. One of the interviewees described the smart glasses user as a brave person. The word "disability" or related words were not used by any of the participants in association with smart glasses.

When asked about the possibility of smart glasses helping visually impaired people, half of the participants believed that it could help people with low vision by serving as an improvement upon traditional optical glasses. However, smart glasses did not seem like a useful device for blind people. Three participants associated smart glasses for blind users with a surgical procedure. Five participants mentioned that smart glasses could help a visually impaired person with mobility, navigation, and localization. These responses are consistent with the comments about the challenges faced by visually impaired people in daily activities, where participants often mentioned outdoor navigation and unknown environments. Two participants also mentioned that smart glasses have the potential to offer routes and directions to the user. The idea of using smart glasses as a tool to give the user information about the environment, and warning against possible dangers, was mentioned by two participants. The use of sound alerts was mentioned by three participants. Other suggestions included using clear images and high contrast on the screen and using smart glasses as a substitute for white canes. Unlike the white cane, the perceptions of smart glasses users were mostly neutral or free of negative judgments related to disability. No participants associated smart glasses with the need for assistance.

The participants also suggested how to improve the quality of visually impaired people's lives. The suggestions included improving the white cane, by making it smaller, more stylized and/or emitting vibration when detecting obstacles; developing devices with sound feedbacks or assistance to enable the person to navigate outdoors and indoors; improving public spaces to ensure easier navigation; and improving the interfaces in software and printed information (for low vision users). In addition to these suggestions, two participants pointed out the importance of device aesthetics. In their opinion, it is negative if a device draws

too much attention towards a user. This negative attention is reduced if the device has discrete aesthetics and a more neutral appearance.

All the participants were willing to use assistive technology if needed, such make something possible, improve life, or have more fun. Two interviewees expressed concern about the device aesthetics and the possibility of attracting negative attention, in which case they would not use it despite the functional benefits.

Discussion

Design background and stigma

The results indicate that the academic background did not affect the perceived stigma. There was no notable difference between the group with formal design training and the group without such training.

Personal experience and stigma

Even though all participants reported knowing someone with a disability, the results indicate that only a close relationship, such as a family relation, seems to have a positive influence on the perception of disability and stigma. Mead [15] explains that social relationships and experiences influence human actions and thoughts.

Students whose parents or relatives have a disability manifested more empathy and sensitivity in dealing with the topic. On the other hand, participants without personal experience exhibited more discomfort, insecurity and pity in their responses. One possible explanation for these reactions could be the fear of being judged by their responses, even though the interviewers ensured the participants that they would not be judged. This corroborates Shinohara and Wobbrock's observations [8] where people without disabilities showed concern over how to react and behave to not be offensive towards people with disabilities.

We observed differences between the vocabulary used by the group with personal disability experience compared to the group without disability experience. Participants without personal disability experience often used words such as "problem" to describe disability and, "functional" and "capable" to describe a person without disabilities, suggesting that disability was associated with a negative symbolism.

Moreover, personal disability experience seems to influence the judgement of assistive technologies. Participants without personal experience showed more concerns related to assistive technology aesthetics.

One participant also noted that simulated activities could improve peoples' understanding of stigma. Besides having personal experience with disability, the participant described an in-class disability simulation activity that provided the first-hand experience of reduced function from a disabled person perspective. Such role-playing techniques have been shown to provide positive results in developing students' empathy towards the needs of people with disabilities [16]. This technique might also be implemented to change peoples' negative attitudes and perceptions towards disability.

Assistive technology adaption and use

Another interesting finding is that the user adaptation to an assistive technology influences the product abandonment. According to Day, Jutai, and Campbell [17], physical discomfort and low efficiency may cause discontinued use of an assistive device. One participant pointed out that his grandmother did not use a hearing aid, even though she needed it, because she did not succeed in adapting it. According to Pape, Kim and Weiner [3], user adaptation and acceptance of the device have a great influence on the decision to use or abandon a device. Verza et al. [9] pointed out that reasons for abandoning an assistive technology device include non-consideration of users' opinions in the selection process, device inefficiency, and insufficient training. In addition, social and psychological factors such as other people's judgments and the users' negatives feelings towards the device also contribute to device abandonment [17]. Therefore, psychosocial factors should be considered to the same degree as device performance.

We observed that knowing someone with a disability influenced how people perceive assistive technology. One interviewee claimed he would use assistive technology if he needed it, even though it could initially be "unfamiliar". This participant had personal experience with assistive technologies and persons with disabilities. His father had positive experiences with a prosthetic leg and eye. One may speculate that communicating the positive benefits of using assistive technologies may influence the perception of assistive technologies. Another participant referred to a successful experience with assistive technology involving a relative. The participant's mother had an independent life with improved mobility due to a scooter. The scooter was chosen instead of a wheelchair.

Assistive technology aesthetics

We observed stigma connected to the aesthetics of assistive technologies. Disability was associated with wheelchairs, where the wheelchair is seen as a symbol of disability, agreeing with Faucett et al. [6] in that the use of assistive technology may emphasize the visibility of disability. The symbolic aspects of wheelchairs and their significance for the user have been discussed in the literature [18]. According to Jonge et al. [13], the functionality is usually prioritized during the development of assistive technology often without considerations for aesthetics. According to Bispo and Branco [19], the design of assistive technology has the potential to change the social image of disability. However, it is necessary to be aware of the symbolism behind the device aesthetics. A non-stigmatizing design may stimulate desire, as with other products. Da Silva et al. [20] reported improved user acceptance through a user-centered design approach involving the development of a prosthesis using 3D scanning, 3D printing and conventional rehabilitation procedures.

Interdisciplinary collaboration between designers, engineers, and rehabilitation professionals is an important step towards the improvement of assistive technologies [21]. Developing solutions that enable independent living is a global challenge as the life expectancy of the world population is increasing. Assistive technologies and universally designed environments can compensate for functional loss due to aging and disabilities [22].

We also observed a connection between device aesthetics and device abandonment. Some participants mentioned that they would not use assistive technology if it attracted negative attention, despite its promise of improving functionality. They would prefer devices with a neutral appearance thereby confirming the negative stigma associated with visible assistive technology. This is in agreement with Faucett et al.'s study [6], where assistive technology is abandoned if it draws negative attention to disability and reinforces stereotypes and exposes a person's disability. Pape, Kim and Weiner [3], claim that the success of assistive

technology in reducing the barriers between users and the environment is not enough to guarantee its use and avoid abandonment. Avoiding social stigma is crucial for users' acceptance of assistive technologies. Shinohara and Wobbrock [8] stated that there is still a social stigma associated with assistive technologies and this is one of the factors that lead to abandonment.

Improvements

Overall, both white canes and smart glasses were considered helpful for visually impaired people. Similar possibilities of use were mentioned for the two devices. In both cases, mobility was a key issue. It is interesting to observe that most participants mentioned outdoors navigation as a daily challenge faced by visually impaired people. This finding is consistent with much of the literature that addresses improving navigation [23–26]. Navigation devices give users alerts and feedback about the environment and possible obstacles. Despite similarities in function, participants exhibited more positive attitudes towards smart glasses compared to white canes.

The perceptions of smart glasses' users were mostly neutral and not related to disabilities. None of the participants associated the smart glasses with the need for assistance. In the case of white canes, the participants were more inclined to have feelings of pity. According to Jonge et al. [13], the stigma associated with needing assistance is a factor of resistance. Devices without such symbolisms are more easily accepted.

According to Shinohara and Wobbrock [4], assistive technology users are more comfortable with devices that look like mainstream objects. They avoid assistive technologies that attract attention. Our findings agree with this as participants associated smart glasses with regular eyeglasses rather than an assistive device. Smart glasses were not associated with stigma and negative perceptions about its users.

Recently, white cane enhancements such as environmental scanning and tactile and audio feedback have been the focus of several studies [27–30]. Though, other potential topics suggested by the participants such as face recognition [31], body language feedback, or reading improvements cannot easily be achieved with white canes. On the other hand, studies with wearable devices, including smart glasses, have shown potential to reach these possibilities and more, besides mobility aspects [32–36].

In addition to the potential functionality, smart glasses may also reduce the perceived stigma. Devices without negative symbolic loads may stimulate use and increase user satisfaction.

Limitations and future work

This study is intended to contribute towards the understanding of what factors influence the perceived stigma of people with disabilities and assistive technologies, and how such devices might be designed to increase acceptance and reduce abandonment. One limitation of this study is the small sample size which is unlikely to be representative of the whole population. The cohort was limited as only European participants were recruited. Since cultural factors may influence the perceptions of stigma, repeating the study with participants from other cultural contexts may reveal additional and/or contrasting insights.

Conclusions

This study investigated which factors affect the perceived stigma of disability and assistive technologies. Knowledge about such factors can help designers and developers to create effective assistive technologies with low product abandonment.

The results show that aesthetics greatly influence how assistive technologies and their users are perceived. Aesthetics seem to have a great influence on how people see and judge users. Assistive technologies are often negatively associated with disability, due to their negative symbolic load, thereby making the users' disability more visible.

In addition to aesthetics, user adaptation seems to be important for assistive technology adoption or abandonment. Furthermore, the results suggest that having a close relationship (such as a family relation) with someone with a disability positively influenced how stigma, disability, and assistive technologies are perceived.

Overall, the smart glasses were more accepted than the white cane. Smart glasses do not have a negative symbolism attached. Smart glasses are seen as modern and, in some cases, desirable.

One implication of the results is that designers should consider aesthetics in addition to functional aspects during design and development to minimize negative symbolisms and hence increase the chance of device acceptance.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This research was funded by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001 and DIKU (Norwegian Agency for International Cooperation and Quality Enhancement in Higher Education) - UTFORSK grant UTF-2016-long-term/10053.

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