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Perspectives on the Acceptance and Social Implications of Smart Glasses: A Qualitative Focus Group Study in Healthcare

Niek Zuidhof[a,b], Somaya Ben Allouch[c], Oscar Peters[a], and Peter-Paul Verbeek[b]

[a]Research Group Technology, Health & Care, Saxion University of Applied Sciences, Enschede, Netherlands; [b]Department of Philosophy, University of Twente, Enschede, Netherlands; [c]Digital Life Centre, University of Amsterdam, Amsterdam, Netherlands

ABSTRACT

Smart glasses were perceived to be potentially revolutionary for healthcare, however, there is only limited research on the acceptance and social implications of smart glasses in healthcare. This study aims to get a better insight into the theoretical foundations and the purpose was to identify themes regarding adoption, mediation, and the use of smart glasses from the perspective of healthcare professionals. A qualitative research design with focus groups was used to collect data. Three focus groups with 22 participants were conducted. Data were analyzed using content analysis. Our analysis revealed six overarching themes related to the anticipated adoption of smart glasses: knowledge, innovativeness, use cases, ethical issues, persuasion, and attitude. Nine themes were found related to anticipated mediation and use of smart glasses: attention, emotions, social influences, design, context, camera use, risks, comparisons to known products, and expected reaction and might influence the acceptance of smart glasses.

1. Introduction

Recent developments in the field of ubiquitous computing have led to a growing interest in smart glasses. Although the first experiments were done in the 1960s (Rhodes, n.d.; Sutherland, 1968), in more recent years these devices have been further developed in a breath-taking speed (Muensterer et al., 2014) and are better known by consumers (Digi-Capital, 2019). A well-known and frequently used example is Google Glass (Google, 2014) but there are more devices with different characteristics. This shows a need to be explicit about what is meant by smart glasses. The definition of smart glasses has evolved (Ro et al., 2018) into head-mounted displays which are worn like eyeglasses and are computerized and connected devices that can explicitly provide information to the user in an augmenting experience (Klein et al., 2015; Tsubosaka et al., 2017). Additionally, smart glasses have an impact on the user and its environment and implicitly mediate our relationship with others, our environment, and technology (Zuidhof et al., 2021). Recent developments have led to an increased interest in the use of smart glasses in healthcare. It was introduced as a new tool in medicine with applications in remote instruction, documenting procedures, patient empowerment, reading signal data, and providing instructional films and simulation (Klein et al., 2015). Similarly, for nursing, applications were studied for wound care, education, and monitoring (Wüller et al., 2019). However, smart glasses are still new and innovative (Romare & Skär, 2020) and there is a need to understand the acceptance and use of smart glasses in this discipline (Mitrasinovic et al., 2015; Wüller et al., 2019; Zuidhof et al., 2019a) and the role theories play in explaining acceptance.

1.1. Adoption of smart glasses in healthcare

Previous research has established that the adoption of smart glass is still limited across various markets (Han et al., 2019; Rani et al., 2021). Several attempts have been made to find relevant factors to the adoption of smart glasses. Influential factors seem to be price, standalone devices, ease of use, enjoyment, self-efficacy, positive attitude, and social influence (Basoglu et al., 2017; Broach et al., 2018). Barriers to smart glasses adoption were related to the look and feel of the devices. The look and feel are important because smart glasses are worn on the face (Adapa et al., 2018) and might relate to the "fashnology" perspective (Chuah et al., 2016; Rauschnabel, 2018) and the construct "image" in adoption frameworks (Lai, 2017; Venkatesh & Davis, 2000). Many of the studies that explored technology adoption have been based on the technology acceptance model (Davis et al., 1989) or one of its successors like the unified theory of acceptance and use of technology (Venkatesh & Davis, 2003). Although the technology acceptance model is perceived as the most applied model in information systems (Lee et al., 2003), the diffusion of innovations provides more insight into which phase of acceptance a potential user is in and can provide insights in the persuasion and decision stage where an individual seeks "information to reduce

CONTACT Niek Zuidhof e.n.zuidhof@saxion.nl Saxion University of Applied Sciences, M.H. Tromplaan 28, Enschede, 7513 AB, Netherlands

uncertainty about an innovation's expected consequences" (Rogers, 1983). Expected but also unexpected consequences provide insight into the impact of smart glasses, which is discussed later in this introduction.

There are various markets for smart glasses, such as in defense, engineering, or gaming (Kress, 2014), the application of smart glasses in healthcare attracts attention and has the potential to revolutionize healthcare (Kolodzey et al., 2017; Lukowicz et al., 2004). Although studies have already been conducted in the field on specific areas of interest, such as skill training (Kim et al., 2021), completion of safety checklists (Boillat et al., 2019) the use of Google Glass in surgical settings (Dougherty & Badawy, 2017; Mitrasinovic et al., 2015), nonsurgical medical settings (Dougherty & Badawy, 2017) and disaster telemedicine triage (Broach et al., 2018; Cicero et al., 2015), the knowledge of both the acceptance phase and influential aspects of acceptance in healthcare is still scarce and social implications are important to take into account as well since there is a high chance of interrupting the user and the closer it becomes to the human body, the higher the need for privacy (Gheorghe et al., 2016).

1.2. Impact of smart glasses on the user and its environment

Smart glasses are worn on the head, therefore it is important to also pay attention to social influences around smart glasses. Several studies have provided important information about technical and design aspects of smart glasses, and social interaction of augmented reality (Miller et al., 2019) but researchers have not explored in detail the social interaction surrounding smart glasses as a wearable product in a broader sense. Observations on social acceptance of augmented reality head-mounted displays were explored in small social settings (Prilla et al., 2019) and a variety of ethical issues were identified, such as privacy issues, but also safety issues, justice, change in human agency, accountability, responsibility and social interaction (Hofmann et al., 2017). However, social implications and ethical aspects can be viewed more broadly with a research method, such as focus groups. The foregoing issues can be seen as implicit aspects and may have not been foreseen by the designers of smart glasses but are important to explore further, and more specifically, little attention has been paid to these aspects in the context of healthcare.

Implicit aspects of smart glasses are also studied as human-technology relationships in the mediation approach in the philosophy of technology. Humans and technology mutually shape each other (Bijker & Law, 1992) and therefore the interaction between humans and technology is seen as the result of interaction instead of two poles. For instance, eyeglasses can be embodied to form a unity with a human being and are termed an embodiment relation in the mediation approach. A user looks through the glasses rather than at the glasses. Furthermore, in hermeneutic relations, human beings read how technologies represent the world, such as an MRI scan can represent brain activity. Now, smart glasses are a bifurcation of embodiment and a hermeneutic relation resulting in an augmentation relationship. Smart glasses can be embodied to form a unity with the user, while the screen can also represent the digital and physical world (Verbeek, 2015). The mediation approach shifts the focus from adoption only to human-technology influences back and forth in aspects that are both explicit and implicit (Zuidhof et al., 2019a). In addition, implicit product capabilities are important for both users and designer because it affects the overall acceptance (Koca et al., 2009; Zuidhof et al., 2019b) however these aspects were not involved earlier in theories of adoption.

Little attention is paid to the adoption and interaction of smart glasses in general (Kim et al., 2018), nor from the prospective users in the context of healthcare. Both adoption and interaction aspects can be combined in an empirical study with a focus on explicit and implicit aspects of smart glasses in an early stage of adoption. The specific objective of the present study was to identify relevant aspects regarding adoption, mediation, and the use of smart glasses for future development from the perspective of healthcare professionals. Involving end-users in the early stages of the development process is important to ensure initial efforts are relevant to the users (Gulliksen et al., 2003). Thus, this user-centered design approach should inform design choices, and provide more understanding of relevant adoption aspects and use behavior from prospective users. This also might help implement strategies and designers in the nearby future.

2. Methods

The present study involved three focus groups with various stakeholders from the healthcare domain. Focus groups were chosen as a method because data results from interaction with relevant stakeholders which contributes to the aim of this study, stimulate discussion, and are rich in information that may be useful in the early phase of research and development (Cohen et al., 2011). Directed content analysis was perceived to be the most appropriate technique and was used in an inductive, qualitative approach since only broad topics in the focus groups were based on theories of adoption and mediation (Elo & Kyngäs, 2008; Hsieh & Shannon, 2005; Vaismoradi et al., 2013). This study was reviewed, discussed with, and approved by the Ethics committee of the Behavioral, Management, and Social Sciences faculty of the University of Twente, The Netherlands (approval number: 200027).

2.1. Participants

Recruiting a variety of participants was attempted by recruiting in a professional setting and a college setting with various levels of a college degree, related to (health)care. The participants in this study were recruited by convenience sampling from a local healthcare provider for the elderly (focus group 1) and two studies (master Healthcare & Social Work, Bachelor of Social Work) from a university of applied

Table 1. Demographic characteristics of the participants ($N = 22$).

Focus group 1: nurses in healthcare ($n = 6$)	
Sex, male/female/other	0/5/1
Age, median (variance)	39 (24–48)
College degree level, BA, MA, MSc	1/4/1
Focus group 2: final year students of Bachelor of Social Work ($n = 6$)	
Sex, male/female/other	1/5/0
Age, median (variance)	25 (21–28)
College degree level, BA, MA, MSc	6/0/0
Focus group 3: combined group of professionals in healthcare and social work ($n = 10$)	
Sex, male/female/other	3/7/0
Age, median (variance)	33 (21–64)
College degree level, BA, MA, MSc	0/10/0

sciences (focus group 2, 3), see Table 1. Since smart glasses are not widespread and healthcare has various professions in addition to doctors and nurses, we were also interested in social workers because they might also represent social aspects regarding the anticipated use of smart glasses. Because this study has an exploratory character, the inclusion criteria were: (health)care-related work or study, and work experience in (health)care. All participants had experience in care, but their experience was diverse. For instance, respondents were nurses, social workers, but also project leaders, managers, and a CEO of a care company. Three focus groups with a total of 22 respondents were conducted between January 2020 and March 2020 and data collection was stopped due to the COVID-19 pandemic.

2.2. Procedures

To identify relevant themes to adoption and mediation, the participants were asked questions in a semi-structured way based on the most commonly accepted theories by scholars (Akbari et al., 2020; Lee et al., 2003) namely the Technology, Acceptance Model (Davis et al., 1989), Unified Theory of Use and Technology (Venkatesh & Davis, 2003) and the stages of the Diffusion of Innovations (Rogers, 1983). Adoption-related aspects were: innovativeness, previous practice, norms of the social system, and felt needs (Rogers, 1983; Venkatesh & Davis, 2003), for the mediation questions (Verbeek, 2014), participants were asked to imagine own use of smart glasses and questions were about the potential environment, personal factors, such as own thoughts, emotions and expected behavior (Bandura, 1999). Similarly, participants were asked to imagine seeing someone else using smart glasses. Additionally, questions were asked about expected implicit aspects of smart glasses, such as unintended effects (Tenner, 1996). The final question was about the attitude of participants to smart glasses (Fishbein & Ajzen, 1975). The interview guide was refined through discussions with experts in qualitative research and in the field of healthcare. Focus groups lasted between 90 and 120 min (mean time: 100) with the option of a break in between and everyone was physically present in a quiet room at the healthcare provider or in quiet classrooms. The interview guide is available in Appendix 1.

2.3. Data collection

Three focus groups were conducted between January 2020 and March 2020 by a moderator, observer and were audio and video recorded for later transcription and analysis. After providing informed consent, an introduction to the focus group was given and the participants' innovativeness and foreknowledge were discussed. Next, a video was shown with neutral examples and use cases of various smart glasses. The moderator brought two types of smart glasses, a Google Glass and J!NS Meme to the focus group, and all participants could get a hands-on experience with these different types of smart glasses. Then the other questions were asked. The moderator was fully aware of the subject, jargon, and key issues related to smart glasses in healthcare.

2.4. Data analysis

Video recordings of the focus group were transcribed verbatim and checked for completeness. Participants were anonymized with random letter combinations. The data was analyzed inductively using qualitative content analysis carried out with Atlas.ti 9. Coding was done in multiple stages and discussed with the researchers. We started with the initial labeling stage, followed by the second more analytical stage to form overarching themes and subcategories which resulted in a codebook with 44 codes for selective coding. Approximately 10% of the data were independently coded and discussed by two researchers with a substantial intercoder agreement (Cohen's Kappa of .93) in three rounds. This study was conducted after approval from the ethics committee and all participants provided written informed consent.

3. Results

In total fifteen overarching themes were formed during the analytical stage of coding. The overarching themes can be partly related to the theoretical stages of anticipated adoption and mediation of smart glasses: anticipated adoption, expected influences of own use of smart glasses, and expected influences of use by others, see Figure 1 (Zuidhof et al., 2019a). The themes and key findings, which are the outcomes of the content analysis of the three focus groups, are presented in Tables 2–4.

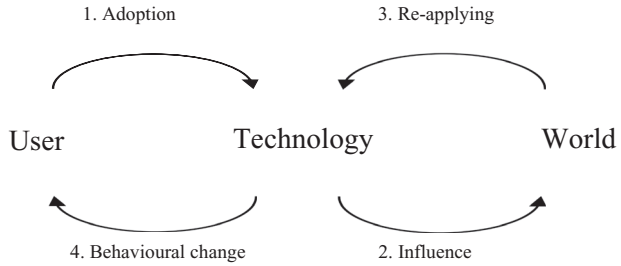

Figure 1. Theoretical framework of adoption and mediation is derived from Zuidhof et al. (2019a).

3.1. Anticipated adoption of smart glasses

The first set of questions aimed to identify themes related to the adoption of smart glasses. Specific questions were asked for the following categories: foreknowledge, innovativeness, use cases, and attitude. The categories of ethical issues and persuasion were not specifically asked for and were created during the analytic phase.

3.2. Knowledge

Participants were asked about their prior knowledge of smart glasses. This resulted in the forming of sub-categories and consisted of previous practice, applications, and how to use smart glasses. About a third of the participant had *previous practice* with smart glasses and Google Glass was mentioned most. From the few experiences with Google Glass, critics came to the table about technical difficulties (e.g., battery problems), and the screen being too small or the

Table 2. Themes regarding anticipated adoption of smart glasses in care.

Themes/known constructs	Sub-themes	Key findings	Example of quotes from participants
Knowledge	Previous practice	Google glass, critics about functionalities of Google Glass, other smart glasses	"I know about Google Glass", "Glass is not real augmented reality"
	Applications	Knows its existence, can be used in healthcare, gaming	"… for therapy in anxiety disorders", "play games"
	How to use	Explains how to use, give commands, explains bone conduction	"Ok Glass, take picture", "It's just literally the vibration above the ear"
		Have no idea	"I really don't know"
Innovativeness	Yes	Yes, ever been	"Yes, always"
	No	No	"No, I'm known as technologically illiterate"
	Under condition	Only work-related	"Not at all like that at home, but at my work, all developments, etc."
Use cases	Remote viewing	Advantages, for professionals, for patients	"So that people don't have to go to a hospital"
	Specific users	Professions, patients, or clients	"See progression in a wound"
	Quick access to information	Reading documents, searching information, patient records, personal use	"Could be ideal to just lookup a file in the electronic health record"
	Education	Raising expertise, when learning, revolutionize school	"No need to physically attend school", "bedside teaching"
	Requirements	Felt needs, expectations	"You should be able to call easily"
	Location of use	At the office, at home, when alone	"More in an office setting"
	Wearing in a social situation	Watching video	"You immediately think that they are looking nice at you, while they are just laughing at stupid movies"
	Comparisons	PC, smartphones	"If I now go to work for a while, you see that I am working on a PC and if I can control all this with my eyes, you think, what am I doing"
	No-go's	Substitute for knowledge, bathroom	"Imagine you want to take the bath, then I think you will feel a little more relaxed when you don't wear smart glasses"
	For safety reasons	Camera	"Then I can go alone, I don't always have to go with 2 people.. or, oh yes, then I can put it on and go to a client in the evening. I can just call for help"
Ethical issues	Privacy	Invasion, become a bigger issue	"That is a major invasion of my privacy"
	Data security	Profiling, safety	"There is also a database somewhere that contains everything about me"
	Unethical activities	Criminal circuit, fraud	"Would it perhaps have added value for the criminal circuit?"
Persuasion	Questions about functionalities	Hardware, adoption related themes, compatibility	"But you can also save information. Is it connected to WiFi or does it contain some sort of SIM card, or how should I see that?"
	Drivers	Usefulness, design, context related aspects, ease of use	"Yes, but I like that futuristic look."
	Barriers	Disadvantages, design, ease of use	"Surely they also made pictures of people 20 years after Google Glass, that one eye straight ahead and the other eye so slanted"
Attitude	Positive	Work-related settings, social settings	"Positive for work and actually also in social interactions. Everyone first uses it for work and then everyone starts using it privately"
	Negative	No added value, social settings	"Functionally it seems like a good development, but not socially"
	Neutral	Opinion might change over time, no usefulness in private settings	"Yes, now it's a bit strange, but in 5 or 6 years it might be different"

Table 3. Themes regarding anticipated own smart glasses usage in a work-related setting.

Themes	Key findings	Example of quotes from participants
Attention	Body worn aspect, more connected to a digital world, less connected to external or physical world	"You have less attention, it is also good if the other person sees that you are doing something different"
Emotions	Natural for use in work situations Uncomfortable in social situations Fear of being hacked	"Yeah, I wouldn't feel comfortable with it either. I wouldn't wear it myself, because I know what I can reflect back on someone else"

Table 4. Themes regarding anticipated smart glasses usage by others in a work-related setting.

Themes	Key findings	Example of quotes from participants
Social influences	Purpose of use should be clear Etiquette needed Habituation Seclusion Influences in care	"I think the purpose should be known", " … because then you are very introverted and someone else really thinks, what is he doing?", " … then we said, I'm not going to walk out the door with the phone after all. We all do that now."
Design	Looks weird Sparks curiosity Norms Positive value judgments	"But I think this [points to top of the frame], you know, you get such a monobrow", "it also has openness, because it doesn't contain any glass"
Context	Work-related setting Depends on the relationship with user	"Yes, because then it can also be used against you from the abuse of power. While you go from the relaxation and the trust and everything is going well and smoothly, it wouldn't matter to anyone"
Camera use	Negative judgments Neutral comments	" … that front camera. What is he doing with it?", "If you have a camera with you, it already becomes quite threatening (…) that is not the case at all with such glasses".
Risks	Lack of control	"You can't control it, you can't deny it to a client, especially if he lives in an open group"
Comparisons to known products	Smartphones, bodycams, snapchat users	"It also has good sides. I think it's very good for the police that they have those bodycams (…) But where do you draw the line when something like that is good and when it is not good"
Expected reaction	Uncomfortable, suspicion, anger, tense	"Yes, I think it depends on the situation. (…) if I were 1-on-1, I'd think, are you filming? Or what are you going to do with it? So quite suspicious"

functionalities being too limited. For the sub-category *applications*, a third of the group heard about the possibilities of smart glasses and mentioned use in healthcare and psychotherapy or talked about pilot studies or gaming. During the focus groups, there was a moment to try out the smart glasses that were brought. Participants helped each other by explaining *how to operate glasses* with their voices or how to take a picture. The foreknowledge category shows that some of the participants already had knowledge of smart glasses and some knew details about applications or specific functionalities.

3.3. Innovativeness

More than half of the respondents felt that he or she was a person who quickly tried new technologies. Some participants added that it also depends on whether it was for work or private circumstances, in favor of the working conditions. The rest of the participants were clear in their answers that they are not that innovative.

3.4. Use cases

When asked for what purpose someone would like to use smart glasses, it was noticed that *remote viewing* was the most common theme. Remote viewing was not only about watching a professional in wound care for example but also learning to understand a patient's perspective with misunderstood behavior in a residential setting. The advantages of remote viewing were discussed, such as saving travel movements, the way images can communicate faster than language, and smart glasses are less conspicuous and threatening than holding a video camera for observations. Furthermore, interviewees mentioned various usage options in *professions and patient target groups*. Some examples are inspection for engineers, observations for therapists, use in coaching, and from a patient perspective, smart glasses might be helpful for visually impaired people, people with dementia, people with autism, and obese people. Another use case was with *quick information access* for documents or electronic health records and reporting. The *educational aspect* of smart glasses usage was an important topic as well during the sessions, it could be used for bedside teaching, raising expertise, and might raise the quality of care. It could also change how we learn at school. For *requirements*, many different aspects were discussed and were about the user experience that should be fast and easy. Other opinions mentioned that use should be discrete with a silent mode for example. One respondent argued that equipment should be able to withstand infection prevention. Smart glasses are perceived to be mostly used in professional *settings*, in private life settings smart glasses were perceived to be used mainly by gadget enthusiasts. If smart glasses were used in a group or *social situation*, video is interesting to view the same material if needed or conversely everybody could watch what they want. When discussing use, *comparisons* were made a small number of times with what one can do

with computers or smartphones. One interviewee argued that *use of smart glasses should not* act as a substitute for knowledge by reading documents or protocols. While a camera could enhance a sense of *safety* when you are alone outside, another interviewee warned that smart glasses should not be used in the bathroom and pointed toward privacy aspects.

3.5. Ethical issues

Concerning aspects of privacy, three themes related to smart glasses emerged from the analysis: privacy issues, data security, and unethical activities in general. Interviewees expected *privacy* to become a more important issue and focused on the dynamic role of privacy issues and some of the participants called smart glasses an invasion of privacy. In the case of *data security*, two perspectives were expressed about information in databases or Google, and protection of data when someone loses the devices. A small number of comments related to *unethical activities* in the criminal circuit or fraud by using the camera.

3.6. Persuasion

To think about smart glasses and possible acceptance, the respondents asked *many questions*. Most of the questions were about hardware, such as questions about how to capture a video, what smart glasses can do, what you see through the screen, and connectivity to smartphones. Other questions were about adoption-related themes like price and why smart glasses are not widespread yet. One interviewee asked about compatibility with prescription lenses. The participants on the whole demonstrated many *drivers* in favor of the adoption of smart glasses. Most of the drivers were expressed by advantages, such as efficiency, increase in quality, cool to use, and the handsfree aspect. Other drivers are concerned about the design of smart glasses. Despite the fact that they are different types of smart glasses, respondents found the design of J!NS Meme more beautiful than Google glass. However, some respondents liked the futuristic design by Google and another interviewee noted that Google's design was not interfering with social contact. Minor themes concerning drivers were context-related statements that innovativeness is good in healthcare and that professionals can show more courage with innovations. At last, the ease of use was expressed by using voice commands. On the other hand, in the number of statements only slightly less than the drivers, are the *barriers* to adoption. It contained almost the same theme, such as disadvantages, design issues, ease of use, and functionalities. The most expressed disadvantage was fear of being hacked. Other themes are the number of devices someone already has, more information can cause stress and it might be addictive to use. Barriers to design were most expressed about Google glass, that the glasses look weird for example. A barrier to the suggested use was that it is probably a lot of hassle and that it might be difficult to use for spectacle wearers or the visually impaired.

3.7. Attitude

The attitude to smart glasses was *positive* for most of the respondents. Much potential and added value are expected. Many see it coming in work-related settings and some of the respondents expect to use it in social settings as well, but that should take more time. Some respondents mentioned that their attitude was positive under the condition that the purpose of use was clear. A smaller amount of the respondents had a *negative* attitude toward smart glasses and the same applied to a neutral attitude. Both groups explained their attitude toward use in social settings.

From these results of adoption-related themes, it can thus be suggested that the following aspects might influence perceived usefulness: foreknowledge, efficiency, and increase in quality. Also, there may be a link between hands-free use, the position of the screen, and perceived usefulness. Ease of use can be influenced by voice commands, cumbersome use, and also spectacle wearers or people with certain disabilities or impairments. Design, coolness, and fear of hacks might influence attitudes toward smart glasses. Other influences on attitude could be usefulness, use in work-related settings, habituation, and a clear purpose for using smart glasses. The following aspects might influence the intention to use: personal innovativeness, privacy, and data security. These propositions will be surveyed in a follow-up study.

3.8. Anticipated influences of smart glasses

Respondents imagined their own use of smart glasses in a work-related setting and were asked about the potential environment, their thoughts, feelings, and their anticipated behavior (Bandura, 1986). *Thoughts* that came to their mind were mainly thoughts about the connection with the other. Respondents thought they would be even more isolated from the outside world because it is body-worn and stimuli in your field of view are more pervasive and harder to ignore. Thus, smart glasses are more distracting to the user and a discussion began about whether smart glass usage would be at the expense of human contact. On the other hand, reading notifications on smart glasses might be less distracting to others around you because you can use it in a discrete way compared to using a smartphone. A few respondents thought that others would look strangely at smart glass users. One interviewee found it strange to see something someone else cannot see. Likert scale questions could be derived from the data on the following themes: interaction with the physical environment and interaction with the social environment.

The results of influences of own use of smart glasses can inform the survey which is planned after this study. The findings could be transformed into statements about interaction with the physical environment, such as engagement and interaction with the social environment, such as image, distance, and closeness to others.

3.9. Expected influences of smart glasses use by others

In another question, respondents were asked to imagine seeing a smart glass user in their working environment and then asked for their thoughts and feelings. Although this question is somewhat similar to the question in Table 3, it generated twice as much discussion. Respondents had various thoughts about seeing a smart glass user. Sub-categories were divided into social influences, design, context, camera use, risks, comparisons to known products and expected reaction.

First, some influences are related to *social aspects* in general. One of the major themes was a need for a clear purpose in the use of smart glasses. Respondents had various ways to express this, some highlighted ambivalent situations in use, and others made a normative statement about the purpose. A theme resulting from this is that there might be rules needed. Especially in private settings like dinner, respondents made comparisons with smartphone usage and one interviewee argued that use should contribute to the other and the user. Eye contact was an important topic as well because having eye contact is quite clear in communication but less when someone is wearing smart glasses. Various situations were discussed, a user walking by was not perceived as a problem, but when being in a room with a smart glass user, it was suggested that would be nice if the user takes a position where the use is less ambivalent, such as sitting at a desk or table. A related topic to this is the social isolation of smart glass users. It disconnects you from the outside world and may hinder social contact. One interviewee found that ironic because glasses in general have an open design. Also, *social aspects* specific to the care context were discussed. Respondents saw also positive implications, such as using smart glasses is calmer for patients compared to many visits by nurses. Most of the respondents agreed on getting used to smart glass users over time. Thoughts about seeing a smart glass user were also related to *design*. The most striking ambivalent theme to emerge from the data is that it looks weird on the one hand, but it sparks curiosity on the other hand. This might seem contradictory, but it was said that it should match a person's appearance and it can go both ways, whether it is acceptable or ridiculous. On the positive side, a user can look modern or fancy. According to some interviewees, it does not necessarily disturb, especially if someone has long hair.

If someone *accepts the situation* when being confronted with a smart glass user depends on where he or she is. Respondents found smart glasses appropriate in work-related settings and when it is related to the profession of the user. Another important theme was trust. It would depend on the relationship with the user if someone were more relaxed or tense about it. Concerns regarding *camera use* of smart glass users were expressed a lot. Respondents would feel uncomfortable with someone walking around making videos and don't like being filmed on the streets. This discussion was mainly in an imagined situation where the purpose of camera use was unknown, but still, smart glasses were perceived as less threatening compared to a manual video camera. The *risks* of smart glass users were an extension of the video use, it was related to a lack of trust and a lack of control. You may find yourself on the Internet or someone can use videos against you. It could be used as a means of power in the wrong hands. Although it was a minor theme, respondents made *comparisons to other products* or services. For example, the actual use of a smartphone is much more noticeable than smart glasses and you can put a smartphone away. Smart glasses are even more present. And related to the camera use of smart glasses, bodycams are regularly used by the police and was perceived with a positive attitude. Furthermore, Snapchat users make videos everywhere as well. A variety of *reactions* were given when imagining a smart glass user. A sense of discomfort came to their mind. Situations that raise that feeling were related to the unknown purpose of use, someone could feel watched. However, if everybody wears smart glasses it wouldn't be strange. Misunderstood behavior of smart glass users could also evoke anger, the same applies if you would be ignored by a smart glass user. Other reactions had to do with suspicion, one interviewee explained that everything new raises suspicion.

These results on the expected influence of smart glasses usage by others provide important insights for a follow-up study. Statements about comparisons with smartphones could be made, such as whether the use of smart glasses interferes more than smartphone usage. And also, about the design compared with normal glasses. Furthermore, statements about trust and wariness could be obtained from a larger dataset in a quantitative study.

4. Discussion

This study has identified various themes in adoption and interaction-related themes. Six overarching themes related to the adoption of smart glasses were identified: knowledge, innovativeness, use cases, ethical issues, persuasion, and attitude. Anticipated mediation revealed nine themes: attentional shift, emotions, social influences, design, context, camera use, risks, comparisons to known products, and expected reaction.

4.1. Themes regarding anticipated adoption of smart glasses

4.1.1. The importance of knowledge about smart glasses

An interesting finding regarding the adoption of smart glasses was that information or knowledge about smart glasses was important to respondents. Although most respondents knew about the existence of smart glasses, there were still many questions about the hardware and compatibility of smart glasses. This finding is in line with the "knowledge/awareness" stage described by Rogers (Rogers, 1983) as is the next theme: use cases.

4.1.2. Understanding anticipated adoption by discussing use cases

While anticipating smart glasses, potential use cases were largely discussed, with advantages and disadvantages and the attitudes toward smart glasses including ethical issues concerning privacy and data security. These aspects are also

part of the "decision" stage and are the third of five stages of the adoption process by Rogers (1983). However, this contradicts Rogers' finding that there is a step-by-step adoption process over time (Rogers, 1983). It can thus be suggested that in an early stage of acceptance, with only prior knowledge but no real experience with smart glasses, all these first three of five stages of the adoption process occur simultaneously and that was no clear sequence found between these stages. A note of caution is due here since an alternative explanation for this may be that these stages had already been completed before this focus group started or that the focus group functions as a kind of pressure cooker, but the researchers did not get that impression.

Furthermore, the key findings from the categories innovativeness, anticipated adoption, and attitude confirm constructs from current technology acceptance models (Davis et al., 1989; Venkatesh & Davis, 2003). The results have revealed various propositions that we can include in a follow-up study. Also, insights from the mediation perspective (Ihde, 1993; Verbeek, 2015) were used and have given a deeper understanding of the interaction between humans and smart glasses and could complement the diffusion of innovations (Rogers, 1983) with a more integrated view on how adopter categories are perceived by others.

4.2. Themes regarding anticipated mediation and use of smart glasses

4.2.1. Potential issues in social interaction

Several conclusions can be drawn regarding anticipated mediation and future use of smart glasses. By making people think about the influences of smart glasses and future use, we did not only gather knowledge from a different perspective on aspects that are relevant for adoption (such as themes on user and design in Table 4), but also indicate where possible issues will come into use, and before use of smart glasses in public is accepted. For example, this study shows under what circumstances people would accept public use, such as a work-related setting, namely a clear purpose in use, and perhaps there are other standards needed. But also what might happen in social interaction, is for instance more isolation or less social connectedness in public use, this confirms earlier findings on social interaction with augmented reality (Miller et al., 2019). Furthermore, what sets smart glasses apart from other wearables here is the dual function of gaze and that is a remarkable tool for social interaction. "Ears cannot speak, lips cannot hear, but eyes can both signal and perceive" (Gobel et al., 2015). This may be a possible explanation for why the acceptance of smart glasses is slower than, for example, the smartwatch.

4.2.2. Influences on work in healthcare

There are also influences on care, for example, smart glasses are less intrusive compared to the use of a video camera or tablet, the calming aspect of fewer people on the bed, and the possibility of bedside teaching. These findings have implications for implementation strategies in care and for designers to shape future products with the user in mind.

4.2.3. Behavioral and emotional implications

On an emotional level, it has become clear for smart glasses how different adopter categories might be perceived by others. Rogers (1983) described that innovators might not be respected by other members of the social system. This study shows that tension, discomfort, suspicion, and anger arise when the purpose is unknown or behavior with smart glasses is misunderstood and confirms earlier findings (Koelle et al., 2015). Furthermore, these emotions would disappear when smart glasses are worn by a majority of people. We conclude that it is important for a successful implementation to pay attention to this in the early phase of adoption and come up with solutions with users from a user-centered design perspective. Some risks, such as lack of trust and a lack of control were related to camera use of smart glasses and therefore also related to privacy issues and confirm previous publications (Zhang et al., 2022), for instance, in the early days of ubiquitous computing this was described as of problem of control, "it becomes hard to know what is controlling what, what is connected to what, where information is flowing, how it is being used (…) (Weiser et al., 1999). It is possible to hypothesize that values, such as control and privacy are dynamic and could lead to re-applying smart glasses in another way and behavioral change (Zuidhof et al., 2019a) as a result of mutual shaping (Bijker & Law, 1992).

5. Limitations

There are some limitations in this present study. One source of weakness in this study that could have affected the results was the mixed professions of the participants. In the healthcare context alone, there are various professions and various target groups of patients. And involving diverse disciplines in care can mean that questions have been looked at from different perspectives. We found it acceptable for the purpose of the study because this study had a qualitative, exploratory nature on acceptance and social influences and thus we needed diverse perspectives for rich data. An additional uncontrolled factor is with all qualitative analysis techniques, the potential bias in analyzing qualitative data. Here, the combination between philosophy and psychology offers both possibilities and limitations. From a philosophical perspective, it may be possible to interpret and reflect more on a quotation than this study examined. But the empirical research requires more observable statements. Therefore, theoretical choices have been made to empirically investigate the theory of mediation from the philosophy of technology in the anticipated use of smart glasses. Despite its exploratory nature, this study offers some insights into how philosophy and psychology can complement each other in the context of technology acceptance and social interaction.

6. Future research

A natural progression of this work is to analyze the propositions derived from the results in a quantitative study and is an essential next step in confirming and modeling the aspects found in this study on the acceptance and impact of smart glasses. Further research might also explore whether the process in the diffusion of innovations (Rogers, 1983) is still applicable in the context of smart glasses.

With regard to the anticipation of social interaction and adoption of smart glasses, respondents found it more difficult to think about themselves with smart glasses than relocate themselves to a situation where someone else is wearing them. It can therefore be assumed that it is better to ask how people respond to others with smart glasses. Based on the findings in this study, we expect that judging the behavior of another person with smart glasses also affects own future use with smart glasses. This observation may also support the hypothesis that mediation and adoption start at the same time (Rogers, 1983; Zuidhof et al., 2019a). In closing, the results of this study show that it is possible to investigate explicit consequences (Rogers, 1983) of the future use of smart glasses with adoption models. And that implicit consequences can be investigated empirically by using the imagination technique, inspired by a combination of mediation from the Philosophy of Technology (Verbeek, 2014) and social cognitive theory of Psychology (Bandura, 1986).

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ORCID

Niek Zuidhof http://orcid.org/0000-0001-7359-0169

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About the Authors

Niek Zuidhof is a senior researcher at the Saxion University of Applied Sciences. His research focuses on human-technology interactions and the acceptance of wearable technologies.

Somaya Ben Allouch focuses on the digital interactions between humans and non-humans. She is appointed at the Amsterdam University of Applied Sciences and the University of Amsterdam, the Netherlands. Furthermore, she is involved in various (inter)national competitively third-party funded research projects and supervises different PhD projects.

Oscar Peters is a lecturer and researcher at the Saxion University of Applied Sciences. His research focuses on media use and effects, with particular attention to the use and adoption of new media and ICT from the user's perspective.

Peter-Paul Verbeek is a distinguished professor of Philosophy of Technology and scientific co-director of the DesignLab of the University of Twente. His research focuses on the philosophy of human-technology relations and aims to contribute to philosophical theory, ethical reflection, and responsible practices of design and innovation. Website: www.ppverbeek.nl.

Appendix 1. Focus group questions

Introduction question

Question	Theoretical construct
Are you someone who quickly tries out new technology, such as a telephone, computer, or other IT products?	Innovativeness (Rogers, 1983)
What do you already know about smart glasses?	Knowledge (Rogers, 1983)
Who has ever tried such smart glasses?	Previous practice (Rogers, 1983)
What was your experience?	

Show the brought examples of smart glasses (Google Glass/J!NS Meme) and by watching a short video about smart glasses
Transition question:

Time for try-out, put it on.	Norms of the social system (Rogers, 1983)
What is your first impression in general?	
Positive or negative and why?	

Key questions about anticipated adoption, influence, use, and impact from own perspective of using smart glasses

Could these glasses help to solve a problem or your needs?	Felt problems/needs (Rogers, 1983)
Imagine wearing smart glasses during your daily activity at work:	Relationship between human-technology (Verbeek, 2015)
• Can you tell us something about what comes to your mind?	Potential environment, personal factors, think, feel, believe, and behavior (Bandura, 1999)
• For what purpose do you use it?	
• Which function?	
• Moment?	
• Place?	
• In the presence of others or not?	
• What would you think if you were wearing smart glasses?	
• What would you feel if you were wearing smart glasses?	
• Which norm or conviction lies behind this?	
• How would you behave if you were wearing smart glasses? How would that be different from not wearing smart glasses?	
• Do you also foresee unintended effects? Unintended behaviors or consequences.	Implicit consequences (Tenner, 1996)
• Which positive effects could the use of smart glasses have?	
• Which negative effects?	

Key questions about anticipated adoption, influence, use, and impact from the perspective of using smart glasses by others

These questions are about the other as user.	Relationship between human-technology (Verbeek, 2015)
Try to imagine this image: imagine you see someone else with smart glasses at work.	Potential environment, personal factors, think, feel, believe, and behavior (Bandura, 1999)
• Can you describe the image and environment of your imagination?	
• What is this person doing? How does this person behave?	
• What is your first thought?	
• How does this make you feel?	
• Which norm or conviction lies behind this?	
• What are your thoughts about the person who uses smart glasses? Does this change in other environments (street, public transport, shops, professional use, at home)?	
• How would you behave toward the user of those glasses?	

Concluding question:

What is your attitude toward smart glasses? Positive, negative, or neutral and why?	Attitude (Fishbein & Ajzen, 1975)