Augmented reality smart glasses: an investigation of technology acceptance drivers

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Abstract: Microsoft Hololens and Google Glass (Project Aura) are two examples of a new stream of wearable technology devices called 'Augmented Reality Smart Glasses' that might substantially influence media usage in the near future. In this study, the authors draw upon prior technology acceptance research and propose an exploratory model of antecedents to smart glasses adoption. An empirical study reveals the importance of various drivers such as functional benefits, ease of use, individual difference variables, brand attitudes, and social norms. Although smart glasses are worn in a similar manner to fashion accessories and capture various personal information, self-presentation benefits and potential privacy concerns seem less likely to influence smart glasses adoption. The findings provide pre-market knowledge about smart glasses that can help scholars and managers understand this new technology.

Keywords: augmented reality; smart glasses; wearables; technology adoption; technology diffusion; TAM

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1 Introduction

The rise of new communication and information technologies has tremendously influenced how individuals communicate with one another and how companies interact with consumers. Nowadays, consumers are not just 'online' or 'always online'. Consumers are, due to mobile devices such as smartphones and tablets, *always* and *everywhere* online (Hennig-Thurau et al., 2010). With social media platforms, consumers have the opportunity to construct an online identity and even escape from the 'real word' into their own virtual world (Whiting and Williams, 2013; Hollenbeck and Kaikati, 2012; Quan-Haase and Young, 2010).

But what comes next? An inspection of the latest developments by leading technology companies such as Microsoft, Google, and Facebook, reveals that the next progression in media technology could be what we call *Augmented Reality Smart Glasses*. These smart glasses are wearable devices that meld both real and virtual information in the consumer's view field. Recent marketing and scholarly forecasts reveal that smart glasses are likely to be the next 'big thing' in the evolution of media (e.g., Technavio, 2015). Likewise, scholars have investigated several aspects and applications of smart glasses. For example, they have investigated the adoption of smart glasses in medical settings (Muensterer et al., 2014; Albrecht et al., 2014), their use in the assistance of people with disabilities (McNaney et al., 2014), the technical features of smart glasses (LiKamWa, 2014), their early adopters (Rauschnabel et al., 2015a), and their managerial importance (Rauschnabel et al., 2015b; Eisenmann et al., 2014; Tomiuc, 2014). Finally, news outlets have reported legal conflicts surrounding the use of smart glasses (CNN, 2014) and have even provided advice on the etiquette of how to use smart glasses in public (Dumenco, 2014).

However, little is known about the underlying mechanisms that drive both the perception and the adoption of smart glasses among users. This knowledge, however, is of particular importance in the early stage of diffusion. Understanding who the innovators and early adopters are, and why they intend to adopt smart glasses, can significantly increase the speed of diffusion, as widely replicated in other industries (c.f., Greenhalgh et al., 2004). Furthermore, Augmented Reality Smart Glasses combine features of augmented reality and wearable devices, two widely but yet independently studied research areas (e.g., Rese et al., 2014; Spreer and Kallweit, 2014; Kim and Shin, 2015). Thus, traditional theories and models of technology acceptance need to be adjusted by incorporating the specific factors of this new theory (Leue et al., 2014).

In this research, we tackle the following research questions (RQs):

RQ1 How are smart glasses perceived from the view of potential users?

RQ2 What are the drivers and barriers of smart glasses from the view of potential users?

To answer these questions, we develop an exploratory model that covers various potential drivers and barriers of Augmented Reality Smart Glasses. The model explores which factors influence the attitude towards the use of smart glasses and the intention to adopt them, respectively. The model is then tested based on a sample of 201 consumers in Germany using regression and mediation analyses as well as descriptive statistics.

To the best of the authors' knowledge, this is the first study on technology acceptance in the context of smart glasses. From a theoretical perspective, our research contributes to the existing stream of technology acceptance research by providing pre-market entry data for smart glasses, a technology that differs substantially from many other existing technologies (Rauschnabel et al., 2015b). On the managerial front, our study provides valuable insights into how smart glasses and apps should be managed to satisfy consumers' needs. Finally, we discuss directions for further research in marketing, technology and innovation management, and other disciplines.

2 Augmented reality smart glasses

Mircosoft Hololens, Google Glass (Project Aura), and Everysight are just three examples of commercially announced smart glasses. We define smart glasses as "wearable Augmented Reality (AR) devices that are worn like regular glasses and merge virtual information with physical information in a user's view field" [Rauschnabel et al., (2015b), p.6]. According to this definition, Augmented Reality Smart Glasses use AR technologies within wearable media devices. Smart glasses capture the physical world with particular technologies (e.g., camera, microphones, GPS), and integrate virtual information that are gathered via mobile internet technologies or stored in the device.

Smart glasses differ in various ways from other mobile and wearable technologies. Most important is the fact that they merge virtual and physical information while being worn rather than providing just a virtual reality (Rauschnabel et al., 2015b). Existing wearables, such as smart watches or virtual reality glasses, do not consist of any augmented reality components. Many existing AR technologies are stationary such as AR mirrors or screens (Eisert et al., 2008). Furthermore, AR applications that can be used on smartphones or tablets have to be controlled proactively by the user whereas smart glasses work essentially autonomously and can be controlled by voice commands (Rauschnabel et al., 2015a; Tomiuc, 2014).

Not much research has been done to understand the psychological factors associated with smart glasses technology adoption and use. Exceptions include Rauschnabel et al.'s (2015a) study on the role of personality in smart glasses use. The authors found that open and emotionally stable consumers are more aware of smart glasses. Also, both the expected social conformity and functional benefits drive adoption intention, whereas the strength of these relationships differs between different types of personalities. In a recent Harvard case study, Eisenmann et al. (2014) discussed the opportunities and threats of the Google Glass smart glasses for consumers. They highlighted the opportunities of exploring the world and being a part of the Google Glass community as well as using the innovative features of the device. However, Eisenmann et al. (2014) also discussed criticism from people who might react sceptically or even rudely (i.e., being called a 'glasshole') to users of this new technology. Other barriers included more technical concerns such as limited battery life, misinterpretation of voice commands, unfashionable design, the small display, and a limited range of applications.

Using a conceptual approach, Rauschnabel et al. (2015b) theorised that smart glasses adoption behaviours should be driven by at least three clusters of motivations: Effectance (i.e., making one's life more efficient), hedonic (i.e., entertainment, fun), and social (i.e., factors maintain or establish social relationships and interactions). The authors point out that more research is needed to better understand these and additional motivations in detail. McNaney et al. (2014) conducted a qualitative study among patients with Parkinson's disease and showed that the technology has promising influence on the well-being of patients.

Another stream of research has studied smart glasses from the perspective of professional applications. For example, research in the medical field has explored the role of smart glasses for healthcare applications, such as documentation purposes in forensic medicine (Albrecht et al., 2014) or to foster international collaborations during surgeries (Muensterer et al., 2014). Likewise, Rauschnabel et al. (2015b) discussed various applications that can increase firm value. Examples include the use of smart glasses for market research, to increase the efficiency of logistical processes in the transport and storage of products in warehouses, and to enable real-time multimedia collaboration in product development. Eisenmann et al. (2014) highlight the potential for manufacturers of traditional glasses to collaborate with smart glasses manufacturers. Finally, Tomiuc (2014) discussed the role of Augmented Reality Smart Glasses to provide value by navigating visitors through museums and providing them with information during their tour. She claims these wearable AR technologies are "the next big thing in museum apps" (p.44).

3 Theoretical background

3.1 Models of technology acceptance

The technology acceptance model (TAM) is a widely cited and extended framework with its roots in information systems to explain the intentions and behaviours of potential users with regards to the acceptance of particular technologies (Davis, 1989). The model is one of the most influential extensions of the theory of reasoned action (TRA) (Ajzen and Fishbein, 1980; Bagozzi et al., 1992). The initial TAM hypothesises that the perceived ease of use and the perceived usefulness of a new technology influence peoples' attitudes towards the acceptance of the technology, which then influences the intention to adopt the new technology (Davis, 1989; Davis et al., 1992). TAM also specifies the role of perceived usefulness: besides the indirect effect on the behavioural intention (i.e., mediated by the attitude towards using a technology), Davis (1989) proposes an additional direct effect on behavioural intention. Also, TAM hypothesises that a technology is perceived as being more useful when consumers perceive the technology as easy to use. Finally, the intention to use a product is hypothesised to predict the actual use of a system. Because of the robustness and the flexibility of TAM, many studies have extended and successfully applied the model in several contexts (for a review, see Turner et al., 2010; King and He, 2006).

The original TAM is fairly easy to comprehend – it basically theorises that the perception of a technology in terms of its ease of use and its perceived usefulness drive its adoption. Venkatesh and Davis (2010) extended the TAM to explain perceived usefulness and usage intentions in terms of social influences (subjective norms, voluntariness, and image) and cognitive instrumental processes (job relevance, output quality, result demonstrability, perceived ease of use). Their new model, TAM2, added additional antecedents of perceived usefulness and also predicted a direct influence of subjective norms on behavioural intentions. In the context of TAM, social norms describe the degree to which a person thinks that his or her important peers expect him or her to use a particular technology (Fishbein and Ajzen, 1975; Venkatesh and Davis, 2000; Davis et al., 1992). People are generally motivated to engage in activities when they believe people who are important to them think they should behave in a certain manner (Fishbein and Ajzen, 1975; Ajzen, 1991; Venkatesh and Davis, 2000; Davis et al., 1992).

One of the criticisms (c.f., Bagozzi, 2007; for a discussion) of TAMs' prominence in the literature is its devastation of other literature and theory streams. TAM has been criticised as being overused by scholars at the expense of other potentially helpful models and factors that could be incorporated into a technology acceptance framework (Bagozzi, 2007). Taking a broader holistic approach, Venkatesh and Davis (2007) integrated findings from various theories and models (e.g., TRA, theory of planned behaviour, TAM, innovation diffusion theory, social cognitive theory, and others) in their unified theory of acceptance and use of technology (UTAUT). Similar to TAM, UTAUT covers the usefulness of a technology (here referred to as 'performance expectancy') and the ease of use (here referred to as 'effort expectancy'). UTAUT also integrates social influences (e.g., norms, image) and facilitating conditions. "Facilitating conditions are defined as the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system" [Venkatesh et al., (2003), p.453]. According to UTAUT, facilitating conditions should be directly related to the actual behaviour of adopters and not to behavioural intentions.

TAM3 (Venkatesh and Bala, 2008) proposes an additional extension of TAM1, TAM2, and UTAUT. The complex model consists of 17 constructs including various mediating and moderating relationships. Briefly, TAM3 includes individual differences, system characteristics, social influences, and facilitating conditions as antecedents of the exogenous variables of the original TAM model.

3.2 Overview of related research

Technology acceptance research, particularly TAM, seems to be a good starting point for exploring the underlying mechanisms of smart glasses adoption. As discussed above, smart glasses are a particular type of wearable augmented reality device. That being said, it is likely that the mechanisms of smart glasses cover findings from prior research on both wearable technologies and augmented reality – two areas that have been investigated through the lens of technology acceptance research.

Rese et al. (2014), Haugstvedt and Krogstie (2012), as well as Spreer and Kallweit (2014) have applied the TAM to study mobile AR technologies. All of these studies consistently show the general appropriateness of the TAM in AR settings. In their conceptual paper, Leue et al. (2014) argue that TAM needs to be revised for AR purposes, and call for the inclusion of additional factors such as the costs of use or personal innovativeness.

Various scholars have applied modified TAM-models on wearable technologies in general. For example, Kim and Shin (2015) studied the acceptance of smart watches using a revised TAM. They highlighted the need for a subcultural appeal of smart watches, affective quality, relative advantage, availability, and costs as additional TAM. Similarly, Spagnolli et al. (2014) studied wearable textiles and conclude that TAM provides a robust theoretical framework for understanding the adoption of this new technology.

3.3 Summary of prior technology acceptance research

Whereas the original TAM prototype model was quite clear and structured, extensions and modifications of the original TAM model (e.g., TAM2, TAM3, UTAUT) have increased the complexity of the model enormously. Likewise, after reviewing and discussing a broad range of technology acceptance research, Bagozzi (2007, p.245) concludes that the "study of technology adoption/acceptance/rejection is reaching a stage of chaos, and knowledge is becoming increasingly fragmented with little coherent integration". Thus, when discussing a new technology in a pre-market entry stage, an exploratory model that includes selected aspects of prior TAMs seems more than reasonable. Therefore, building on earlier research in general (rather than applying a single prior model), we will outline an exploratory model that covers both the most important TAM factors as well as context specific factors for augmented reality smart glasses. This is also in line with the common practice of technology acceptance research where researchers apply the basic TAM and extend it with important, context-specific findings from other theories (e.g., Lin, 2003), such as innovation diffusion theory (Rogers, 2010) and others.

4 An exploratory model

4.1 Expected functional benefits

A core motivation as to why consumers might adopt smart glasses lies in its functional benefits, which both TAM and other technology acceptance theories have widely replicated. As discussed above, TAM research has used the term 'perceived usefulness' and UTAUT used the term 'performance expectancy'. Other terms for this idea are derived from theories that we did not review in detail and include 'relative advantage' [Innovation diffusion theory (Rogers, 2010)] or 'outcome expectations' [social cognitive theory; Compeau and Higgins (1995)].

As we will discuss later, we distinguish between functional and self-presentation benefits because of the nature of smart glasses as a form of wearable device. Thus, we use the term 'expected functional benefits' to cover the "the degree to which a user believes that using smart glasses enhances his or her performance in everyday life" [Rauschnabel et al., (2015a), p.639]. In particular, the model proposed in the current research argues that the extent to which consumers expect smart glasses to bring about efficiencies in their daily lives (as reflected by accomplishing tasks more effectively in less time and with less effort) impacts the degree to which they will react more favourably towards smart glasses.

4.2 Self-presentation

Prior research has shown that other people's perceptions of a user or adopter of a certain technology is a determinant of that technology's acceptance. For example, TAM2, TAM3, and UTAUT all incorporate 'image' as a factor. This image factor describes the degree to which the use of a particular technology enhances the user's status among other people in the same social system (Moore and Benbasat, 1991).

Our model proposes that this basic idea of an image factor is also relevant for smart glasses (Kim and Shin, 2015). Rauschnabel et al. (2015b, p.12) include a discussion on the role of smart glasses from a fashion standpoint. Particularly, they state that "Smart glasses are, as any wearable, also a new form of fashion accessory for their users". That is, an individual who is very technology-focused and innovative in nature might be motivated to express his/her innovativeness to his/her peers and wear smart glasses in public as a means of communicating this trait. In contrast, a person who sees him/herself as less technology-affine might, when wearing smart glasses, project an image that is less desirable to him/herself.

Research in other academic disciplines has also addressed this particular issue of self-presentation. For example, the branding literature has shown that people tend to prefer brands with a brand personality that matches their own (e.g., Malär et al., 2011; Batra et al., 2012), especially when products of these brands are worn or used in public (Graeff, 1996). Similarly, Hollenbeck and Kaikati (2012) show that following brands in online social networks can help consumers present themselves in a desired manner, and Muntinga et al. (2011) identified self-expression and self-presentation as strong motivators for social media use. Thus, in short, our model proposes that consumers who anticipate that smart glasses can help them present themselves in a desired manner tend to react more favourably towards smart glasses.

4.3 Social norms

People's behaviours usually conform to social norms which are, broadly speaking, unwritten rules about how to behave. As we have already outlined in the literature review, norms are important antecedents of the perceived usefulness and of the intention to adopt a new technology.

As in most TAM research, we focus on injunctive norms (Cialdini et al., 1990), which with regards to smart glasses, are defined as a consumer's belief that his or her peers (i.e., friends, acquaintances, colleagues, and so on) expect him or her to adopt smart glasses (c.f., Fishbein and Ajzen, 1975; Davis et al., 1989). Prior research has widely replicated the strong influence of different norms on various behaviours (e.g., Nolan et al., 2008). Norms represent an influential factor since individuals generally have an innate need for companionship and association with other humans (c.f., Cialdini and Goldstein, 2004; for a discussion). Likewise, innovation diffusion research has shown consumers' adoption intention can be influenced when their peers start adopting new products (Rogers, 2010; Pescher and Spann, 2014). Thus, we assume that norms should play a key role in understanding consumers' reactions towards smart glasses.

4.4 Perceptions of the technology and manufacturer brand

Most technology acceptance research streams incorporate antecedents that describe the efforts consumers have to make to use a particular technology. In TAM and innovation diffusion research, this factor was termed (perceived) ease of use (e.g., Venkatesh et al., 2003; Lu and Hsiao, 2007). This is an established finding in the literature, and we propose that perceived ease of use is positively related to consumers' reactions towards smart glasses.

Moreover, consumers might associate the overall value of a new technology based on the brand image of the corresponding manufacturer, where brand image is defined as "perceptions about a brand as reflected by the brand associations held in consumer memory" [Keller, (1993), p.3]. For example, enthusiastic Apple consumers that possess a strong emotional love-like connection with Apple (Batra et al., 2012) might be interested in just about any new product that Apple offers. In contrast, consumers who dislike Apple will be less likely to purchase an iPad or iPhone, and therefore might prefer a tablet or smartphone from a competing brand. Such spillover effects from one type of technology to another at the brand level are possible as studied in the literature on brand extensions (e.g., Völckner and Sattler, 2006). Thus, we expect that consumers who value a brand positively in general (i.e., a more positive brand attitude) will also transfer more positive attributes to a particular smart glass model.

In line with this argument, smart glasses have the potential to make a strong impact on users' lives (Rauschnabel et al., 2015b). Everything a user sees or hears while wearing smart glasses can be captured and processed by the features of this new technology. Not surprisingly, consumers have to trust a manufacturer that his/her personal data will be kept secure and confidential, and misuse is utterly out of the question. Recent claims by mass media journalists and in online discussion boards reflect the fear of data abuse by smart glasses technology critics (Eisenmann et al., 2014). Some companies such as Google or Facebook are often criticised for collecting too much personal information from their users, leading to a fear of potential data abuse. These concerns influence users' behaviour on these platforms (e.g., Krasnova and Veltri, 2010). Although these companies claim not to share or abuse the data, there is a lot of criticism of the practice. Thus, we expect that consumers' perceptions and overall evaluation of privacy concerns associated with the manufacturer brand will influence the likelihood of smart glasses technology use and adoption.

4.5 Individual difference variables

Not all consumers exhibit the same tendency to adopt new technologies, especially if they do not have to use them (Parasuraman, 2000; Lin and Hsieh, 2007). Thus, many of the TAMs incorporate individual difference variables such as personality traits or demographics (e.g., Venkatesh et al., 2003). In the context of AR technologies, Leue et al. (2014) propose researchers should include consumers' levels of innovativeness as an antecedent, especially when studying technologies that consumers use voluntarily (as compared to, for example, a technology they have to use at work). Lin et al. (2007) studied the role of technology readiness in technology acceptance research and found that the notion of technology readiness may better gauge technology adoption in situations where adoption is not mandated by organisational objectives. Moreover, a large stream of research has investigated the role of personality in predicting technology adoption (e.g., Vishwanath, 2005) or in understanding differences in media use (e.g., Moore and McElroy, 2012; Pagani et al., 2011). With regards to smart glasses, a recent study by Rauschnabel et al. (2015a) has shown that open and emotionally stable consumers tend to be more aware of smart glasses, but common personality traits (such as those presented in the Big Five model of human personality) do not perform very well in directly predicting purchase intention. However, factors that describe consumers' interests in new innovative technologies [as measured by the variable technology innovativeness or readiness; c.f., Nov and Ye (2008), Venkatesh and Bala (2008), Lin et al. (2007)], rather than the broader and multidimensional factor of 'openness to experience' in general (Costa and McCrae, 1992), might be a means to explain smart glasses adoption intention (Nov and Ye, 2008). Related to this, consumers who have higher levels of interest in new technologies also judge his or her knowledge and ability to use a technology more highly, a widely replicated antecedent of technology adoption (e.g., Venkatesh and Bala, 2008).

Subsequently, consumers' knowledge about smart glasses technology should be added into the model to control for systematic differences of their extant knowledge concerning smart glasses in general. Recent research has shown that a user's prior experience in using a technology explains a substantial amount of variance in use (e.g., Moore and McElroy, 2012). Since the current research is conducted in a pre-market stage (and thus prior experiences are unlikely to be existent), knowledge about the technology is used as a proxy.

Finally, socio-demographic variables (age and gender) have been found to be associated with technology and media adoption and/or have been included as control variables. Following this common practice in technology and media research (Moore and McElroy, 2012; Venkatesh et al., 2003), we include age and gender as additional antecedents in our exploratory model.

4.6 Mediating and dependent variables: attitude towards using smart glasses and adoption intention

Our model also includes two important target variables, the attitude towards using smart glasses and the adoption intention (Davis, 1989; Davis et al., 1992). Similar to previous research, we expect that the attitude towards using smart glasses (ranging from very negative to very positive) mediates the relationship between the antecedents and adoption intention. However, we do not expect a full mediation of these constructs and also consider that some of the antecedents will influence the adoption intention but not the attitude towards using smart glasses. Theoretical rationales for this will be outlined in the *discussion* section.

5 Methodology and research design

A survey design was conducted to assess the exploratory model as discussed above. Therefore, we re-analysed an existing dataset (Rauschnabel et al., 2015a). This sample consists of 201 respondents that were randomly selected and surveyed in German shopping centres with laptop computers. Using a sample collected in shopping centres allowed us to generate sufficient variance in our constructs, whereas in other forms of surveys (e.g., an online surveys or student samples), younger and technology-oriented consumers might have been overrepresented. With a focus on Germany, we were able to understand smart glasses in a technologically and economically developed country with yet basically no smart glasses market penetration. These market characteristics enable us to gather widely unbiased pre-market knowledge. Candy and sweets were offered as incentives for participation. The sample description is provided in Table 1.

Table 1 Sample description

Gender	
Male	59.2%
Female	40.8%
Age	
Under 20	16%
20–29	44%
30–39	10%
40–49	15%
50–59	14%
60–69	1%
70 and older	16%
Average age (SD) in years	31.8 (13.1)
Job/occupation	
Unemployed	1%
Housewife/-man	2%
Pupil/apprentice	15%
Student (university level)	20%
Employed	34%
Employed (leading/executive position)	13%
Civil servant	4%
Self-employed, freelancer	5%
Retired	2%
Other, N/A	4%
Monthly household net income	
Less than EUR 500	7%
EUR 500 to EUR 1,000	15%
EUR 1,000 to EUR 2,000 EUR	21%
EUR 2,000 to EUR 3,000 EUR	16%
EUR 3,000 to EUR 4,000 EUR	10%
EUR 4,000 to EUR 5,000 EUR	9%
EUR more than EUR 5,000	6%
N/A	16%

Note: n = 201 respondents in German shopping centres.

Source: Dataset has also been used in Rauschnabel et al. (2015a)

Table 2 Correlations and Cronbach's alpha

		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
1	Knowledge about smart glasses	*N/A*											
2	Social norms	.10	*.98*										
3	Expected ease of use	.33***	.23***	*.83*									
4	Expected self-presentation benefits	.13T	.35***	.33***	*.87*								
5	Expected functional benefits	.15*	.34***	.52***	.48***	*.91*							
6	Brand attitude towards the manufacturer	–.16*	.07	.05	.06	.16*	*.95*						
7	Privacy image of the manufacturer	–.23***	.22**	–.08	.06	.08	.58***	*.95*					
8	Technology innovativeness	.37***	.16*	.33***	.16*	.30***	–.09	.06	*.86*				
9	Attitude towards using smart glasses	.18*	.32***	.48***	.33***	.74***	.24***	.16*	.33***	*.92*			
10	Adoption intention	.19**	.51***	.39***	.35***	.56***	.22**	.22**	.42**	.70***	*.81*[a]		
11	Age	–.04	.00	–.15*	.00	–.23***	–.13T	.01	–.01	–.23**	–.08	*N/A*	
12	Gender	.27***	.04	.14T	.06	.15*	–.17*	–.09	.50**	.09	0.14T	.08	*N/A*

Notes: Diagonal: Cronbach's alpha (cannot be computed for single item measures).
[a]Values represent Spearman-Brown correlation for two-item measures.
Pearson correlations (two-tailed significance, ***p < .001; **p < .01; *p < .05; T p < .10).

Table 3 Additional descriptive statistics

	Overall sample		*Group comparisons*								
			Gender			*Age*			*Technology innovativeness*		
	Mean	*SD*	*F*	*M*	*p*	*≤ 25*	*> 25*	*p*	*Low*	*High*	*p*
Knowledge about smart glasses	4.54	2.24	*4.05*	*5.26*	*< .001*	4.53	4.56	.92	*3.83*	*5.37*	*<. 001*
Social norms	1.38	1.06	1.34	1.43	.55	1.37	1.38	.95	*1.25*	*1.52*	*.07*
Expected ease of use	3.69	1.47	*3.53*	*3.93*	*.05*	3.73	3.66	.72	*3.28*	*4.17*	*< .001*
Expected self-presentation benefits	2.32	1.59	2.25	2.43	.42	2.32	2.32	.98	2.21	2.45	.30
Expected functional benefits	2.75	1.61	*2.56*	*3.04*	*.04*	*3.02*	*2.51*	*.03*	*2.46*	*3.09*	*< .001*
Brand attitude towards the manufacturer	4.96	1.74	*5.20*	*4.61*	*.02*	*5.28*	*4.67*	*.01*	*5.16*	*4.73*	*.08*
Privacy image of the manufacturer	3.03	1.72	3.16	2.83	.19	2.99	3.06	.76	2.91	3.17	.28
Technology innovativeness	3.61	1.71	*2.90*	*4.63*	*< .001*	3.60	3.62	.93	N/A	N/A	N/A
Attitude towards using smart glasses	2.71	1.74	2.58	2.89	.21	*3.00*	*2.44*	*.02*	*2.39*	*3.08*	*< .001*
Adoption intention	1.93	1.39	*1.77*	*2.16*	*.05*	2.06	1.81	.21	*1.59*	*2.33*	*< .001*
Age	31.82	13.14	31.99	33.02	.28	N/A	N/A	N/A	31.31	32.42	.55
Gender	0.41	N/A	N/A	N/A	N/A	0.35	0.46	.10	.21	.63	*< .001*

Notes: N/A – average values were not calculated for the split variables.
Values for gender represents percent.
Age and technology innovativeness were grouped based on a median split.
F: female; M: male, SD: standard deviation; p-values based on F-test.

We first measured attitudes towards, and privacy concerns with regard to, the manufacturer brand (Park et al., 2010). We then provided some distraction and filler questions about other brands before presenting a short description of smart glasses (Rauschnabel et al., 2015a). Respondents' knowledge about smart glasses was measured before presenting the questions about the evaluation of the proposed independent and dependent variables. Finally, we surveyed individual difference variables such as demographics.

When possible, we adapted existing measures from the literature and adjusted them to the context of smart glasses. A double-blind translation-re-translation procedure was conducted by two bilingual speaking persons. Differences were revealed with the help of a third native speaker. Seven-point Likert scales were used (except for brand attitude where a seven-point semantical differential was applied) to measure the constructs, and higher values represented better evaluations, or higher agreement, respectively. Before beginning the data collection, the survey instrument was discussed and adjusted to the context of this study based on a discussion with an expert from a consulting company with a specialisation in augmented reality. All items are presented in the Appendix.

Table 2 presents the correlations between the model variables and the results from the reliability analyses. As shown on the diagonal axis, we calculated Cronbach's alpha values for each multi-item variable. Furthermore, following Eisinga et al.'s (2013) recommendations, Spearman-Brown correlations served as a means to estimate the reliability for two-item scales. As all reliability coefficients exceeded the critical value of .7 (all $\alpha \geq .80$), our measurement model indicates high levels of reliability (Nunnally, 1978; Hair et al., 2006).[1] Because Google's smart glasses are the most prominent brand of smart glasses discussed in German media, we focused our research design on Google Glass.

Justified by the high internal consistency of the constructs and by the common practice in related research (e.g., Spagnolli et al., 2014; Moore and McElroy, 2012), items of each factor were averaged. Descriptive statistics and correlations are presented in Tables 2 and 3, respectively.

6 Results

We organise our results around the two RQs presented in the *Introduction*.

6.1 RQ1: Perceptions of augmented reality smart glasses

To address RQ1, we analyse the surveyed constructs descriptively. Table 3 shows the means and standard deviations of all our constructs for the whole sample and selected sub-samples. Table 2 furthermore presents the correlations between the focal constructs.

First, it is an interesting finding that knowledge about smart glasses is relatively high (m = 4.54), above the scale middle point, which is 4. Additionally, the standard deviation with 2.24 is, compared to the other constructs, quite high. This indicates higher levels of heterogeneity among the respondents with regards to their knowledge regarding smart glasses. Additional analyses reveal, for example, that male respondents (who are, at least on average in our sample, also more technology oriented) seem to have a higher level of knowledge (m = 5.26). Perhaps that is the reason why male respondents see higher functional benefits than women with regards to this technology (3.04 vs. 2.56; $p = .04$); they just know the technology better. This might be the case as, in line with prior TAM research (Davis, 1989), respondents who perceive smart glasses to be easy to use also tend to highly value the functional benefits ($r = .52$; $p < .001$).

Intuitively, one might suggest that younger people tend to react more favourably towards smart glasses. The descriptive statistics and the regression models, however, indicate that age is not the crucial factor of consumers' reactions towards smart glasses; it is technology innovativeness.

Perhaps the most important finding is that social norms play a crucial role in the adoption of smart glasses, as the regression analyses in RQ2 will show later. However, the average values of social norms reveal that social norms, in the current stage of development, are not present that extensively ($m = 1.38$). However, technology innovative consumers tend to be confronted with expectations of their (maybe also technology innovative) peers more than their lower scoring counterparts (1.52 vs. 1.25; $p = .07$). More surprising, though, is the fact that the studied smart glasses manufacturer – Google – is slightly less positively evaluated by the more innovative respondents ($m = 4.73$) as compared to their less innovative counterparts ($m = 5.16$; $p = .08$) when analysing the median-splitted sample.

Table 2 also shows a negative correlation between the attitude towards the Google brand and the extent of consumers' self-reported knowledge about Google Glass ($r = -0.16$; $p = .02$). A similar effect is found for Google's privacy image ($r = -0.23$; $p < .001$). This might indicate that people with a lower attitude towards Google (for example, due to common criticism about Google's collection and use of user data) are more aware of the skepticism of the new technology, and thus trace news about their smart glasses more carefully and critically.

6.2 *RQ2: Antecedents of augmented reality smart glasses adoption*

RQ2 focuses on the factors that might explain consumers' adoption intention of Augmented Reality smart glasses. Therefore, the factors outlined in the description of our exploratory model earlier in the manuscript model section were conceptualised as independent variables and both the attitudes towards using smart glasses and the adoption intention as dependent variables. Moreover, as widely replicated in the technology acceptance literature (Venkatesh et al., 2003; Venkatesh and Davis, 2000; Davis et al., 1992; Davis, 1989), attitude towards using smart glasses was also conceptualised as a mediating variable in the relationships between the independent variables and the dependent variables and the adoption intention.

Due to the complexity of our model and with regards to the sample size, we applied multiple regression analyses. This is a common procedure used in exploratory studies in the early development of new technologies (e.g., Spagnolli et al., 2014; Spreer and Kallweit, 2014). Justified by the high internal consistency of the constructs and by the common practice in related research (Spagnolli et al., 2014; Spreer and Kallweit, 2014), items of each factor were averaged. We applied a three-step hierarchical ordinary-least squares regression approach to better understand the nature of the direct and indirect effects proposed in our exploratory model (Baron and Kenny, 1986). Regression model 1 assessed the relationship between all antecedents on attitude towards using smart glasses. Regression model 2 included all antecedents as independent variables and attitude towards adoption intention as dependent variables. Finally, regression model 3 consisted of all antecedents and the attitude towards using smart glasses as independent variables and adoption intention as the dependent variable. Tests for multicollinearity were conducted prior to assessment of the regression results. The findings did not reveal any concerns in all models as all VIF-values were lower than < 2.1, and thus substantially below the critical value of 10 (Marquardt, 1970). The results of the regression analyses are presented in Table 4.

Table 4 Regression analyses

	Model 1	*Model 2*	*Model 3*
Dependent variable	*Attitude towards using smart glasses*	*Adoption intention*	*Adoption intention*
Independent variables			
Attitude towards using smart glasses	– – –	– – –	.51***
Social norms	.07	.32***	.28***
Self-presentation benefits	-.06	.01	.05
Functional benefits	.63***	.33***	.00
Expected ease of use	.10T	.05	.00
Brand attitude	.13*	.15*	.09
Privacy brand image	.03	.02	.01
Technology innovativeness	.13*	.28***	.21***
Knowledge about smart glasses	.05	.03	.08
Age	–.05	.03	.05
Gender (0 = female)	–.07	–.05	–.02
R-squared	.60	.52	.62
Adj. R-squared	.58	.49	.60

Notes: ***p < .001; **p < .01; *p < .05; T p < .10.
All F-tests were significant on a p < .001-level.

Attitudes toward using smart glasses: as regression model 1 in Table 4 shows, functional benefits ($\beta = .63$; $p < .001$), attitude towards the manufacturer's brand ($\beta = .13$; $p = .03$) and consumers' technology innovativeness ($\beta = .13$; $p = .03$) are significant antecedents of consumers' attitudes towards using smart glasses. Furthermore, a partially significant effect was found for perceived ease of use ($\beta = .10$; $p = .09$). The R-squared of 60% (57% adjusted) furthermore reveals a sufficient amount of explained variance.

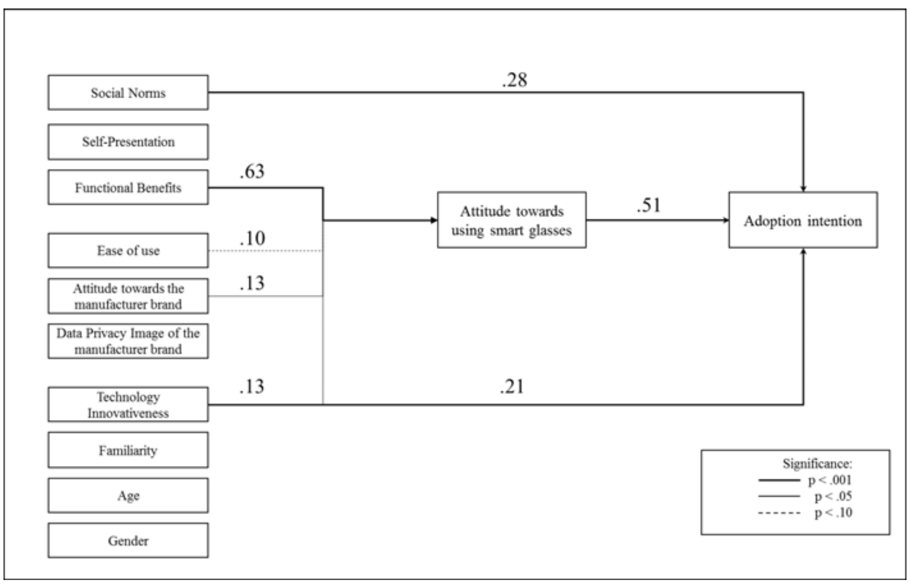
Adoption intention: regression models 2 and 3 investigate factors that predict adoption intention. To better understand the indirect effects, we did not include attitude towards using smart glasses in model 2 but did so in model 3.

In model 2 we found similar effects as in model 1, namely, that functional benefits ($\beta = .33$; $p < .001$), attitude towards the manufacturer brand ($\beta = .15$; $p = .02$) and consumers' technology innovativeness ($\beta = .28$; $p < .001$) are significant predictors of adoption intention. However, in contrast to model 1, social norms seem to play an important role ($\beta = .32$; $p < .001$). The R-squared value of 52% (49% adjusted) furthermore reveals a sufficient amount of explained variance.

Model 3 investigates the role of attitudes towards using smart glasses and all the antecedents in predicting adoption intention. Three variables were found to be significantly related: attitudes towards using smart glasses ($\beta = .51$; $p < .001$), social norms ($\beta = .28$; $p < .001$), and consumers' technology innovativeness ($\beta = .21$; $p < .001$). Again, the R-squared value of 62% (60% adjusted) reveals a sufficient amount of explained variance.

Interestingly, the functional benefits ($\beta = .00$; $p = .95$) and attitude towards the manufacturer brand ($\beta = .09$; $p = .14$) became insignificant when controlling for attitude towards using smart glasses. This indicates an indirect (i.e., mediating) effect of attitudes towards using smart glasses. We assessed this indirect effect using Hayes' (2013) bootstrapping procedure (PROCESS Macro) with 5,000 re-samples. Particularly, we inspected the 95% bias corrected confidence interval (CI) of the indirect effects. A mediating effect is established if the CI of the indirect effect does not include zero (Zhao et al., 2010). All other independent variables were included in the model as covariates as suggested by Hayes' (2013). Both the attitude towards the manufacturer brand ($\beta_{indirect} = .05$; [.01; .12]) and the functional benefits ($\beta_{indirect} = .28$; [.19; .39]) were found to be indirectly related to the adoption intention; they were mediated by the attitude towards using smart glasses. An indirect effect of social norms could neither be identified on a .95-level ($\beta_{indirect} = .05$; [–.04; .16]) nor on a .90-level ($\beta_{indirect} = .05$; [–.02; .14]). Figure 1 summarises the significant effects of regression models 1 and 3.

Figure 1 Summary of the findings



Note: Significant effects presented only.

7 Discussion

Although market research studies anticipate tremendous growth rates over the next several years for smart glasses (Technavio, 2015) and researchers in and outside the business domain (e.g., Muensterer et al., 2014; Albrecht et al., 2014; Tomiuc, 2014) have identified various ways smart glasses can create value, surprisingly little research has been done to understand the potential consumers of this new type of technology. With this study, we provide an attempt to close this research gap by providing results of an exploratory study using the example of Google Glass and drawing up on prior technology acceptance research. By doing so, we provide findings where future research can build on, and more importantly, provide first insights into the mechanisms that explains consumers' attitudes and behavioural intentions towards smart glasses.

7.1 Theoretical contribution

One obvious aspect concerning smart glasses is that the technology is still in an early phase of technology diffusion and lies within the introductory stage of the product lifecycle. A dominant design (Utterback and Abernathy, 1975; Henderson and Clark, 1990; Christensen et al., 1998) concerning this form of wearable AR device has not yet emerged in the industry. As a result, the most likely adopters of this new technology would be innovators and early adopters. This is reflected in our results as the variable technology innovativeness, which measures the level of interest one has in new innovative technologies, turned out to be one of the strongest predictors of smart glasses technology adoption intention.

In the current nascent stage of the product life cycle of smart glasses, functional benefits seem to be the core reason why consumers are interested in adopting this new technology. Thus, consumers who expect smart glasses to better their lives in some form or fashion have a more positive attitude towards smart glasses and thus seem to be more likely to adopt them. Interestingly, although self-presentation motivations have long been revealed to be important factors in marketing (Hollenbeck and Kaikati, 2012) and media usage (e.g., Mehdizadeh, 2010), our study's results indicate that self-presentation was not found to be related to any of the investigated target variables. It is important to note that our study serves as just a snapshot from a pre-market standpoint, which might (and very likely will) change over time.

There has been much discussion in the media concerning smart glasses technology due to potential privacy concerns. Existing recording-capable technologies, such as digital cameras or smartphones, have to be held in the user's hand and aimed at the target object. Smart glasses, however, are still a relatively unknown and unfamiliar technology. Its small, portable and semi-invisible footprint (as in the case of Google Glass) makes the technology unobtrusive, and thus can easily be overlooked or unnoticed by the general public when being worn. However, among the surveyed respondents, even those respondents with less trust in the smart glasses manufacturer's handling of personal data did not rate this technology worse than those respondents with high levels of trust.

Another finding in our study is the role of social norms. Both the theory of planned behaviour (Ajzen, 1991; Fishbein and Aizen, 1975) and the theory of normative conduct (Cialdini et al., 1990) have widely shown their relevance in predicting behaviour in general. Likewise, the technology acceptance and media literature have replicated the importance of norms influencing consumers (Lu and Hsiao, 2007; Davis et al., 1992). In our model, we tested the importance of normative aspects by asking consumers to what extent their peers expect them to use smart glasses. Although the average values of these norms were (still) low, a small amount of variation in these beliefs explained a significant amount of variance in the respondents' adoption intention. Our findings also showed that these normative beliefs were not related to consumers' attitudes towards using smart glasses (and had no indirect effect) but were related to adoption intention. This adds to the understanding of research on social norms (Nolan et al., 2008) and illustrates that people, even though they might not like the idea of using smart glasses, might adopt the technology – because their peers expect them to do so. This is an important and interesting finding. For example, Nolan et al. (2008) found when researchers asked consumers about the importance of social influence, they usually rated its importance much lower than many other factors such as monetary aspects. However, when being confronted with norms, the norms outperformed other factors in predicting behaviour. Although we did not ask respondents about the importance of various factors concerning the smart glasses themselves (e.g., the importance of the design or the functionalities), our findings are in line with those of Nolan et al. (2008). Particularly, our results suggest that norms play a very important (if not *the* most important) role in influencing behaviour but not in the formation of their attitude towards using smart glasses.

7.2 Managerial implications

In this early stage of smart glasses evolution, functional benefits appear to be one of the core reasons why consumers are interested in adopting this new technology. And since in the early stages of a new technology, firms tend to compete by providing exceptional technological performance (Christensen et al., 2002; Ulrich, 1995), smart glasses manufacturers should aim at highlighting the role of functional benefits for users and performing these functions in the best possible way. How can smart glasses improve or positively impact user's lives? How can it aid in making user tasks at home or work or recreation more efficient and effective and enjoyable? These are the types of questions concerning functional benefits users may ask. Potential examples of functional benefits of smart glasses could be their use in vehicle navigation systems, personal organisers, text messaging services that enable hands-free texting, and so forth. Helping potential users envision how smart glasses technology can be used in various business functions such as teleconferencing, product development and prototyping, supply chain and logistics management, and so forth enables companies to better envision the functional benefits of this nascent technology and provide such benefits to their customers. Also, new media platforms, such as YouTube, provide a way to explain the benefits in a very vivid and effective way. Both Microsoft and Google are already showing various use cases, how their smart glasses can make their users' personal and/or professional lives more efficient (c.f., Rauschnabel et al., 2015b).

Likewise, our findings show that consumers with high levels of technology innovativeness are particularly motivated to adopt smart glasses. Adapting prior research to the context of smart glasses (e.g., Pagani et al., 2011), these consumers are likely to use social media platforms to discuss smart glasses and other technologies. Several online discussion boards do exist where users discuss the developments of smart glasses. Examples include Microsoft's official forum (http://forums.windowscentral.com/microsoft-hololens/) or user generated forums such as

Techglasses (http://techglasses.com/forums/) or EDUGLASSES (http://eduglasses.com), a community for educators who want to use smart glasses in classrooms. Manufacturers and app developers can place their messages in these forums and other online platform communities, answer user questions, and learn from user dialogues.

Managers who aim at increasing the sales of smart glasses should also focus on influencing normative beliefs – that is, managing normative expectations of target users' peers. This could, for example, be done using sponsored stories or other forms of ads and postings on Facebook. With these activities, friends in social networks can be encouraged or incentivised by marketers and manufacturers to motivate each other concerning the adoption of smart glasses.

7.3 Limitations and future research

As with any study, this research has its limitations. We focused on a pre-market study in Germany with a limited sample size. Focusing on Germany and on a sample collected in shopping malls allowed us to cover a wide range of demographics, to control for intercultural influences and to focus on pre-market knowledge, whereas in other countries such as the USA, smart glasses penetration has already started. This contributed to higher levels of internal validity, but on the other hand, limited the generalisability of our results in the context of other countries. Future research should address these limitations.

Hedonic and social aspects were not included in the current model because this would have required too much knowledge on the respondent's part about smart glasses technology to think about applications. However, these factors will likely be very important in explaining attitudes and behaviours related to smart glasses adoption and the diffusion of this new technology. Future research is needed to investigate other benefits than just functional ones. Uses and gratifications theory (Katz et al., 1974; Sundar and Limperos, 2013) could provide the basis for this. Likewise, with regards to the importance of social norms, the identification of lead users remains another important avenue for further research (Bilgram et al., 2008).

Future research should investigate smart glasses marketing – for example, how can ads be spread via smart glasses? Findings from research in mobile marketing (e.g., Amirkhanpour et al., 2014) could provide theoretical access for further investigations. Future research areas also emerge in business markets: How can smart glasses be used in business-to-business marketing? For example, when used by key account managers (Ivens and Pardo, 2007), how do they influence key account relationships? What industries would find the adoption of smart glasses attractive? How can smart glasses effectively be used in other business functions such as product development and logistics management? How can cost intensive R&D processes be managed with augmented reality smart glasses? Are employees themselves accepting of adopting smart glasses technology in their workplaces? These and other important questions have yet to be investigated since smart glasses technology is still in its infancy.

8 General conclusions

In sum, this research has provided first insights into the underlying mechanisms of processing smart glasses technology adoption. Because of the promising forecasts and the technical and conceptual differences from other disciplines, we see this as a starting point for future research. Thus, we hope that future researchers will be inspired in building upon our findings.

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References

Ajzen, I. (1991) 'The theory of planned behaviour', *Organizational Behavior and Human Decision Processes*, Vol. 50, No. 2, pp.179–211.

Ajzen, I. and Fishbein, M. (1980) *Understanding Attitudes and Predicting Social Behaviour*, Prentice-Hall, Englewood Cliffs, NJ.

Albrecht, U.V., von Jan, U. and Kuebler, J. et al., (2014) 'Google Glass for documentation of medical findings: evaluation in forensic medicine', *Journal of Medical Internet Research*, Vol. 16, No. 2.

Amirkhanpour, M., Vrontis, D. and Thrassou, A. (2014) 'Mobile marketing: a contemporary strategic perspective', *International Journal of Technology Marketing*, Vol. 9, No. 3, pp.252–269.

Bagozzi, R.P. (2007) 'The legacy of the technology acceptance model and a proposal for a paradigm shift', *Journal of the Association for Information Systems*, Vol. 8, No. 4, p.3.

Baron, R.M. and Kenny, D.A. (1986) 'The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations', *Journal of Personality and Social Psychology*, Vol. 51, No. 6, p.1173.

Batra, R., Ahuvia, A. and Bagozzi, R.P. (2012) 'Brand love', *Journal of Marketing*, Vol. 76, No. 2, pp.1–16.

Bilgram, V., Brem, A. and Voigt, K.I. (2008) 'User-centric innovations in new product development – systematic identification of lead users harnessing interactive and collaborative online-tools', *International Journal of Innovation Management*, Vol. 12, No. 3, pp.419–458.

Christensen, C.M., Suárez, F.F. and Utterback, J.M. (1998) 'Strategies for survival in fast-changing industries', *Management Science*, Part 2, Vol. 44, No. 12, pp.S207–S220.

Christensen, C.M., Verlinden, M. and Westerman, G. (2002) 'Disruption, disintegration and the dissipation of differentiability', *Industrial and Corporate Change*, Vol. 11, No. 5, pp.955–993.

Cialdini, R.B. and Goldstein, N.J. (2004) 'Social influence: compliance and conformity', *Annual Review of Psychology*, Vol. 55, No. 1, pp.591–621.

Cialdini, R.B., Reno, R.R. and Kallgren, C.A. (1990) 'A focus theory of normative conduct: recycling the concept of norms to reduce littering in public places', *Journal of Personality and Social Psychology*, Vol. 58, No. 6, pp.1015–1026.

CNN (2014) *Movie Theaters Ban Google Glass and Other Wearables* [online] http://money.cnn.com/2014/10/30/technology/google-glass-movies/ (accessed 22 June 2015).

Compeau, D.R. and Higgins, C.A. (1995) 'Application of social cognitive theory to training for computer skills', *Information Systems Research*, Vol. 6, No. 2, pp.118–143.

Costa, P.T. and McCrae, R.R. (1992) 'The NEO personality inventory: manual, form S and form R', *Psychological Assessment Resources*.

Davis, F.D. (1989) 'Perceived usefulness, perceived ease of use, and user acceptance of information technology', *MIS Quarterly*, Vol. 13, No. 3, pp.319–340

Davis, F.D., Bagozzi, R.P. and Warshaw, P.R. (1992) 'Extrinsic and intrinsic motivation to use computers in the workplace1', *Journal of Applied Social Psychology*, Vol. 22, No. 14, pp.1111–1132.

Dumenco, S. (2014) 'Your complete guide to Google Glass etiquette', *Ad Age* [online] http://adage.com/article/the-media-guy/complete-guide-google-glass-etiquette/291390/ (accessed 30 June 2015).

Eisenmann, T., Barley, L. and Kind, L. (2014) *Google Glass*, HBS Case 814-102.

Eisert, P., Fechteler, P. and Rurainsky, J. (2008) '3-D tracking of shoes for virtual mirror applications', *Computer Vision and Pattern Recognition, 2008: CVPR 2008: IEEE Conference on*, June, pp.1–6, IEEE.

Eisinga, R., Te Grotenhuis, M. and Pelzer, B. (2013) 'The reliability of a two-item scale: Pearson, Cronbach, or Spearman-Brown?', *International Journal of Public Health*, Vol. 58, No. 4, pp.637–642.

Escalas, J. and Bettman, J. (2003) 'You are what they eat: the influence of reference groups on consumers' connections to brands', *Journal of Consumer Psychology*, Vol. 13, No. 3, pp.339−348.

Fishbein, M. and Ajzen, I. (1975) *Belief, Attitude, Intention and Behavior*, Addison-Wesley, Reading.

Graeff, T.R. (1996) 'Image congruence effects on product evaluations: the role of self-monitoring and public/private consumption', *Psychology & Marketing*, Vol. 13, No. 5, pp.481–499.

Greenhalgh, T., Robert, G., Macfarlane, F., Bate, P. and Kyriakidou, O. (2004) 'Diffusion of innovations in service organizations: systematic review and recommendations', *Milbank Quarterly*, Vol. 82, No. 4, pp.581–629.

Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E. and Tatham, R.L. (2006) *Multivariate Data Analysis*, Vol. 6, Pearson Prentice Hall, Upper Saddle River, NJ.

Haugstvedt, A.C. and Krogstie, J. (2012) 'Mobile augmented reality for cultural heritage: a technology acceptance study', *Mixed and Augmented Reality (ISMAR), 2012 IEEE International Symposium on*, November, pp.247–255, IEEE.

Hayes, A.F. (2013) *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach*, Guilford Press, New York, NY.

Henderson, R.M. and Clark, K.B. (1990) 'Architectural innovation: the reconfiguration of existing product technologies and the failure of established firms', *Administrative Science Quarterly*, Vol. 35, No. 1, pp.9–30.

Hennig-Thurau, T., Malthouse, E.C. and Friege, C. et al. (2010) 'The impact of new media on customer relationships', *Journal of Service Research*, Vol. 13, No. 3, pp.311–330.

Hollenbeck, C.R. and Kaikati, A.M. (2012) 'Consumers' use of brands to reflect their actual and ideal selves on Facebook', *International Journal of Research in Marketing*, Vol. 29, No. 4, pp.395–405.

Ivens, B.S. and Pardo, C. (2007) 'Are key account relationships different? Empirical results on supplier strategies and customer reactions', *Industrial Marketing Management*, Vol. 36, No. 4, pp.470–482.

Katz, E., Blumler, J.G. and Gurevitch, M. (1974) 'Uses and gratification research', *The Public Opinion Quarterly*, Vol. 37, No. 4, pp.509–523.

Keller, K.L. (1993) 'Conceptualizing, measuring, and managing customer-based brand equity', *The Journal of Marketing*, Vol. 57, No. 1, pp.1–22.

Kim, H.W., Chan, H.C. and Kankanhalli, A. (2012) 'What motivates people to purchase digital items on virtual community websites? The desire for online self-presentation', *Information Systems Research*, Vol. 23, No. 4, pp.1232–1245.

Kim, K.J. and Shin, D-H. (2015) 'An acceptance model for smart watches: implications for the adoption of future wearable technology', *Internet Research*, Vol. 25, No. 4, pp.527–541.

King, W.R. and He, J. (2006) 'A meta-analysis of the technology acceptance model', *Information & Management*, Vol. 43, No. 6, pp.740–755.

Krasnova, H. and Veltri, N.F. (2010) 'Privacy calculus on social networking sites: Explorative evidence from Germany and USA', *System Sciences (HICSS), 2010 43rd Hawaii International Conference on*, January, pp.1–10, IEEE.

Krasnova, H., Spiekermann, S., Koroleva, K. and Hildebrand, T. (2010) 'Online social networks: why we disclose', *Journal of Information Technology*, Vol. 25, No. 2, pp.109–125.

Leue, M.C., Dieck, T.D. and Jung, T. (2014) 'A theoretical model of augmented reality acceptance', *eReview of Tourism Research*, Vol. 5(1), pp.1–5.

LiKamWa, R., Wang, Z., Carroll, A., Lin, F. and Zhong, L. (2014) 'Draining our glass: an energy and heat characterization of Google glass', *Proceedings of 5th Asia-Pacific Workshop on Systems*, p.10, ACM.

Lin, C.A. (2003) 'An interactive communication technology adoption model', *Communication Theory*, Vol. 13, No. 4, pp.345–365.

Lin, J.S.C. and Hsieh, P.L. (2007) 'The influence of technology readiness on satisfaction and behavioral intentions toward self-service technologies', *Computers in Human Behavior*, Vol. 23, No. 3, pp.1597–1615.

Lu, H.P. and Hsiao, K.L. (2007) 'Understanding intention to continuously share information on weblogs', *Internet Research*, Vol. 17, No. 4, pp.345–361.

Lu, J., Yao, J.E. and Yu, C.S. (2005) 'Personal innovativeness, social influences and adoption of wireless internet services via mobile technology', *J. Strateg. Inf. Syst.*, Vol. 14, No. 3, pp.245–268.

Malär, L., Krohmer, H., Hoyer, W.D. and Nyffenegger, B. (2011) 'Emotional brand attachment and brand personality: the relative importance of the actual and the ideal self', *Journal of Marketing*, Vol. 75, No. 4, pp.35–52.

Marquaridt, D.W. (1970) 'Generalized inverses, ridge regression, biased linear estimation, and nonlinear estimation', *Technometrics*, Vol. 12, No. 3, pp.591–612, Chicago.

McNaney, R., Vines, J. and Roggen, D. et al. (2014) 'Exploring the acceptability of Google Glass as an everyday assistive device for people with Parkinson's', *Proceedings of the 32nd Annual ACM Conference on Human Factors in Computing Systems*, pp.2551–2554, ACM.

Mehdizadeh, S. (2010) 'Self-presentation 2.0: narcissism and self-esteem on Facebook', *Cyber Psychology, Behavior, and Social Networking*, Vol. 13, No. 4, pp.357–364.

Moore, G.C. and Benbasat, I. (1991) 'Development of an instrument to measure the perceptions of adopting an information technology innovation', *Information Systems Research*, Vol. 2, No. 3, pp.192–222.

Moore, K. and McElroy, J.C. (2012) 'The influence of personality on Facebook usage, wall postings, and regret', *Computers in Human Behavior*, Vol. 28, No. 1, pp.267–274.

Muensterer, O.J., Lacher, M., Zoeller, C., Bronstein, M. and Kübler, J. (2014) 'Google Glass in pediatric surgery: an exploratory study', *International Journal of Surgery*, Vol. 12, No. 4, pp.281–289.

Muntinga, D.G., Moorman, M. and Smit, E.G. (2011) 'Introducing COBRAs: exploring motivations for brand-related social media use', *International Journal of Advertising*, Vol. 30, No. 1, pp.13–46.

Nolan, J.M., Schultz, P.W., Cialdini, R.B., Goldstein, N.J. and Griskevicius, V. (2008) 'Normative social influence is under detected', *Personality and Social Psychology Bulletin*, Vol. 34, No. 7, pp.913–923.

Nov, O. and Ye, C. (2008) 'Personality and technology acceptance: personal innovativeness in IT, openness and resistance to change', *Hawaii International Conference on System Sciences, Proceedings of the 41st Annual*, January, pp.448–448, IEEE.

Nunnally, J.C. (1978) *Psychometric Theory*, McGraw Hill, Chicago.

Pagani, M., Hofacker, C.F. and Goldsmith, R.E. (2011) 'The influence of personality on active and passive use of social networking sites', *Psychology & Marketing*, Vol. 28, No. 5, pp.441–456.

Parasuraman, A. (2000) 'Technology readiness index (TRI) a multiple-item scale to measure readiness to embrace new technologies', *Journal of Service Research*, Vol. 2, No. 4, pp.307–320.

Park, W.C., MacInnis, D.J., Priester, J., Eisingerich, A.B. and Iacobucci, D. (2010) 'Brand attachment and brand attitude strength', *Journal of Marketing*, Vol. 74, No. 6, pp.1–17.

Pescher, C. and Spann, M. (2014) 'Relevance of actors in bridging positions for product-related information diffusion', *Journal of Business Research*, Vol. 67, No. 8, pp.1630–1637.

Quan-Haase, A. and Young, A.L. (2010) 'Uses and gratifications of social media: a comparison of Facebook and instant messaging', *Bulletin of Science, Technology & Society*, Vol. 30, No. 5, pp.350–361.

Rauschnabel, P.A., Brem, A. and Ivens, B.S. (2015a) 'Who will buy smart glasses? Empirical results of two pre-market-entry studies on the role of personality in individual awareness and intended adoption of Google Glass wearables', *Computers in Human Behavior*, Vol. 49, No. 8, pp.635–647.

Rauschnabel, P.A.; Brem, A; Ro, Y. (2015b) *Augmented Reality Smart Glasses: Definition, Conceptual Insights, and Managerial Importance*, Working paper, The University of Michigan-Dearborn.

Rese, A., Schreiber, S. and Baier, D. (2014) 'Technology acceptance modeling of augmented reality at the point of sale: can surveys be replaced by an analysis of online reviews?', *Journal of Retailing and Consumer Services*, Vol. 21, No. 5, pp.869–876.

Rogers, E.M. (2010) *Diffusion of Innovations*, Simon and Schuster, Chicago.

Schultz, P.W., Nolan, J.M., Cialdini, R.B., Goldstein, N.J. and Griskevicius, V. (2007) 'The constructive, destructive, and reconstructive power of social norms', *Psychological Science*, Vol. 18, No. 5, pp.429–434.

Spagnolli, A., Guardigli, E., Orso, V., Varotto, A. and Gamberini, L. (2014) 'Measuring user acceptance of wearable symbiotic devices: validation study across application scenarios', *Symbiotic Interaction*, pp.87–98, Springer International Publishing.

Spreer, P. and Kallweit, K. (2014) 'Augmented reality in retail: assessing the acceptance and potential for multimedia product presentation at the PoS', *Transactions on Marketing Research*, Vol. 1, No. 1, pp.20–35.

Sundar, S.S. and Limperos, A.M. (2013) 'Uses and grats 2.0: new gratifications for new media', *Journal of Broadcasting & Electronic Media*, Vol. 57, No. 4, pp.504–525.

Technavio (2015) *Global Smart Glasses Market for Augmented Reality 2015–2019*, Press Release [online] http://bit.ly/1HOTWA6 (accessed 30 June 2015).

Thompson, R.L., Higgins, C.A. and Howell, J.M. (1994) 'Influence of experience on personal computer utilization: testing a conceptual model', *Journal of Management Information Systems*, Vol. 1, No. 1, pp.167–187.

Tomiuc, A. (2014) 'Navigating culture: enhancing visitor museum experience through mobile technologies: from smartphone to Google Glass', *Journal of Media Research*, Vol. 3, No. 20, pp.33–46.

Turner, M., Kitchenham, B. and Brereton, P. et al. (2010) 'Does the technology acceptance model predict actual use? A systematic literature review', *Information and Software Technology*, Vol. 52, No. 5, pp.463–479.

Ulrich, K. (1995) 'The role of product architecture in the manufacturing firm', *Research Policy*, Vol. 24, No. 3, pp.419–440.

Utterback, J.M. and Abernathy, W.J. (1975) 'A dynamic model of process and product innovation', *Omega*, Vol. 3, No. 6, pp.639–656.

Venkatesh, V. and Bala, H. (2008) 'Technology acceptance model 3 and a research agenda on interventions', *Decision Sciences*, Vol. 39, No. 2), pp.273–315.

Venkatesh, V. and Davis, F.D. (2000) 'A theoretical extension of the technology acceptance model: four longitudinal field studies', *Management Science*, Vol. 46, No. 2, pp.186–204.

Venkatesh, V., Morris, M.G., Davis, G.B. and Davis, F.D. (2003) 'User acceptance of information technology: toward a unified view', *MIS Quarterly*, September, Vol. 27, No. 3, pp.425–478.

Vishwanath, A. (2005) 'Impact of personality on technology adoption: an empirical model', *Journal of the American Society for Information Science and Technology*, Vol. 56, No. 8, pp.803–811.

Völckner, F. and Sattler, H. (2006) 'Drivers of brand extension success', *Journal of Marketing*, Vol. 70, No. 2, pp.18–34.

Whiting, A. and Williams, D. (2013) 'Why people use social media: a uses and gratifications approach', *Qualitative Market Research: An International Journal*, Vol. 16, No. 4, pp.362–369.

Zhao, X., Lynch, J.G. and Chen, Q. (2010) 'Reconsidering Baron and Kenny: myths and truths about mediation analysis', *Journal of Consumer Research*, Vol. 37, No. 2, pp.197–206.

Notes

1 One reviewer suggested to conduct an exploratory factor analyses as an additional validation of the measurement model. These analyses clearly supported the existence of the factor structure, as reflected by standardised factor loadings above .69 on the proposed factor, and the absence of substantial cross-loadings (all cross-loadings < .25). Detailed results are not presented in the manuscript, but are available from the first author upon request.

Appendix

Measurement scales

Construct and items	*References*
Knowledge about Google Glass	
[Concept Presentation of Google Glass] We would like to know from you, how familiar you are with the content of this text. Did you know this before? [–3: These information were completely new to me … +3 I already knew all of these information]	Ad hoc and refined in discussions with an AR expert, c.f., Rauschnabel et al. (2015a) for details
Social norms	
My close friends expect me to use Google Glass. My acquaintances expect me to use Google Glass. My colleagues expect me to use Google Glass.	Adapted from Venkatesh et al. (2003) and Schulz et al. (2007)
Expected ease of use	
I think it is easy to learn how to use Google Glass. Google Glass is easy to use. Google Glass is self-explaining.	Adapted from Lu et al. (2005), Venkatesh et al. (2003) and Lu and Hsiao (2007)
Expected self-presentation	
The use of Google Glass says something about me and my personality. With Google Glass, I can show others who I am. With Google Glass, I can show others how I am.	Adapted and revised based on the scales used in Kim et al. (2012), Lu et al. (2005), Escalas and Bettman (2003) and Krasnova et al. (2010)
Expected functional benefits	
With Google Glass, I can make many daily things better. With Google Glass, I can make many daily things faster. Generally speaking, Google Glass is useful for me.	Adapted from Thompson et al. (1994) and Lu et al. (2005)
Attitude towards the manufacturer brand	
I find the brand Google good. I like the brand Google. I have a positive attitude toward Google.	Adapted from Park et al. (2010)

Notes: All items (except 'Knowledge about Google Glass') were measured using seven-point Likert scales, anchored from 1 = totally disagree, 4 = moderately agree, to 7 = totally agree. The final wording was discussed with an expert with AR background from a consultancy, and, if necessary, discussed with consumers.

Measurement scales (continued)

Construct and items	*References*
Privacy image • I trust Google with the usage of user data • I associate the brand Google with high levels of data protection • I think Google does a good job with maintaining user data • When I see or hear about the brand Google I think of good user data protection	Ad hoc scale, based on discussions with consumers and an expert on augmented reality
Technology innovativeness • I am very interested in technical things • I am very interested in new internet technologies • I am an internet freak	Ad hoc scale, based on Zaichowski (1985), Nov and Ye (2008) and Pagani et al. (2011)
Attitude towards using smart glasses • Using Google Glass is good • I have a positive attitude towards using Google Glass	Adapted from Venkatesh et al. (2003)
Adoption intention • I'll be one of the first who will use Google Glass • Certainly, I will use Google Glass • I am interested in buying Google Glass	Adapted from Venkatesh et al. (2003)

Notes: All items (except 'Knowledge about Google Glass') were measured using seven-point Likert scales, anchored from 1 = totally disagree, 4 = moderately agree, to 7 = totally agree. The final wording was discussed with an expert with AR background from a consultancy, and, if necessary, discussed with consumers.