

Does Perceived Health Risk Influence Smartglasses Usage?

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Abstract The World Health Organization has warned populations about illnesses that can develop due to radiation. Since smartglasses, which are worn on the head right next to the brain, can emit radiation, their usage might be hindered by the Perceived Health Risks people associate with such devices. In this article, we empirically evaluate the topic by studying the influence of Perceived Health Risk on smartglasses usage. After collecting 109 completed online questionnaires about one specific pair of smartglasses, Microsoft HoloLens, and applying a structural equation modeling approach, our findings indicate that smartglasses are at least partly hedonic technologies whose usage is influenced by Perceived Enjoyment. Furthermore, although we could not confirm a direct negative influence of Perceived Health Risk on the Behavioral Intention to Use smartglasses, we confirmed an indirect negative influence of Perceived Health Risk on Behavioral Intention to Use through Perceived Enjoyment. These findings suggest that smartglasses manufacturers need to emphasize the hedonic benefits of their devices as well as address people's potential negative perceptions of these devices in terms of their health.

1 Introduction

After notebooks, smartphones and tablets, wearable devices—i.e., “electronic technologies or computers that are incorporated into items of clothing and accessories which can comfortably be worn on the body” (Tehrani and Andrew 2014)—might be the next driver of mobile computing. There is a broad range of different kinds of wearable devices, from bracelets that measure people's daily activities to smartglasses that enhance the real world with virtual functions or immerse the user into fully virtual worlds. According to forecasts, the revenues of wearable devices are expected to exceed 9 billion Euros in 2018 in Europe alone (Statista 2014).

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However, some companies seem to have problems with successfully bringing their wearable devices to market. Smartglasses in particular, which are overtly worn on the head, seem to suffer from a lack of acceptance by a majority of people. Indeed, Google ended their explorer program for their Google Glass in the beginning of 2015 (Lardinois 2015).

One aspect hindering people's acceptance of smartglasses might be the Perceived Health Risk associated with these devices. More specifically, smartglasses can emit radiation, which might have negative health consequences such as the development of illnesses (Burgess 2002; Seigneur et al. 2010). The potential fear of people regarding their health might be increasingly enhanced by the fact that smartglasses are worn right next to the brain, thus exposing their brains to potentially harmful radiation.

In this article, we seek to shed light on the potential role of Perceived Health Risk on the usage of smartglasses by carrying out an empirical evaluation. After collecting 109 completed online questionnaires about one specific pair of smartglasses, Microsoft HoloLens, and applying a structural equation modeling approach, our findings indicate that smartglasses are at least partly hedonic technologies whose usage is influenced by Perceived Enjoyment. Furthermore, although we could not confirm a direct negative influence of Perceived Health Risk on the Behavioral Intention to Use smartglasses, we confirmed an indirect negative influence of Perceived Health Risk on Behavioral Intention to Use through Perceived Enjoyment. These findings suggest that smartglasses manufacturers need to emphasize the hedonic benefits of their devices as well as to address people's potential negative perceptions of smartglasses in terms of their health.

In the next section, we will present background information on smartglasses, introduce Perceived Enjoyment as an influence factor of hedonic technologies, and also present the theoretical foundations of the Perceived Health Risk construct. Following this, we will present our research model and research design. We will then reveal and discuss our results before summarizing our findings, presenting their theoretical as well as practical implications, and providing an outlook on further research.

2 Theoretical Background

2.1 *Smartglasses*

Smartglasses are head-mounted displays and can be divided into two categories: Augmented Reality Smartglasses (ARSG) and Virtual Reality Smartglasses (VRSG) (Amorim et al. 2013; Due 2014; Milgram et al. 1994; Nilsson and Johansson 2007). VRSG such as Oculus Rift place the user in an artificial environment. The user cannot interact with the real world—rather, he/she is completely immersed in the virtual world. In contrast, ARSG such as Google Glass allow users

to interact with the real world since they complement the real world with virtual functions (Azuma 1997; Nilsson and Johansson 2007).

Multiple instrumental benefits of smartglasses have been discussed in the literature (e.g., Kim et al. 2013; McNaney et al. 2014; Nguyen 2013). Additionally, smartglasses can also be used for hedonic purposes such as video games and some are even built exclusively for gaming purposes. However, due to the novelty of these devices, only a few studies have studied the factors that drive people to use smartglasses (e.g., Rauschnabel et al. 2015).

2.2 The Role of Perceived Enjoyment on Smartglasses Usage

Generally, hedonic technologies “aim to provide self-fulfilling value to the user, ... [which] is a function of the degree to which the user experiences fun when using the system” (Van der Heijden 2004, p. 696). Perceived Enjoyment—“the extent to which the activity of using a specific system is perceived to be enjoyable in its own right, aside from any performance consequences resulting from system use” (Venkatesh 2000, p. 351)—reflects a hedonic system’s intrinsic motivations, such as fun, enjoyment, and other positive experiences, which stem directly from the system-user interaction (Brief and Aldag 1977; Van der Heijden 2004; Venkatesh et al. 2012).

Various studies in a variety of contexts have consistently confirmed that Perceived Enjoyment is a central antecedent of hedonic technology usage (e.g., Van der Heijden 2004). By applying these findings to our contexts, a person can be expected to use smartglasses if he/she believes that they fulfill his expectations with regards to enjoyment.

2.3 Perceived Health Risk

Risk can be generally described as “the extent to which there is an uncertainty in significant and disappointing outcomes that may be realized” (Chen 2013, p. 1222; Sitkin and Pablo 1992). Perceived Risk is thus consistently understood as “the expectation of losses associated with... [specific actions]” (Peter and Ryan 1976, p. 185).

Several studies have confirmed that Perceived Risk (e.g., Privacy Risk) can exert a negative influence on the usage of technologies (e.g., Egea and Gonz  les 2010; Tan 1999). Moreover, in addition to a direct effect of Perceived Risk on technology usage, Ernst (2014) also confirmed that Perceived Risk can have an indirect negative influence on technology usage through Perceived Enjoyment.

One specific kind of risk that might be of relevance in the context of smart-glasses is Perceived Health Risk, which we describe as the extent to which a person believes that using smartglasses has negative consequences in terms of his/her health. More specifically, smartglasses can emit radiation; multiple studies have suggested that exposing the human body to radiation might have adverse health consequences such as the development of illnesses (Burgess 2002; Seigneur et al. 2010). For example, the World Health Organization (2013) has warned that radiation might increase the risk of developing cancer, and Myung et al. (2009) has suggested that the risk of developing tumors increases after using devices such as mobile phones. Moreover, popular media has also reported on the potential health risks associated with wearable device usage (e.g., Bilton 2015), which might increase the general public's awareness of the problem.

3 Research Model

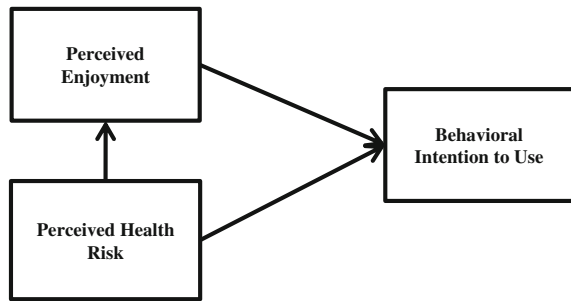
In the following section, we will present our research model in Fig. 1 and then outline our corresponding hypotheses.

As described earlier, smartglasses can be used for hedonic purposes such as video games. Therefore, smartglasses are at least partly hedonic technologies (cf. Van der Heijden 2004) that provide positive feelings and experiences for their users in the form of Perceived Enjoyment. Perceived Enjoyment has been shown to be an important antecedent of hedonic technology usage (e.g., Ernst et al. 2013; Van der Heijden 2004). We hypothesize that:

H1 *There is a positive influence of Perceived Enjoyment on the Behavioral Intention to Use¹ smartglasses.*

The Theory of Reasoned Action (Fishbein and Ajzen 1975) postulates that an individual's behavior is influenced by his/her particular beliefs concerning the behavior's consequences (e.g., Perceived Enjoyment). Consequently, Perceived Health Risk can be expected to exert an influence on the usage of smartglasses. More precisely, since Perceived Health Risk is associated with negative feelings, the influence it could be exerting is probably negative. Indeed, multiple studies

¹Since at the time of the survey (June 2015), the smartglasses under study, Microsoft HoloLens, were not yet available to the general public, we only included Behavioral Intention to Use, and not Actual System Use, into our research model. Behavioral Intention to Use is a commonly accepted mediator between people's beliefs and their actual behavior. It "capture[s] the motivational factors that influence a [person's] behavior; they are indications of how hard people are willing to try, of how much of an effort they are planning to exert, in order to perform the behavior" (Ajzen 1991, p. 181).

Fig. 1 Research model

from a variety of contexts have confirmed that various risk perceptions negatively influence technology usage behavior (Featherman and Pavlou 2003; Jarvenpaa et al. 2000; Pavlou 2001, 2003). We hypothesize that:

H2 *There is a negative influence of Perceived Health Risk on the Behavioral Intention to Use smartglasses.*

Moreover, Perceived Risk, in general, can alter an individual's feelings (Yüksel and Yüksel 2007). More specifically, due to the perceived negative consequences associated with it, Perceived Risk causes negative feelings such as anxiety, discomfort and uncertainty (Dowling and Staelin 1994; Featherman 2001). Indeed, in a shopping context, Yüksel and Yüksel (2007) confirmed a negative influence of Perceived Risk on Pleasure, which is "the degree to which the person feels good, joyful, happy, or satisfied in the situation" (Yüksel and Yüksel 2007, p. 706). In line with this, Ernst (2014) confirmed in a Social Network Site context that Perceived Privacy Risk exerts a negative influence on Perceived Enjoyment. In this sense, due to the potential negative consequences of smartglasses on an individual's health, Perceived Health Risk can also be expected to cause negative feelings, i.e., to negatively influence Perceived Enjoyment. We hypothesize that:

H3 *There is a negative influence of Perceived Health Risk on the Perceived Enjoyment of smartglasses.*

4 Research Design

4.1 Data Collection

To empirically evaluate our research model, we collected 109 completed German-language online questionnaires about one specific pair of smartglasses, Microsoft HoloLens. At the beginning of the questionnaire, we provided a short

description of Microsoft HoloLens, including official images and an explanation of its general functionalities. Microsoft HoloLens, which was not yet available at the time of the survey (June 2015), promises users to see “high-definition holograms ... seamlessly integrating with ... physical places, spaces, and things” (Microsoft 2015).

56 of our respondents were male (51.38 %) and 53 were female (48.62 %). The average age was 27.58 years (standard deviation: 7.33). 1 respondent was unemployed (0.9 %), 3 were apprentices (2.6 %), 5 were pupils (4.6 %), 26 were currently employed (23.85 %), 12 were self-employed (11.0 %), 61 were students (56.0 %), and 1 selected “other” as a description of themselves (0.9 %).

4.2 Measurement

We adapted existing reflective scales to our context in order to measure Behavioral Intention to Use, Perceived Health Risk, and Perceived Enjoyment. Table 1 presents the resulting reflective items with their corresponding sources. All items were measured using a seven-point Likert-type scale ranging from “strongly agree” to “strongly disagree”.

5 Results

Since our data was not distributed joint multivariate normal (cf. Hair et al. 2011), we used the Partial-Least-Squares approach via SmartPLS 3.2.0 (Ringle et al. 2015). With 109 datasets, we met the suggested minimum sample size threshold of

Table 1 Items of our measurement model

Construct	Items	Adapted from
Behavioral Intention to Use	I intend to use a HoloLens in the next 6 months (BI1)	Hu et al. (2011) Venkatesh et al. (2003)
	I predict that I will use a HoloLens in the coming 6 months (BI2)	
	In the future, I am very likely to use a HoloLens (BI3)	
Perceived Enjoyment	Using HoloLens seems to be fun (PE1)	Davis et al. (1992)
	Using HoloLens would be enjoyable (PE2)	
	Using HoloLens would be exciting (PE3)	
Perceived Health Risk	I think using HoloLens would not cause adverse health effects (PHR1) [reversed]	Zhang et al. (2012)
	I believe that the use of HoloLens involves health risks (PHR2)	
	HoloLens involves risks for its user’s health (PHR3)	

“ten times the largest number of structural paths directed at a particular latent construct in the structural model” (Hair et al. 2011, p. 144). To test for significance, we used the integrated Bootstrap routine with 5,000 samples (Hair et al. 2011).

In the following section, we will evaluate our measurement model. Indeed, we will examine the indicator reliability, the construct reliability, and the discriminant validity of our reflective constructs. Finally, we will present the results of our structural model.

5.1 Measurement Model

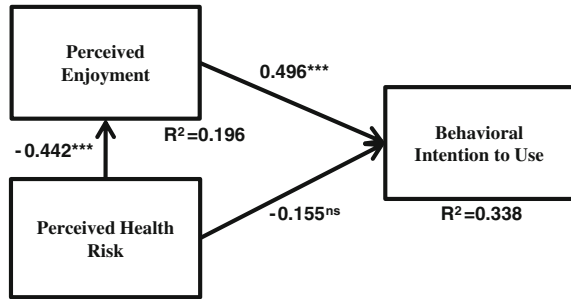
Tables 2 and 3 present the correlations between constructs along with the Average Variance Extracted (AVE) and Composite Reliability (CR), and our reflective items’ factor loadings, respectively: All items loaded high (0.783 or more) and significant ($p < 0.001$) on their parent factor and, hence, met the suggested threshold of indicator reliability of 0.70 (Hair et al. 2011); AVE and CR were higher than 0.65 and 0.84, respectively, meeting the suggested construct reliability thresholds of 0.50/0.70 (Hair et al. 2009). The loadings from our reflective indicators were highest for each parent factor and the square root of the AVE of each construct was larger than the absolute value of the construct’s correlations with its counterparts, thus indicating discriminant validity (Fornell and Larcker 1981; Hair et al. 2011).

Table 2 Correlations between constructs [AVE (CR) on the diagonal]

	BI	PE	PHR
Behavioral Intention to Use (BI)	0.901 (0.965)		
Perceived Enjoyment (PE)	0.565	0.785 (0.916)	
Perceived Health Risk (PHR)	−0.375	−0.442	0.650 (0.847)

Table 3 Reflective items’ loadings (T-Values)

	BI	PE	PHR
BI1	0.934 (44.241)	0.529	−0.367
BI2	0.965 (124.757)	0.568	−0.347
BI3	0.949 (72.825)	0.509	−0.354
PE1	0.493	0.898 (40.020)	−432
PE2	0.547	0.863 (29.383)	−0.363
PE3	0.455	0.896 (35.025)	−0.379
PHR1R	−0.382	−0.455	0.807 (9.773)
PHR2	−0.240	−0.242	0.783 (7.221)
PHR3	−0.234	−0.307	0.827 (8.915)

Fig. 2 Findings

5.2 Structural Model

Figure 2 presents the path coefficients of the previously hypothesized relationships as well as the R^2 s of both endogenous variables (***) = $p < 0.001$; ns = non-significant). Hypothesis 2 was not confirmed since Perceived Health Risk, in line with the findings of other similar risk-related studies (e.g., Ernst 2014; Von Stetten et al. 2011), had no significant influence on Behavioral Intention to Use ($\beta = -0.155$, $t = 1.783$). However, it was found to have a significant negative influence on Perceived Enjoyment ($\beta = -0.442$, $p < 0.001$), which, in turn, was found to have a positive influence on Behavioral Intention to Use ($\beta = 0.496$, $p < 0.001$), confirming hypotheses 3 and 1, respectively.

Our research model included two predecessors of Behavioral Intention to Use (Perceived Enjoyment and Perceived Health Risk), and one predecessor of Perceived Enjoyment (Perceived Health Risk). By taking this into account, the explanatory power of our structural model is good, since it explains 33.8 % of the variances of Behavioral Intention to Use as well as 19.6 % of the variances of Perceived Enjoyment.

6 Conclusions

In this article, we evaluated the potential influence of Perceived Health Risk on the usage of smartglasses. After collecting 109 completed online questionnaires about one specific pair of smartglasses, Microsoft HoloLens, and applying a structural equation modeling approach, our findings indicate that smartglasses are at least partly hedonic technologies whose usage is influenced by Perceived Enjoyment. Furthermore, although we could not confirm a direct negative influence of Perceived Health Risk on the Behavioral Intention to Use smartglasses, we confirmed an indirect negative influence of Perceived Health Risk on Behavioral Intention to Use through Perceived Enjoyment.

Our findings have important practical implications. Indeed, they suggest that smartglasses manufacturers need to emphasize the hedonic benefits of their devices

as well as address people's potential negative perceptions of the devices in terms of their health. For example, they could collaborate with respected medical experts or ask health-oriented athletes to provide testimonials about the products in order to convince people that their health will not be adversely affected by the use of smartglasses.

Our study has some limitations. First, our empirical findings are based on only one specific pair of smartglasses: Microsoft HoloLens. Hence, the results found for these particular smartglasses might be very different in studies that use other smartglasses. In addition, Microsoft HoloLens is a product that is not yet available to the general public. Hence, our respondents did not have any hands-on experience with the device and could only state their guesses based on our product description as well as on information they might have gathered on their own. Moreover, since we only surveyed German-speaking people, our results might not hold true for non-German speakers. Also, our sample individuals were relatively young (mean: 27.58 years; standard deviation: 7.33). Hence, differences might be found for other age groups. Finally, our survey was only conducted online and, hence, excluded people that do not use the Internet (which might also explain the lack of older people in our sample).

As a next step, we plan to expand our research and address its limitations. More specifically, we want to rollout our survey to a number of other countries around the world and with different smartglasses such as Oculus Rift, in order to evaluate for potential differences between countries and devices. Also, we plan to identify and empirically evaluate a number of additional influence factors of smartglasses usage. For example, the substitutability of physical objects through virtual ones could be an exciting subject to consider and we would like to take a closer look at the implications of this possibility in terms of smartglasses usage.

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<http://www.springer.com/978-3-319-30374-1>

The Drivers of Wearable Device Usage
Practice and Perspectives

Ernst, C.-P. (Ed.)

2016, VII, 68 p. 12 illus., Hardcover

ISBN: 978-3-319-30374-1