Virtual Reality on the Go? A Study on Social Acceptance of VR Glasses

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Abstract
Virtual reality (VR) glasses enable to be present in an environment while the own physical body is located in another place. Recent mobile VR glasses enable users to be present in any environment they want at any time and physical place. Still, mobile VR glasses are rarely used. One explanation is that it is not considered socially acceptable to immerse in another environment in certain situations. We conducted an online experiment that investigates the social acceptance of VR glasses in six different contexts. Our results confirm that social acceptability depends on the situation. In the bed, in the metro, or in a train, mobile VR glasses seem to be acceptable. However, while being surrounded by other people where a social interaction between people is expected, such as in a living room or a public cafe, the acceptance of mobile VR glasses is significantly reduced. If one or two persons wear glasses seems to have a negligible effect. We conclude that social acceptability of VR glasses depends on the situation and is lower when the user is supposed to interact with surrounding people.

Author Keywords
Virtual reality; social acceptance; virtual reality glasses.

ACM Classification Keywords
H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous

Introduction & Background

Due to technological advances and increased commercial interest, virtual reality (VR) glasses currently become mobile. This enables the pervasive use of VR glasses. We will be able to use VR glasses when waiting for appointments, when commuting or when sitting in a cafe. While the use of VR glasses in such situations seems unlikely today, they are common situations in which we already use other mobile devices. Envisioning what Gugenheimer et al. calls Nomadic VR [2], the pervasive use of VR glasses in social settings, raises the question if this vision is realistic or if a lack of social acceptance may prevent it.

Social acceptance of technology in public or social settings differs across technologies. The social acceptance of mid-air gestures, for example, depends on the audience and location [14]. If users feel comfortable when performing spatial gestures depends on the relationship between the user and the bystanders. Furthermore, mid-air gestures can be inadequate in crowded settings, as the user may enter the intimate zone of a bystander [4]. The use of mobile and portable devices can also be perceived as impolite. A user may seem physically present, but mentally absent and hence, appear unable to provide bystanders with the expected attention [6].

Especially the social acceptance of smart glasses has been subject of previous discussions. Wearing smart glasses can reduce the quality of face-to-face communication [10, 11, 19]. Devices with cameras, such as smart glasses, AR glasses, and life-logging cameras, can reduce social acceptance because bystanders have privacy concerns and do not know what the captured footage is used for [7, 18]. Studies investigating the social acceptance of smart glasses from the user's perspective show that users are more willing to interact with their device in private spaces than in public spaces surrounded by strangers [5, 8]. Häkkilä et al. [3] found that users of smart glasses can feel embarrassed and uncomfortable in public situations because bystanders might think that they do something unethical. Koelle et al. [7] studied social acceptance from the bystander's perspective and found that acceptance increases when the purpose of the recording is clear to the bystander.

While a substantial body of work aimed to understand the social acceptance of smart glasses in public and social settings, previous work on VR glasses focused on the comfort of VR users (e.g., [15]) or on providing technical solutions for increasing VR glasses' acceptance. Pohl & Tejada [12] assume that the social acceptance of VR glasses is limited because bystanders cannot see what the VR user sees. The authors accordingly extend the VR glasses by a front-facing screen that shows the VR scene form the user's perspective. Previous work aimed to reduce the communication barrier between the user wearing VR glasses and bystanders using eye tracking in combination with a front facing screen to visualize the user's eyes [1] or face [9].

While previous work extensively looked at the social acceptance of smart glasses and also provided technical solutions to increase the social acceptance of VR glasses, it is unclear what affects the acceptance of VR glasses. According to Rico & Brewster, audience and location, for example, are essential for the acceptance of mobile interaction [14] but it is unclear if the social acceptance of VR glasses also depends on audience and location. Therefore, we conducted an online experiment to examine the effect of the situation and the number of persons wearing VR glasses on social acceptance. Results show that wearing VR glasses while being surrounded by people, as in a living room or a cafe, seems to be not acceptable. The number of people wearing VR glasses seems to have a negligible effect.

Figure 1: Photos shown to participants. First row shows the six situations and the female person wearing VR glasses, the second row the male person wearing VR glasses and the third row shows both persons wearing VR glasses.

Method

We conducted an online experiment to determine how VR glasses are perceived in different situations. While we were mainly interested in differences between situations where users commonly use mobile phones, we also wondered about effects caused by multiple persons wearing VR glasses. We provided photos of persons wearing VR glasses to participants, which were asked to answer a set of questions.

We used a full-factorial repeated measures design with two independent variables. For the first independent variable, SITUATION, we selected six situations where users commonly use mobile phones. SITUATION had the following six levels: on a train, in a car, in the metro, in a cafe, in a living room, and in the bedroom. PERSON, the second independent variable had three levels: A female person wearing VR glasses, a male person wearing VR glasses, and both persons wearing VR glasses. Figure 1 shows the 6x3 photos resulting from the 18 conditions.

Two sets of questions were adadpted from the questionnaire proposed by Profita et al. [13] to determine the social acceptability of the use of VR glasses. As Profita et al. in-

vestigated the use of augmented reality glasses as accessibility device, we did not use the second question group (statements about the user) and changed the phrase "wearable computing device" to "virtual reality glasses" in all remaining questions. Accordingly, this resulted in the eight Likert items shown in Table 1. All Likert items were mandatory and had to be answered on a seven-point scale ranging from "'strongly disagree"' to "'strongly agree"'.

We prepared an online questionnaire using our LimeSurvey server. After asking about participants demographics, we showed 18 pages (one for each photo) with the photo at the top and the eight questions below. We randomized the order of the 18 pages. After answering questions about each of the 18 conditions, we asked two qualitative questions for each of the six situations. Therefore, we showed the three photos of the situation at the top and asked *"Describe in your own words your personal impression about using virtual reality glasses in this context. What causes this impression?"*, as well as *"Are there, features that attract your attention particularly?"* below. Again, we randomized the order of the six resulting pages. Finally, we asked participants about their experience with VR glasses (again adapted from Profita et al. [13]).

We recruited participants through social media, university mailing lists, and personal contacts. We raffled a 25 EUR or $25 Amazon voucher. 47 participants completed all questions. 17 stated to be female, and 30 stated to be male. Participants were between 19 and 78 years old (M=28.8, SD=11.4). All but two participants were familiar with VR glasses beforehand, and 38 already used VR glasses. 38 participants identified themselves as German.

Statements about the interaction:
Q1: It looked awkward when this person was using the virtual reality glasses. (Awkward)
Q2: It looked normal when this person was using the virtual reality glasses. (Normal)
Q3: It was appropriate for this person to use the virtual reality glasses in this setting. (Appropriate)
Q4: It was rude for this person to use the virtual reality glasses. (Rude)
Q5: I felt uncomfortable watching this person use the virtual reality glasses. (Uncomfortable)
Q6: I would be distracted by this person if I were at the bus stop with them. (Distracting)

Statements about the device:
Q7: The virtual reality glasses seemed useful. (Useful)
Q8: The virtual reality glasses seemed unnecessary. (Unnecessary)

Table 1: The eight questions adapted from Profita et al. [13]

Results

Quantitative Results

For data analysis, we performed multiple multi-factorial repeated measures analyses of variance (RM-ANOVAs) of aligned rank transformed data as introduced by Wobbrock et al. [17]. The analyses were performed on all eight measures with SITUATION and PERSON as independent variables. We found significant main effects for all measures, except for Q5 (uncomfortable) measure related to PERSONS. Furthermore, there were no interaction effects of SITUATION $\times$ PERSON. All other effects and interaction were statistically significant with $p<.05$ (Table 2). Statistics show higher F-values in all questions for SITUATION than for PERSON, except for Q6 (distracting).

Furthermore, we were interested if social acceptance depends on the number of people (with levels 1 or 2) wearing

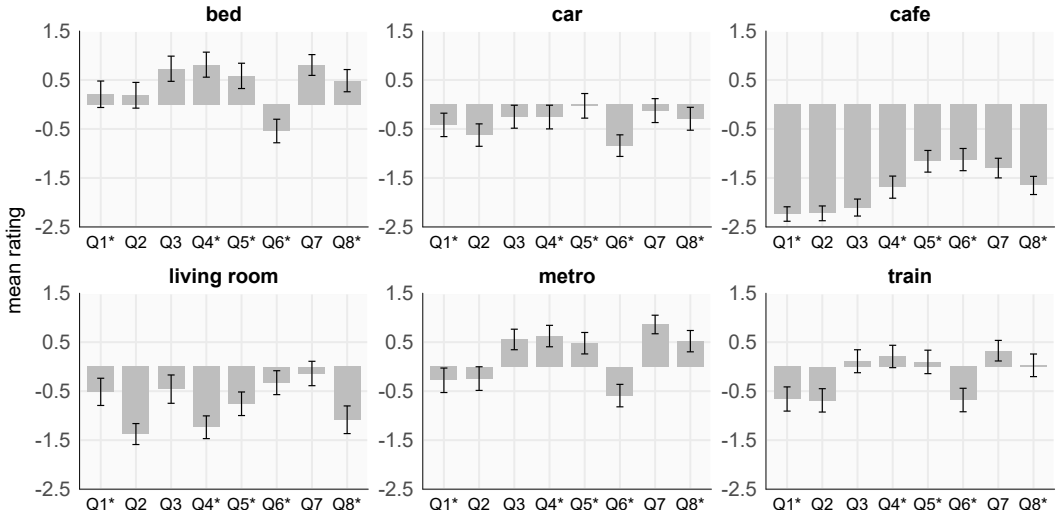

Figure 2: Summary of the quantitative ratings for the six situations and the eight questions. Error bars show the 95% confidence intervals. Asterisks (*) indicate inverse items.

the virtual reality glasses. Therefore, we performed eight additional ANOVAs with SITUATION, PERSONS, and NUMBER OF VR-GLASSES-WEARER with PERSONS as nested variable of NUMBER OF VR-GLASSES-WEARER. None of the main effects for NUMBER OF VR-GLASSES-WEARER were significant, with p>.05, except for the Q4 (rude) measure, $F(2,47) = 11.789$, $p<.001$.

Qualitative Results

Qualitative feedback reveals why acceptability depends on the situation. The participants thought it was inappropriate for at least one of the two persons to wear VR glasses, particularly in the cafe situation. Most of the surveyed participants mentioned the limited face-to-face communication and the limited abilities to communicate with surrounding people: “If you are at a restaurant, I think you are supposed to pass the time together and enjoy each other, the use of VR here seems pretty unnecessary” (P33). In the living room situation, the surveyed participants often felt that the social acceptance depends on the togetherness in the virtual space and assume that people in VR share the same experience: “That not everyone is participating. [...] It may be acceptable when everyone is using them together” (P3) and excluding people seems to be associated with unsocial behavior: “I find it rude because it is excluding other people” (P18).

Both, the train as well as metro situation cause similar feedback. Our participants mentioned that the driving time could be efficiently used by using VR glasses, for example, to watch movies or play games. Many participants noticed that the existing entertainment programs during flights or train rides are not very different from using VR systems in this context: “It’s okay, because they are entertaining themselves while they wait to arrive at their destination” (P38).

	SITUATION (df=5)		PEOPLE (df=2)		SITUATION × PEOPLE (df=10)	
	F	**p**	**F**	**p**	**F**	**p**
Q1	60.392	<.001	13.888	<.001	10.837	<.001
Q2	59.217	<.001	4.323	0.013	2.308	0.011
Q3	76.923	<.001	23.572	<.001	14.747	<.001
Q4	83.210	<.001	26.050	<.001	4.457	<.001
Q5	38.668	<.001	2.997	0.050	1.458	0.150
Q6	9.581	<.001	15.668	<.001	11.453	<.001
Q7	53.843	<.001	12.642	<.001	7.338	<.001
Q8	58.767	<.001	3.905	0.02	2.002	0.036

Error: df=47

Table 2: Results of the eight RM-ANOVAs between SITUATION and PERSON for all eight questions (Q1-Q8).

However, participants also noted that it could potentially be unsafe to use VR glasses in a metro: “lots of passers-by, luggage not in view” (P6). Comments about the car situation were more diverse. Participants were concerned about distractions for the car driver caused by the passengers wearing VR glasses. Some of the comments compared the situation in a car with the living room situation, in which not everybody shares the VR experience.

Discussion

In this paper, we explored the social acceptability of VR glasses, assuming that lacking social acceptance is preventing VR glasses from becoming more ubiquitous. Previous work has shown that social acceptance of AR glasses depends on the context [13]. Moreover, we were interested, if the context while wearing VR glasses depends on the situation or the number of persons in different social settings. Considering these aspects, we conducted an online survey with 47 participants in which we presented photos of two different persons wearing VR glasses in six different situations. While the number of the VR glasses-wearing users (1 or 2) affect social acceptance, the acceptance significantly depends on the person and the situation. Quantitative and qualitative data showed that wearing VR glasses in bed, metro, and a train were socially accepted while wearing them in a car was only slightly inappropriate. Being in a cafe or the living room, however, seems inadequate.

In line with Profita et al. [13], we confirm that social acceptability depends on the person wearing a head-mounted display. While their work showed that social acceptance depends on the user’s disability status and the observers’ information about the device, our work further showed that the situation and the number of users can also influence the users’ judgments. Due to privacy issues with built-in cameras as used in Google Glass head-mounted AR displays were heavily criticized and rejected in public spaces. Such concerns could not be found in the qualitative comments of our survey with VR displays in public spaces. That VR users obviously have no relation to the real environment reduces privacy concerns by observers. However, as our results show, people clearly differentiate between the situation and how many people use VR glasses.

Conclusion & Future Work

Reasons for the lacking acceptability of VR glasses in cafes and living rooms were that these situations are meant to spend time together by sharing the same experience and being in a conversation. As VR is excluding either some people from the social context (as the user is present in VR) or people from the VR experience (as they have no VR glasses), such situations were considered rude and impolite against the people without VR glasses. Our results provoke the assumption that when people face each other and wear VR glasses, social acceptance decreases as a face-to-face arrangement of people triggers communication, which is prevented by the VR glasses.

In this work we specifically investigated how users wearing VR glasses are perceived by bystanders. Consequently, future work should investigate how VR users perceive wearing VR glasses in public. Furthermore, we recommend investigating the design of VR glasses so that bystanders and VR users share the virtual experience and that VR users can participate in the surrounding social situation. Finally, future work could target a unified questionnaire that quantifies the underlying concepts of social acceptance [16].

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