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*Research paper*


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## Abstract


*As first Virtual Reality (VR) shopping environments have begun to appear on the market, the question arises whether users will adopt them for doing their shopping. However, the evaluation of systems that have not yet diffused the market is potentially challenging because it requires bringing larger samples of respondents into a VR laboratory. Therefore, by conducting two experimental studies we shed light on the research question of whether evaluating the acceptance requires that respondents experience the immersive and interactive shopping environment. Our results reveal that particularly the hedonic variable perceived enjoyment as well as the VR specific variable perceived telepresence are underestimated when participants only imagine (based on a video) being in a VR shopping environment while there is no difference with respect to the behavioral intention to use the system. In addition, we show that particularly the hedonic variable perceived enjoyment and the utilitarian variable perceived usefulness influence the intention to use the shopping environment in the future. Overall, we conclude that experiencing the VR shopping environment is essential for users to be able to evaluate the respective technology.*



*Keywords: Virtual Reality, Technology Acceptance, Experience, Imagination.*

# 1 Introduction

With Virtual Reality (VR) entering the mass markets, companies are becoming increasingly interested in using this new technology in shopping applications. SATURN, for example, which is Europe's largest retailer for consumer electronics, recently launched the *Virtual SATURN* shopping environment. Other VR shopping applications were started by the Chinese e-commerce company Alibaba, the US department store Macy's and the Swedish company IKEA. These multi-national retailers are thus experimenting with VR shopping applications, potentially because they see the technology as an opportunity to create competitive advantages (Inman and Nikolova, 2017). An obvious reason for using VR is to increase the number of different ways in which consumers can shop, extending the typical range from brick-and-mortar stores to e- and m-commerce further to VR shopping. The new VR stores are attractive for companies and customers as they are accessible 24/7 from any place with internet access. With the steady advance in and diffusion of VR technology, VR shopping environments could also soon be used by companies to provide consumers with a livelier online shopping experience. Up to this point, however, it remains an open research question, whether VR shopping environments will – once launched – be adopted by end-consumers.

Researchers from the fields of Information Systems (IS) (Suh and Lee, 2005; Steffen et al., 2017), Marketing (Pantano and Servidio, 2012; Grewal et al., 2017) and Innovation Management (Füller and Matzler, 2007; Berg and Vance, 2017) are beginning to realize the potential of VR, but only very few publications have conducted empirical tests of immersive and interactive VR shopping environments (Van Herpen et al., 2016; Meißner et al., 2017). Thus, we see the necessity to evaluate VR shopping similar to e-commerce 15 years ago (e.g., Gefen and Straub, 2000; Gefen et al., 2003) as one of the key practical questions is whether customers will accept and use VR for shopping.

Research lacks empirical studies that investigate VR shopping from a user acceptance perspective. In the last decade, IS research has studied user acceptance of VR applications, primarily in non-immersive virtual worlds such as Second Life or in form of virtual product presentation formats (Jiang and Benbasat, 2005; Nah et al., 2011). The recent advance of VR technology, however, has substantially changed the degree of immersion generated by the system leading to VR environments, which can create an "illusion of reality to the sense of a human participant" (Slater and Wilbur 1997, p.605) and which can create real-world experiences (Bowman and McMahan, 2007). These changes were anticipated by the aforementioned authors, but are just becoming reality with the steady advance of VR technology. Because the degree of immersion is substantially higher in today's VR systems, research needs to (re-) examine user acceptance in high immersive VR shopping environments. However, the evaluation of new VR shopping environments is potentially challenging, because it requires bringing larger samples of respondents into VR. Therefore, the question arises whether respondents need to truly experience the VR environments to be able to evaluate them or whether they would also be able to do the same evaluation when just imagining to be in the respective environment based on a video. The latter could save high costs and effort from the experimenters' point of view, since today's VR studies are mainly conducted on a one-to-one basis. We therefore focus on the following research question:

RQ: Does the acceptance evaluation of VR shopping environments depend on whether users have imagined (based on a video) versus experienced being in the VR environment?

To answer this research question, we conducted two experiments comparing judgements from respondents who have either experienced a shopping environment wearing a head-mounted display (HMD) or had to imagine how the VR experience would be just based on watching a video introducing the VR environment. The contribution of our research paper thus is twofold. First, with respect to VR shopping systems, we determine how much potential customers see in VR shopping applications, especially how easy they think the environment is to use. We will also be able to evaluate the utilitarian and hedonic values of VR shopping. As we will test two very different shopping environments in Study 1 and 2, we will also see whether the respective evaluation holds across different VR implementations. By investigating our research question in two environments: a very basic one in Study 1 that is rather easy to imagine and a more complex and advanced environment in Study 2, we are furthermore able to specify whether an "imagined" scenario is applicable for simple but not for more complex to imagine scenarios. Second, our paper makes a methodological contribution, as we will be able to conclude whether experiencing the VR shopping environment is essential for users to be able to evaluate the respective technology. If we find that the intention to adopt to a large extent depends on user's prior experience, we must put adoption research that is solely based on an "imagined" experience with a system into question.

# 2 Theoretical Background

## 2.1 Immersive Virtual Reality Environments

VR can be defined as a simulated environment in which the user is perceptually surrounded (Loomis et al., 1999). The vision of a VR application can be realized by a Cave Automatic Environment (CAVE) or a HMD. HMDs available in 2018 have a view of about 110° diagonally and small but perceivable pixels. Together with the HMD, a head tracker and a fast computer are used that generate the visual field based on the position and orientation of the user. An immersive VR systems is "capable of delivering an inclusive, extensive, surrounding and vivid illusion of reality to the senses of a human participant" (Slater and Wilbur 1997, p.605). Whereas the term *inclusiveness* indicates to what extent the VR system isolates a person from reality, the term *extensiveness* describes how and in what range the different sensory modalities are accommodated (Slater and Wilbur, 1997). If, for example, users can touch objects in VR by using controllers, the sense of touch accompanies the visual input. Similarly, smell or taste can make the VR experience more extensive. If the VR offers a panoramic field of vision, it is *surrounding*. Finally, *vividness* captures the "resolution, fidelity, and variety of energy simulated within a particular modality" (Slater and Wilbur 1997, p. 605). A high richness of the shown information content or high resolution and quality of the display (e.g. number of pixels) contribute to increasing vividness. While telepresence – a term coined by Steuer (1992) – describes the feeling of "being in a virtual environment" (Slater and Wilbur, 1997, p. 605), the degree of immersion describes to what extent the perception of the virtual environment is similar to perception of reality (Suh and Lee, 2005) and is therefore predetermined by the applied technology. Telepresence thus "is a human response to immersion" (Schultze and Orlikowski, 2010, p. 813). Making VR environments more immersive is thus one of the main goals for further technological development (Blascovich et al., 2002).

## 2.2 The Potential Effect of Pre- and Post-Experience on the Evaluation of Technology Acceptance

Several empirical papers have already asked the question to what extent the acceptance of a technology might depend on the user's experience with it. Venkatesh and Davis (2000) hypothesized two moderating effects of user experience. The authors showed that the influence of subjective norms on perceived usefulness and intention to use the technology decreased with increasing experience. An explanation for this finding is that users who have more experience using a technology will be less dependent on the opinions of others and will to a larger extent base the evaluation of the technology on their own experience. In the context of the UTAUT model, Workman (2014) argued that previous positive or negative experiences with the technology are going to lead to positive and negative future expectations regarding the use of the technology. Having had positive experiences, users are expected to have a higher assessment of the technology and should more likely recommend the technology to others (Laforet and Li, 2005). Workman (2014) found a positive direct effect of user experience on intention to use for two technologies, social media and smart applications. Depending on the technology investigated, the author also found different positive interaction effects with key variables of the UTAUT model. More recently, Maruping et al. (2017) included experience into the UTAUT model and found that experience worked as a moderator for some of the predictors of the behavioral intention.

The results of the empirical studies investigating the UTAUT model, however, are less conclusive for the VR shopping context, as subjective norms, for example, have not yet been developed because of the newness of the technology. At this early stage, we consider it to be almost impossible to test experience in a similar way as it was done by Venkatesh and Davis (2000), Maruping et al. (2017) or Workman

(2014). Instead we follow Bhattacherjee and Anol (2001), who suggested to use empirical designs that test for differences in pre- and post-experience of user acceptance. Although our experiments are not longitudinal in the sense that it compares the level of acceptance in a within-subjects design across several months, it still allows us to at least compare pre- and post-experience evaluation of key acceptance constructs in a between-subjects experiment in terms of "imagined" based on a video versus "experienced."

In line with this previous research, we expect that whether a user has experienced the VR environment before or not will affect key constructs related to user acceptance. We further think that this effect is pronounced for VR technology and deserves particular attention, because VR technology is said to be a fundamental different and new technology (Walsh and Pawlowski, 2002), as it is highly interactive and affects several senses to a degree that lets users fully immerse in an environment. The sensory experience makes VR technology different from other ISs like smartphones or social networks. It is therefore likely that users can hardly anticipate interacting with and experiencing such a system that is supposed to affect them through different modalities (gestures, movements, visually, sometimes even haptic, etc. (Mihelj et al., 2014)). Based on our experience with lab studies using VR, we can indeed say that first-time users of VR are oftentimes quite excited when taking their first steps in an immersive and interactive VR environment. These prior observations suggest that the intention to use VR shopping will change when users experience VR shopping using a HMD compared to a situation in which they are asked to imagine what the VR experience would be like.

## 2.3 Variables of Interest

Technology adoption research is a core research field within the IS discipline (Benbasat and Barki, 2007; Venkatesh et al., 2007). Numerous studies were conducted and several technology acceptance models (TAM) were developed to predict behavioral outcomes such as the intention to use an IS (Davis et al., 1989; Venkatesh et al., 2003, 2012). The initial model by Davis et al. (1989) was continually adapted to reflect the respective research context as accurately as possible. In most models, however, the main predictors remain *perceived usefulness* of the system, *perceived ease of use* of the system and the *intention to use* the system in the future. Whereby perceived usefulness is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" and perceived ease of use as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320). Despite the continuous criticism towards the TAM model (Benbasat and Barki, 2007), we argue that the variables provide a solid basis for initial research in the field of user acceptance of VR shopping environments.

In addition to the three well-known constructs from the original TAM (Davis, 1989), which primarily aims at explaining utilitarian adoption motives, van der Heijden (2004) emphasized the importance of considering a hedonic perspective within IS adoption theories especially for pleasure-oriented ISs. Within an online shopping context, the importance of including both utilitarian and hedonistic motives in predicting behavioral intention has already been shown (Childers et al., 2001; Koufaris, 2002). Thus, we argue that also for VR shopping environments hedonic motivations need to be considered as determinants of technology acceptance. The most widely applied construct for measuring the affective response to a system is *perceived enjoyment*, which can be seen as the hedonic counterpart to the utilitarian construct *perceived usefulness* (Wu and Lu, 2013). Isolated from all utilitarian motives, Venkatesh (2000) refers to perceived enjoyment as "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" (p. 351). One of the key characteristics of VR systems is the ability to induce a feeling of telepresence. Telepresence refers to the "extent to which one feels present in the mediated environment, rather than in the immediate physical environment" (Steuer, 1992, p. 76). Telepresence is therefore the system-generated ability to cross-fade physical reality. The interplay between telepresence and perceived enjoyment was shown in contexts such as virtual museums (Sylaiou et al., 2010) or virtual worlds that were used to enhance brand equity (Nah et al., 2011). Because of the connection of the constructs, we argue that both constructs represent hedonic motivations and should be considered when studying user acceptance of VR shopping environments.

# 3 Study 1 – Basic VR Shopping Environment

Since the VR technology has not yet found its way into many living rooms and, so far, only a very few VR shopping applications are available, the question is whether consumers can judge the acceptance of a VR application without having experienced it. To address this research question, the first study focuses on a **basic** virtual shopping environment that is rather simple to imagine for potential users. We compare data from two treatments (between subjects). In the first treatment, participants took part in a laboratory study in a basic VR shopping environment (see Peukert et al. (2019)). In the second treatment, the participants completed an online study. Participants from the laboratory treatment experienced a basic VR shopping environment wearing a HMD (HTC Vive) and using hand-held controllers to interact with the environment (one for each hand) in the KD²Lab of the Karlsruhe Institute of Technology. In the following, we therefore refer to this group as **VR1Experienced**. Participants from the online questionnaire treatment received an introduction to the shopping environment using a 2D video. We thus call this experimental group **VR1Video**. Participants were then asked to *imagine* – based on the video – how their shopping experience in the virtual shopping environment would be like and to answer the final questionnaire against this background.

The considered (basic) VR shopping environment was designed to replicate reality and consisted of a single supermarket shelf that was filled with 24 different products (3D models of muesli packages) and placed in an ordinary room. Thus, the environment only showed one single shelf and not complete supermarket aisles or even an entire supermarket. Moreover, there was a shopping cart next to the shelf in which the participants had to put their chosen products. The environment allowed participants to take products from the shelf to have a closer look on each side of the package. The interactions in VR are close to interactions in the physical world: when a product is selected it sticks to the controller and can be moved, turned, and swapped to the other hand as in reality. Participants were also able to take two products at the same time (one with each controller) or even throw products on the floor. The virtual environment enabled a real-scale stereoscopic vision. Furthermore, participants could move freely within the environment by body movements – which is possible due to room-scale tracking, but limited to the available physical space. We decided to use muesli as product category for the study, as they can be easily modelled in 3D and our participants were used to this product and could easily relate to it.

## 3.1 Operationalization of Dependent Variables

We operationalized all dependent variables of interest adapting common scales from literature and using a 7-point Likert scale ranging from 1: “I totally disagree” to 7: “I totally agree.” Table l provides an overview on the applied items and the respective sources. For the VR1Video treatment, we added the words “I think” to the beginning of all items and set the tense to “conditional simple” in order to express the imagination aspect (except for intention to use, as this scale already fitted to the context). We rephrased for example the item “I found my shopping experience interesting” to “I think I would find this shopping experience interesting.” Within the online questionnaire, we additionally added “virtual” in front of “shopping environment” whenever it appeared to make sure that participants refer to the virtual shopping environment, e.g., “the shopping environment is easy to use” was rephrased to “I think the virtual shopping environment would be easy to use.”

| | | | Outer Loading | |
|---|---|---|---|---|
| **Constructs** | | **Items (adapted)** | Study 1 | Study 2 |
| **Telepresence** (Kim and Biocca, 1997; Klein, 2003; Nah et al., 2011) | TEL.1 | I forgot about my immediate surroundings when I was doing the shopping. | .856 | .858 |
| | TEL.2 | When the shopping task ended, I felt like I came back to the “real world” after a journey. | .810 | .804 |
| | TEL.3 | During the shopping tasks, I forgot that I was in the middle of an experiment. | .700 | .648 |
| | TEL.4 | The shopping environment displayed on the screen (in the virtual reality) seemed to be “somewhere I visited” rather than “something I saw.” | .462 | .474 |
| **Enjoyment** (Ghani et al., 1991; Koufaris, 2002) | ENJ.1 | I found my shopping experience interesting. | .839 | .846 |
| | ENJ.2 | I found my shopping experience enjoyable. | .788 | .837 |
| | ENJ.3 | I found my shopping experience exciting. | .739 | .758 |
| | ENJ.4 | I found my shopping experience fun. | .917 | .918 |
| **Ease of use** (Davis, 1989; Vrechopoulos et al., 2004) | EOU.1 | The shopping environment is easy to use. | .887 | .875 |
| | EOU.2 | It is easy to become skillful at using the shopping environment. | .827 | .909 |
| | EOU.3 | Learning to operate the shopping environment is easy. | .805 | .901 |
| | EOU.4 | Interactions with the shopping environment are clear and understandable. | .879 | .837 |
| **Usefulness** (Davis and Venkatesh, 1996; Koufaris, 2002; Vrechopoulos et al., 2004) | USE.1 | The shopping environment is useful for doing the shopping. | .810 | .777 |
| | USE.2 | The shopping environment improves my shopping performance. | .881 | .874 |
| | USE.3 | The shopping environment enhances my effectiveness when doing the shopping. | .836 | .869 |
| | USE.4 | The shopping environment increases my shopping productivity. | .822 | .872 |
| **Intention to use shopping environment** (Wang and Benbasat, 2009; Xu et al., 2014; Venkatesh et al., 2017) | INT.1 | Assuming I have access to the shopping environment, I intend to use it next time I am doing my shopping. | .965 | .973 |
| | INT.2 | Assuming I have access to the shopping environment, I predict I would use it next time I am doing my shopping. | .933 | .948 |
| | INT.3 | Assuming I have access to the shopping environment, I plan to use it next time I am doing my shopping. | .949 | .973 |

*Table 1. Scales Used in Study 1 for the VR1Experienced Treatment.*

## 3.2 Task, Procedure, and Participants

Within the VR1Experienced treatment, participants were asked to make several decisions in front of a virtual shelf (experimental design based on a choice-based conjoint analysis (Sawtooth Software Inc., 2013) to simulate a real shopping situation. The task was to choose the muesli package which they would most likely buy in reality out of the displayed product sample. To increase the participants’ motivation to behave as they were really doing their shopping, the experiment was incentive-aligned (Ding et al., 2005), i.e., participants received an initial endowment of 14€ from which the price of one of their decisions was debited, but in return they received the respective product (average price of the offered mueslis was 2.69€). The laboratory treatment lasted on average 38.42 min (SD=7.76 min).

In the VR1Video treatment, participants conducted the study only in front of their desktop computers. Thus, instead of experiencing VR, they saw a video of 43s showing the same environment and the supported interactions that the participants in the VR1Experienced treatment experienced. The video was taken from a first-person perspective and they were instructed that they would normally use a HMD and controllers to experience the shopping environment. They were asked to imagine based on the video that they would do their shopping within the introduced environment and to answer the questionnaire against this background. Participation was incentivized by the possibility to take part in a lottery in which the payoff was on average 3.85€ per participant (survey duration: mean=15.11 min; SD =4.55 min).

We recruited our participants from a subject pool of a large German university using the organizing and recruiting software *hroot* (Bock et al., 2012). For the VR1Experienced treatment, in total, datasets for 132 participants are available for which the sessions have run technically impeccable. Whereas for the VR1Video treatment, 65 participants completed the survey. During the data cleansing process, the number of participants for the analysis decreased to 62 (one person failed to correctly answer a control question, another indicated having problems with playing the video, and a third person was excluded because the person watched the video for 15 s only). Altogether, this leads to a sample of 194 participants with an average age of 22.5 years (SD=3.29) and among the participants 37.6% were female.

## 3.3 Results

First, we were interested in the pure effect of the treatment variable on the dependent variables independent of any theoretically underlying relationship between the dependent variables. By doing so, we can observe how the isolated evaluations of variables differ between treatments, which helps us to answer the research question of whether subjects really need to experience a VR environment to be able to judge it properly. We therefore examined the reliability of our scales using Cronbach's alpha. All values were greater than the commonly applied threshold of 0.7 (see Table 2), confirming the internal consistency reliability of the applied scales (Hair et al., 2016). We then merged the scores of the construct's individual items by calculating the mean value. Depending on whether the distribution assumptions for parametric tests were met, we applied the Welch Two Sample T-test or the Mann-Whitney U Test in order to compare the means between the treatments. Table 2 reports the results:

| | **VR1Experienced (N=132)** | | | **VR1Video (N=62)** | | | | **ALL (N=194)** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Const.** | **M (Mdn)** | **SD** | **SW-Test** | **M (Mdn)** | **SD** | **SW-Test** | **p** | **M (Mdn)** | **SD** | **α** | **CR** | **AVE** | **HTMT** |
| **TEL** | 4.24 (4.25) | 1.14 | .138 | 3.77 (4.00) | 1.46 | .132 | **.028*[a]** | 4.09 (4.00) | 1.27 | .716 | .807 | .523 | yes |
| **ENJ** | 5.08 (5.25) | 1.22 | <.001** | 4.15 (4.00) | 1.55 | .045* | **<.001***[b]** | 4.78 (5.00) | 1.40 | .842 | .893 | .678 | yes |
| **USE** | 4.27 (4.50) | 1.23 | .036* | 4.23 (4.25) | 1.47 | .358 | **.962[b]** | 4.26 (4.50) | 1.31 | .859 | .904 | .702 | yes |
| **EOU** | 6.48 (6.75) | 0.69 | <.001** | 5.61 (5.75) | 1.01 | .013* | **<.001***[b]** | 6.20 (6.50) | 0.90 | .875 | .912 | .722 | yes |
| **INT** | 4.05 (4.00) | 1.66 | .002** | 3.88 (4.33) | 1.85 | .001** | **.618[b]** | 3.99 (4.00) | 1.72 | .945 | .964 | .900 | yes |
| * *p* <.05; ** *p* <.01; *** *p* <.001 | | | | | | | | | | | | | |

*Table 2. Summary variables of interest and test for group differences (SW = Shapiro-Wilk, p-value based on appropriate test a. Welch Two Sample T-test, b. Mann-Whitney U Test; calculating the tests using t-tests only, leads to qualitatively similar results; α = Cronbach's alpha, CR = Composite reliability, AVE = Average variance extracted, HTMT = Heterotrait-Monotrait Ratio: 1 is not included in confidence interval).*

The results of the comparison of means for the two variables perceived telepresence (t(97.55)=2.24, p<.05, with an effect size of r=.22 (Rosnow and Rosenthal, 2005)) and perceived enjoyment (W=5580, p<.001, r=-.29), reveal significant differences for the treatments in the evaluation of the variables. The values for both show significantly higher values for the VR1Experienced treatment, indicating that participants underestimate the VR system's ability to induce a feeling of telepresence and that the perceived enjoyment which is created through using the VR environment is higher than expected. On the contrary, the results for perceived usefulness do not differ significantly between the treatments (W=4110, p=0.962, r=-.003). Accordingly, participants can well estimate the perceived usefulness without having the need to experience it. Similarly, the results for the behavioral outcome intention to use are not significant (W=4274, p=0.618, r=-.04). Here, as well, values for the intention to use from the VR1Experienced group coincide with the VR1Video group evaluation. For the remaining TAM variable perceived ease of use, the differences are, again, significant (W=6248, p<.001, r=-.43).

Second, since most of the variables originate from technology acceptance research, we are also interested in the effect of the individual variables on the ultimate TAM outcome variable intention to use. We therefore investigate a simple structural equation model (SEM) with two layers: From the treatment variable paths are modelled to telepresence, enjoyment, usefulness and ease of use (first layer), and from the latter variables a path to intention to use is modelled (second layer). Due to the exploratory research objective of our analysis, PLS SEM is used for the data analysis (Gefen et al., 2011). We first analyzed the quality of the measurement model. Cronbach's alpha (as stated above) as well as the composite reliability are above the threshold value of 0.7 (Hair et al., 2016) for all constructs, thereby confirming internal consistency reliability. Then, we evaluated the convergent validity by examining each indicator's outer loading and a construct's average variance extracted (AVE) (see Table 1 and Table 2). For the latter, the values for all the constructs were above the proposed threshold of 0.5 (Hair et al., 2011). However, with respect to the outer loadings, the indicator TEL.4 (0.462) had to be considered in more detail: Following Hair et al. (2016), indicators with an outer loading between 0.4 and 0.7 shall only be removed from the scale when item deletion increases the AVE or internal consistency reliability above the threshold. Since we have already met the respective threshold values, we decided to retain TEL.4 in the model. For assessing the discriminant validity, we draw upon the Fornell-Larcker criterion (Fornell and Larcker, 1981), the consideration of the cross loadings, as well as the Heterotrait-Monotrait Ratio (HTMT, see Table 2). All three tests confirm the discriminant validity of the measurement model.

Having confirmed the reliability of the measurement model, we then evaluated the results of the structural model. First, we checked the structural model for collinearity issues by analyzing the Inner VIF values among predicting constructs. We can confirm that all the values for predicting constructs are well below the commonly used threshold of 5 (Hair et al., 2011). Second, we proceeded with assessing the structural model. Figure 1 shows the results for the PLS structural model. The significance values for the path coefficients were obtained by means of bootstrapping (5000 samples, two tailed, bias-corrected and accelerated (BCa) without sign change).

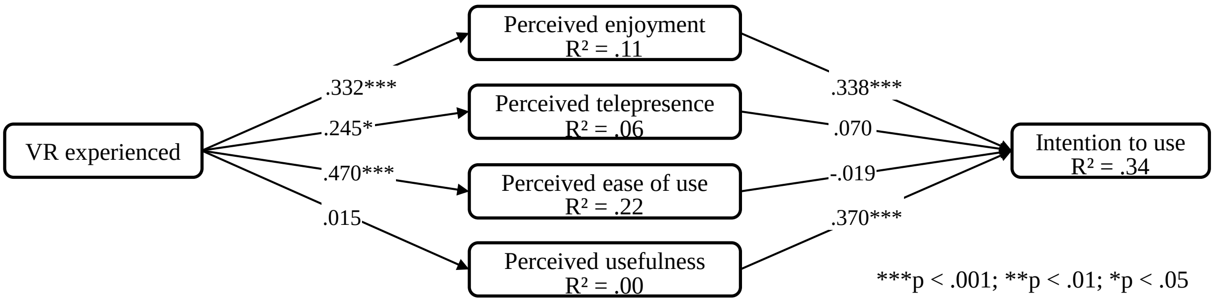


*Figure 1. SEM basic VR shopping environment.*

In the following, we primarily focus on the second layer of the SEM to answer the question of which variables have an influence on the intention to use. We find significant paths for perceived enjoyment and perceived usefulness (both significant at a .001 level), whereas the paths leading from telepresence and ease of use to intention are not significant. The independent variables explain 34 percent (adj. $R^2$ = .32) of the variance in intention to use, with perceived enjoyment ($f^2$ = .142; small effect) and perceived usefulness ($f^2$ = .190; medium effect) being the predictors with highest contribution ($f^2_{(TEL \rightarrow INT)}$ = .007;

$f^2_{(EOU \rightarrow INT)} = .001$).[1] Based on the results we conclude that the hedonic variable enjoyment as well as the utilitarian variable usefulness have the strongest influence on intention.

## 3.4 Discussion

According to the results, participants significantly underestimate the hedonic properties of the basic VR shopping environment (namely enjoyment and telepresence) purely in imagination, whereas the utilitarian outcome perceived usefulness and the behavioral outcome intention to use are surprisingly equally perceived. The findings for perceived telepresence show that participants cannot reliably envision the extent of the key characteristic of VR – inducing a feeling of telepresence – without having experienced the respective application. Research has already shown the linkage between the variables covering our hedonic perspective (Sylaiou et al., 2010; Nah et al., 2011). Interestingly, the significantly higher values for ease of use provide the insight that the basic VR shopping environment was perceived as being easier to use when experienced than when imagined (the average values are anyhow rather high for measurements on a 7-point Likert scale). This finding could be explained by the closeness of the supported interactions in the virtual shopping environment to the known habits in reality. The assessment of the perceived usefulness and intention was congruent, which may have been caused by the simplicity of the design of the basic shopping environment. When considering the relationships from the individual variables to intention to use, we find significant paths for enjoyment (hedonic) and usefulness (utilitarian). These findings are consistent with literature (Koufaris, 2002; van der Heijden, 2004), in which utilitarian and hedonic variables equally predict the intention to use.

Within Study 1, we investigated consumer behavior in a highly controlled task that should be easy to be imagined with only a single shelf representing the shopping environment. Moreover, we choose muesli – mainly to reduce implementation effort – as product under consideration which can be classified as low-involvement product for which, for example, the real-scale product presentation only offers a small added value. This study thus serves as a starting point and establishes a lower bound for our investigated effect. We hence can conclude that for a basic and rather easy to imagine environment, participants are able to anticipate utilitarian effects of the system but not effects on hedonic values. We therefore now shed more light on our research question by analyzing a more advanced VR environment next.

# 4 Study 2 – Advanced VR Shopping Environment

The possibilities for designing virtual shopping environments are almost unlimited. Hence, VR shopping environments have by no means to be a one-to-one replication of reality. Whereas the Swedish furniture manufacturer IKEA sticks to modelling a realistic kitchen within their VR application – which seems to be reasonable for their context, SATURN let customers choose between two different VR environments to shop for consumer electronics: either in a penthouse-loft or in space on the planet Saturn. These VR shopping environments represent an entire world, in contrast to the plain environment which was applied in Study 1, and thus a much more pronounced experience. Similar to Study 1, we compare data from a treatment, in which participants take part in a laboratory study experiencing the advanced VR environment (**VR2Experienced**), with data from another treatment, in which participants participated in an online study watching a video that introduces the advanced shopping environment (**VR2Video**).

In the Virtual SATURN environment irrespective of the selected shopping environment, several consumer electronic products are displayed. As soon as participants take a closer look at a product, additional information about the product pops up. Moreover, further products can be considered in a virtual product catalog and put into the environment to view them in real-scale stereoscopic vision. The product catalog allows for browsing different product categories reaching from digital cameras over large kitchen appliances to drones. Generally, several functionalities are offered such as bookmarking products, requesting remote product advice by an employee, or gimmicks like a tape measure to determine the size of a product, a pen to draw within the environment, or a photo feature. Due to the size of the

[1] Adj. $R^2$: ENJ (.106), TEL (.055), EOU (.217), USE (-.005); $f^2$ VR Exp. on: ENJ (.124), TEL (.064), EOU (.284), USE (.000).

shopping environment, a feature is implemented to teleport oneself from one point to another, which can be used instead moving by body movements. The latter is possible due to room-scale tracking, but only in the restricted area of the available physical space. The general handling of products is – similar to Study 1 – close to interactions in reality (grabbing, turning, and throwing products is supported). Finally, products can be purchased via a direct link to the online shop. As outlined, the described shopping environment is relatively comprehensive and offers various possibilities, but, in turn, the question arises whether consumers can judge the acceptance of this advanced VR environment without having experienced it. We considered the penthouse-loft as experimental scene for Study 2, to limit the participants to only one environment to control for this factor. The penthouse-loft can be described as a huge fully furnished living room (including all kinds of electronic devices) with a connected open kitchen. To sum up, the main differences to the environment applied in Study 1 are that the shopping environment is comprehensive (in size and content), multiple product categories are presented, and that additional features are offered (i.e., features that do not exist in physical reality).

## 4.1 Task, Procedure, and Participants

Within the VR2Experienced treatment, we asked the participants to visit SATURN's penthouse-loft. We did not specify a specific task to let the participants experience the environment and the various functionalities on their own. However, they were asked to put one product that they liked into their shopping basket whenever they wanted to leave the shopping environment. The procedure for the VR2Video treatment was similar to Study 1. Hence, instead of experiencing the advanced shopping environment, participants saw an introduction video of 4:39 min taken from a first-person perspective that introduced the environment and the supported possibilities of interaction (as described above; VR2Experienced participants saw the same video as part of the instructions). Afterwards, participants were asked to imagine that they would do their shopping within the introduced shopping environment and to answer the questionnaire against this background. For the operationalization of the variables of interest, we applied the same scales as in Study 1 for both treatments respectively (Table 1). The recruiting process was similar to Study 1. Initially, 46 participants took part in the VR2Experienced treatment. Due to technological problems during the experiment, we excluded five participants from further analysis as the technological problems influenced their experience in the virtual shopping environment. In addition, we excluded two participants because of very limited German language skills resulting in a sample of 39 participants for further analysis. On average, a session lasted 38.16 minutes (SD=6.63) and participants received 10€ for taking part in the laboratory study. In total, 51 participants completed the online questionnaire for the VR2Video treatment of which, however, one person failed to correctly answer a control question and three additional only watched less than half of the video. After removing two other participants who in turn stated to have problems playing the video, the sample size for analysis is 45. Participation was incentivized by the possibility to take part in a lottery in which the payoff was on average 3.33€ per participant (survey duration: mean=20.64 min; SD =2.61 min). The average age of participants in both subsamples is 23.74 years (SD=5.83) and 25% of the participants are female.

## 4.2 Results

First, we examined the reliability of our scales using Cronbach's alpha. All values were greater than the commonly applied threshold of .7 (Hair et al., 2016) except the value of perceived telepresence (see Table 3). We then tested whether removing individual items leads to a decisive improvement in the alpha value, however, this was not the case. As Cronbach's alpha tends to underestimate the internal consistency of the scale (Hair et al., 2016), we argue that we can apply the scale for the analysis as the value is only slightly below the threshold. Furthermore, the results are robust of whether we build the telepresence scale on three (dropping TEL.4 leads to an alpha of .683) or four items (W=1411.5, p<.001, r=-.55). Second, we continued the analysis in line with the approach of Study 1 (see Table 3).

The results of the comparison of means between treatments for perceived telepresence (t(82.0)=4.51, p<.001, r=.45) as well as perceived enjoyment (W=1557.5, p<.001, r=-.72) show significant differences. For both variables representing the hedonic perspective, the mean values are significantly higher in the VR2Experienced treatment from which the conclusion can be drawn that the hedonic capabilities of the system cannot be predicted without having experienced it. However, the results for the TAM variables perceived ease of use (W=1066, p<.1, r=-.18) and intention to use (W=1069.5, p<.1, r=-.19) do not reveal significant differences. Finally, the evaluation of the VR2Video group for the construct perceived usefulness is significantly lower than participants' evaluation in the VR2Experienced group (t(79.21)=2.16, p<.05, r=.24). Accordingly, participants state that the usefulness of the advanced shopping environment is higher when experienced than imagined based on a video.

| | **VR2Experienced (N=39)** | | | **VR2Video (N=45)** | | | | **ALL (N=84)** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Const.** | **M (Mdn)** | **SD** | **SW Test** | **M (Mdn)** | **SD** | **SW Test** | **p** | **M (Mdn)** | **SD** | **α** | **CR** | **AVE** | **HTMT** |
| **TEL** | 5.03 (5.00) | 0.98 | .327 | 3.99 (4.00) | 1.13 | .638 | **<.001*****[a] | 4.48 (4.50) | 1.18 | .680 | .797 | .507 | yes |
| **ENJ** | 6.11 (6.25) | 0.74 | .011* | 4.37 (4.75) | 1.36 | .032* | **<.001*****[b] | 5.18 (5.50) | 1.41 | .862 | .906 | .708 | yes |
| **USE** | 4.10 (4.00) | 1.26 | .800 | 3.51 (3.50) | 1.21 | .360 | **.034***[a] | 3.78 (3.75) | 1.26 | .871 | .911 | .721 | yes |
| **EOU** | 5.55 (5.75) | 1.04 | .071 | 5.04 (5.25) | 1.30 | .043* | **.090**[b] | 5.28 (5.50) | 1.21 | .904 | .933 | .776 | yes |
| **INT** | 4.44 (5.00) | 1.69 | .054 | 3.67 (3.33) | 1.90 | .001** | **.084**[b] | 4.02 (4.50) | 1.83 | .962 | .976 | .930 | yes |
| * *p* <.05; ** *p* <.01; *** *p* <.001 | | | | | | | | | | | | | |

*Table 3. Summary variables of interest and test for group differences (SW = Shapiro-Wilk, p-value based on appropriate test a. Welch Two Sample T-test, b. Mann-Whitney U Test; calculating the tests using t-tests only, leads to qualitatively similar results; α = Cronbach's alpha, CR = Composite reliability, AVE = Average variance extracted, HTMT = Heterotrait-Monotrait Ratio: 1 is not included in confidence interval).*

Second – similar to Study 1 – we are interested in the effect of the variables on the intention to use and therefore follow the same approach as in Study 1 for the more advanced environment. We test the same SEM and proceed similarly to Study 1 with the evaluation of the measurement and structural model. As mentioned above, the Cronbach's alpha of perceived telepresence was slightly below the recommended 0.7 threshold. However, the composite reliability for telepresence indicated a sufficient value (0.797). In addition, the tests for convergent and discriminant validity were satisfactory, confirming the reliability of the measurement model (see Table 1 and Table 3). Only the outer loadings of TEL.3 (0.648) and TEL.4 (0.474) fell within the interval between 0.4 and 0.7 (see Table 1). Following the same argumentation as in Section 3.3, we decided to retain the items in the model. After having confirmed the reliability of the measurement model, we ruled out the possibility to suffer from collinearity issues (all the values for predicting constructs are well below 5) and proceeded with the analysis of the structural model. Figure 2 shows the results for the PLS structural model.

Similar to Study 1, we solely focus on the second layer of the SEM since this is the subject of investigation. The two paths leading from enjoyment and usefulness to intention to use turn out to be significant (both positive and significant at a .001 level), whereas the remaining paths were not. The four predicting variables jointly explain 44 percent of the variance in intention to use (adj. $R^2 = .416$). However, perceived enjoyment ($f^2 = .134$; small effect) and perceived usefulness ($f^2 = .288$; medium effect) are the main contributors ($f^2_{(TEL \rightarrow INT)} = .009$; $f^2_{(EOU \rightarrow INT)} = .000$).[2] Based on the results, the hedonic variable enjoyment as well as the utilitarian variable usefulness turn out to have the highest impact on intention.

[2] Adj. $R^2$: ENJ (.380), TEL (.254), EOU (.037), USE (.047); $f^2$ VR Exp. on: ENJ (.633), TEL (.356), EOU (.051), USE (.062).

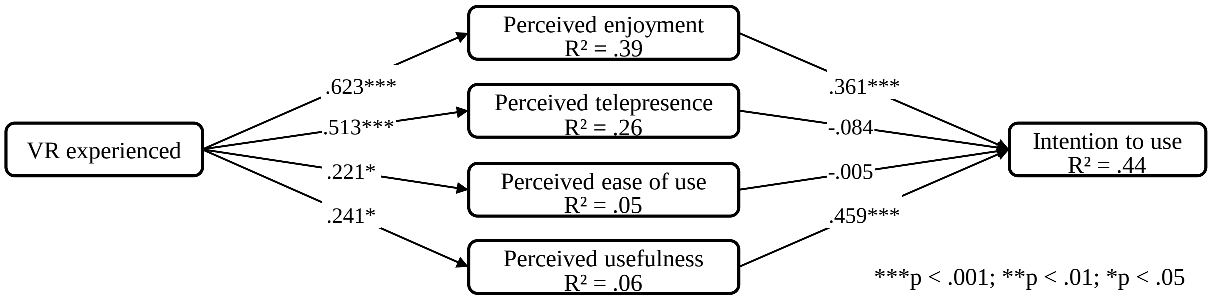


*Figure 2. SEM advanced VR shopping environment.*

## 4.3 Discussion

We can overall summarize that within Study 2 the most part of the variables of interest have been (significantly) underestimated in the VR2Video treatment emphasizing the need to experience this advanced VR shopping environment. In particular, the effect of perceived enjoyment is very large with an effect size of r=-.72 followed by the effect of perceived telepresence (r=.45). All three TAM variables show small effect sizes. Although perceived ease of use and intention to use are not significant at a .05 level, we find a trend that participants who experienced VR had higher overall ratings on these two constructs.

When comparing the individual results of Study 2 with those of the first study, it is noticeable that in both cases the hedonic variables were significantly lower rated in the VR1/2Video than in the respective VR1/2Experienced treatment. Thus, it seems to be a general problem that hedonic aspects are underestimated when only imagined based on a video, irrespective of whether the environment is basic or advanced. In contrast, for both studies the effects between groups on the intention to use are not significant, whereas for perceived usefulness and ease of use the results are inconsistent when comparing both studies – either significant for one study or the other (perceived usefulness significant in Study 2 only; perceived ease of use significant in Study 1 only). The results for the examination of variables influencing the intention to use are similar for the two studies: In both studies the hedonic variable perceived enjoyment and perceived usefulness are the variables that have a significant influence on the intention to use which fosters theories of two-sided motivations, i.e. hedonic and utilitarian, in the area of online retail consumer behavior (Childers et al., 2001; Koufaris, 2002).

In order to further understand the influence of the shopping environment's design on the shopping experience, the next section will only compare results between the two experience groups (VR1/2Experienced) from Study 1 and 2: We find that the more advanced shopping environment (M=6.11, SD=0.74) indeed leads to significantly higher perceived telepresence compared to the basic shopping environment (M=5.08, SD=1.22), t(71.32)=-4.24, p<.001, r=-45. Similarly, the comparison reveals significant differences with respect to perceived enjoyment (advanced: M=6.11, SD=0.74; basic: M=5.08, SD=1.22), W=1223.5, p<.001, r=-.38. Interestingly, the perceived usefulness was rated as equally high (advanced: M=4.10, SD=1.26; basic: M=4.27, SD=1.23), W=2704.5, p=.632, r=-.04. As expected, the perceived ease of use was higher in the simpler environment of the first study (W= 4011, p<.001, r=-0.42). In sum, there is no difference with respect to the intention to use between the simpler and the more advanced environment (W=2208.5, p=.178, r=-.10).

# 5 Limitations and Future Research

Within this paper, we reported results for two experiments trying to shed light on the acceptance of VR shopping environments from different perspectives – namely experience and imagination (based on a video). The analyses reported within this paper focused on investigating effects on several variables of interest and are of a more explorative nature. Although we have examined which variables have the largest impact on the intention to use, it remains a point for future research to theorize about and test further relationships between the variables. Overall, the paper has primarily been driven by the idea to investigate ways to reduce the effort and expenses that result from conducting VR lab experiments. As a result, we compared an online study showing a video (lower effort and expenses) to a real VR experience in the lab and wanted to learn whether similar results can be obtained. We are aware of the fact that the experimental design is not entirely clean in a classical sense (i.e. everything is kept constant except the manipulation) since the experiment duration and the incentive structure were not identical. Now that we have gained initial insights, the next step is to conduct another set of studies that follows a clean experimental design in order to validate the results.

Our research is also limited to studying the initial use based on the technology acceptance model. However, investigating continued use or "continuance" (Bhattacherjee and Anol, 2001) seems impossible at this point as these VR applications were launched very recently. Understanding the continued use of VR shopping environments, however, is an essential next step for future research, as the long-term survival of VR as a retail channel will be depending on customers' demand to use it. Adopters of VR shopping are supposed to decide at a later point in time whether they will continue or discontinue to use VR shopping. Future research can, for example, measure users' expectations with respect to the initial use of VR shopping as well as assess the degree to what expectations are met and change after the initial use of the system. The expectation-confirmation model (Bhattacherjee and Anol, 2001) is an excellent starting point that can guide this investigation.

As the VR shopping market is in the very early stages, the time is right to also start research projects tracking the change of beliefs and attitudes (Bhattacherjee and Premkumar, 2004) towards VR shopping over time. For retailers planning to offer VR shopping, it is essential to understand the factors that drive the changes of beliefs and attitudes as it will help them to build realistic user expectations that can be met. The Virtual SATURN environment is a good example demonstrating that companies will be able to extend user experience beyond the capabilities of physical stores or e-commerce (Shankar et al., 2011). Not only might certain groups of customers find this new way of shopping more appealing, it might also enable customers to make decisions that better satisfy their needs if they are able to compare products in new ways. More generally, companies can use VR environments as test settings to evaluate new sensory cues (Berg and Vance, 2017), such as changes in the lighting, colors or music of the store without implementing such changes in their physical stores. Adapting the shopping environment to individual needs might thus be a way to further increase user acceptance and to foster the continued use.

# 6 Conclusion

We conducted two experimental studies in the context of VR shopping environments. The most important finding of the studies is that experiencing VR shopping versus only imagining the VR experience had a substantial impact on the evaluation of the VR shopping experience. In a basic shopping environment, perceived telepresence, enjoyment and ease of use were rated to be significantly more positive than when experienced. In a more complex environment, perceived telepresence, enjoyment and usefulness were rated to be significantly more positive than when experienced. Thus, besides telepresence, the hedonic aspects of shopping are evaluated to be significantly better when participants have experienced the shopping environment than when they had to imagine it based on a video. Our empirical results are therefore important for retailers who plan to build and develop VR shopping applications and suggest that the enjoyment of the shopping experience is an essential factor for building successful VR shopping environments. Thus, our paper makes two main contributions: First, our results show that experiencing the VR shopping environment is essential for users to be able to evaluate the respective technology. Our empirical findings thus put adoption research into question that investigates ISs based on "imagined" experiences. Second, across two very different shopping environments, participants evaluated the utilitarian and particularly the hedonic dimensions of VR shopping very positive which suggests that investments in building VR shopping environments could be profitable for retailers and customers.


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