Immersive Shopping
Presentation of Goods in Virtual Reality

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Abstract. Mixed Reality is gaining popularity in more and more areas. One of such application, which has gained recent interest, is the enhancement of shopping experiences by presenting virtual goods in a real or virtual surrounding. While product representation (e.g. quantity, placement, size, surrounding) in brick-and-mortar retail stores is naturally constrained, e-commerce is liberated. But instead of using those possibilities the best practice to represent products in the web is to show a single whole object on a white background. Contextual information is therefore removed and from the shown image alone it is unclear if the product is available, in what quantity, its size, or how valuable it is in comparison to other products. In retail stores, however, those incentives have a well understood influence on customer behavior and are used to actively steer the buying habit. But if those incentives can also have a positive effect in immersive virtual environment has, to the best of our knowledge, not been investigated.
Our results show that basic findings on the presentation of goods do not behave significantly differently in virtual in comparison to real environments. The virtual surrounding in which the product was presented had a significant impact on the product evaluation.

Keywords: Immersive Virtual Reality · Virtual Shopping · Customer Experience

1 Introduction

Although the beginnings of *virtual reality* (VR) glasses date back to the 1960s, it was only in the last few years that the technology could be made accessible to a broad mass of people. As a result of constant further development, VR is being used in more and more areas, the hardware of *head-mounted displays* (HMD) is improving and enthusiasm for and interest in this rather new end-user technology is growing. Virtual representations of goods are expected to gain relevance in e-commerce applications. But how to present goods with immersive technologies is not well understood. Can learnings from brick-and-mortar retail stores simply be transferred into the digital domain? Or should we follow standards

and guidelines from the mobile and web sectors regardless of the differences and characteristics to VR? Probably not! See for instance Speicher et al. [13]

It has been experimentally demonstrated that there is a difference between the perception of space in physical and virtual environments. Saleeb [10] showed that the perception of size lies in a perceived reduction of height by 4% to 9%, width by 9% to 31% and depth by 18% to 32%. These values apply to the static state. Through movement, the values decrease, so that the changed perception of space corresponds somewhat better to reality, but still shows differences. Experiments by Rojas et al. showed that rendered 3D objects with medium quality alter consumer perception in comparison to real objects. [9]

So how could immersive shopping look like in the future? Besides simply resembling well known shopping spaces, the question arises, if and how the liberation from physical constraints can be combined to good effect. To answer the raised question we first review how goods are presented in different environments (see Section 2) before we present our test setup where we change the position, quantity and size of the products on the one hand and the influence of different environments on the other (see Section 3). Thereafter we present our findings (see Section 4) and conclusion (see Section 5).

2 Presentation of Goods

In this section we present a brief overview on how products or goods are presented in different media. A full discussion of this topic is beyond the scope of this publication.

2.1 Store

The presentation of goods is seen as part of the shop design and includes the distribution, arrangement and decoration of the goods in the room. It influences the behavior of the customer and his/her emotional and cognitive processes. [4] Therefore, a lot of attention has been put into the investigation in how to distribute and arrange goods. In retail goods are presented in the four zones: stretch level, eye level, touch level and stoop level following particular rules for the vertical and horizontal arrangement; e.g. items that are promoted should be placed in the eye level, cheap items belong down and sensitive items are placed high. The eye level receives the most attention and everything above and below is not perceived to the same extent. A product in the eye level sells between 50% and 80% more frequently than a product in the stoop level. [5] In the horizontal positioning the center of a shelf achieves the most sales, followed by the right side of the shelf. The left side of the shelf forms the area with the weakest sales. [11] This can be explained by the fact that customers not only walk in the right direction, but also reach to the right. [15] Research has shown that customers think they have more choice when shelves are filled with few, but well presented, items. The sales could be increased by 10% despite a reduction of items by about 30%. [5]

2.2 Web

In recent years, online trading has been able to expand through platforms such as eBay or Amazon and is gaining more and more importance. Food is a significant part of the global retail market, but it is still not strongly represented in e-commerce. On websites food is presented using 2D images, text description and white background, which do not create a real shopping experience, see for instance left image in Figure 1. [4] Usually the product is also shown as a single product and presented by photographs and additional text descriptions. [6] The decision to buy food in a store is mainly influenced by the haptic experience. It is important for consumers to know the appearance of the goods and to be able to judge the quality derived from it themselves which, of course, is not possible with a digital sales channel. Only the sense of vision is able to check and assess product quality independently of product characteristics. Visual representations or text descriptions of the product on the web can partly compensate the lack of tactile information. [7]

Fig. 1. Typical representations of goods (left image) in a web store where the products are presented without background (with white space) and augmented-reality application (right image) where the real environment is augmented with virtual content.

Both text and visual product information may not be presented in a structured and organized way on the Internet. However, the arrangement of products and the placement of information about product characteristics are important in order to influence the behavior of users. As discussed in Section 2.1 relative shelf position is affecting consumer choices. Breugelmans et al. show that product placement can also have an effect on the consumer choices in the context of online grocery. [2]

Previous research by Alba et al. has shown that users can more easily capture and process information if it is clearly presented. [1] A plain background will bring focus to the product and allows the user to take a better look at it.

Details of the product can get lost with a contextual background. Efficient visual presentation helps the buyer to process the product information and gain a realistic understanding of the product. The challenge is to present products through images and text that all important information is given and a real product experience can be replaced. [6]

2.3 Augmented Reality

The use of *augmented reality* (AR) in retail is twofold: It can be either used

- to augment products at the point of sale or
- to present a product in any given environment such as home.

While the former is focused on the presentation of product-related information the latter shows the product itself in a given environment. A typical AR retail application is depicted in the right image in Figure 1. Spreer and Kallweit have revealed that AR has the potential to improve the assessment of information and that, to ensure the users' acceptance, it needs to offer a clear customer benefit and enjoyment-related elements. [14]

2.4 Virtual Reality

The use of VR department stores is not commonplace yet. This can be contributed to the availability of VR, the VR experience itself and the lack of VR shops. The world's first VR department store was 'opened' in collaboration with eBay and the Australian company Myer. With a smartphone and a customized version of the Google Cardboard, the user can enter the personalized department store and view 3D models of certain products from all possible perspectives in VR. Chinese e-commerce Alibaba also uses buy+ to show what a virtual shop can look like. [8] At the Taobaoer Maker Festival, users could buy a cardboard, insert their smartphone and walk through the virtual shop. The focus was on buying experiences from foreign shops that do not have a location in China. Unlike the VR department store from eBay and Myer, buy+ not only offers 3D models and 360° views of the products, but also a virtual environment of real shops. This should enable users to have a realistic and improved shopping experience. There was a lot of interest in the beginning, but no further updates and news were released, although nearly 8 million users tried buy+ during the Taobaoer Maker Festival. Possible reasons could be that the users had no added value because the virtual shopping experience was not very immersive due to the cardboard. Another reason could be that there wasn't much to see since only six retailers were available. [8]

3 Test Setup

As we have seen in Chapter 2 there exists different approaches between real and virtual shopping which come with different advantages and disadvantages.

While real and web-based commerce is well understood, immersive shopping is not. The aim of our study, therefore, is to figure out if customer behavior is influenced by the same parameters in an immersive virtual environment as in a physical environment. The test setup concentrated on four purchasing decision parameters (the first two are optimized in retail, the third investigates perceptual differences and the last one can probably profit the most from the possibilities of immersive virtual environments), namely:

- **placement**: Does product placement in VR has the same influence as the four shelf zones in brick-and-mortar retail?
- **quantity**: Is the scarcity effect transferable to VR even though it does not really make sense in e-commerce?
- **size compared to reality**: Are there any differences in the perception of size of a product between real and virtual? And how is the displayed size of a product influencing the buying decision?
- **environment**: How can the surrounding influence the perception of the product according to the attributes ecological, healthy, regional, sustainable, fair, valuable?

We decided to use two goods, a milk package as a representation of a daily commodity and a wine bottle as a luxury commodity, and to place them into five different environments as depicted in Figures 6 until 9.

The software for the study was developed by us using the game engine Unity and was particular designed to fit to the requirements of the test. The hardware setup consisted of a PC with i7 CPU and 1080i GPU running Windows 10, HTC Vive + Lighthouses and a Leap Motion mounted on the head mounted display.

3.1 Procedure

The entire experiment consists of a total of 16 different environments, of which 8 environments with the milk or wine variant are shown to the test person. Whether the subject sees the milk or wine variant is decided by chance. The test lasted 15 to 20 minutes and had the following structure:

1. participant enters the room and is welcomed and instructed by the test leader
2. participant fills in the demographic information
3. participant puts on VR glasses and adjusts them accordingly
4. the test leader starts the next randomly selected environment
5. participant has time to look around, interact in this environment and to fulfill the given task
6. questions about this environment are asked and entered into the form by the test leader
7. steps 4. until 6. are repeated until the last environment is tested
8. the experiment is finished and the participant can write comments or other suggestions into the form
9. the test leader thanks the participant and the subject leaves the room

3.2 Participants

The study included a total of 70 subjects (24 females, 46 male) at an age between 20 and 76 years. 51 participants have already experienced VR before the test. A total of 57% of participants shop online every month and 25.7% shop weekly. 70% of the participants have never bought food online.

4 Results

In this section we present the results from the experiments described in the previous section. If not stated otherwise the results are given as Likert scales from 1 (fully disagree) to 5 (fully agree). Figure 2 presents the three free variables placement, quantity and size while Figures 6 until 9 show the different tested environments. All differences considered relevant ($p<0.05$) according to ANOVA are marked with an asterisk *, those considered highly relevant ($p<0.005$) are marked with two asterisks **.

Fig. 2. A wine bottle in different places, in different quantities and in different sizes.

4.1 Placement

Based on the results in Figure 3 where the difference between the four shelf levels is presented, it can be stated that the participants have chosen the products nearly exclusively from the eye level (a much higher *buying interest*** as well as *grasping*** for the product). In comparison to the physical environment this effect seems to be even more pronounced in VR. Comparing, in Figure 3, the perceived *effort* ($p\approx0.49$) we see that there is not a large variation. A tendency to higher effort is in the stretch level, the least effort is located in the touch level.

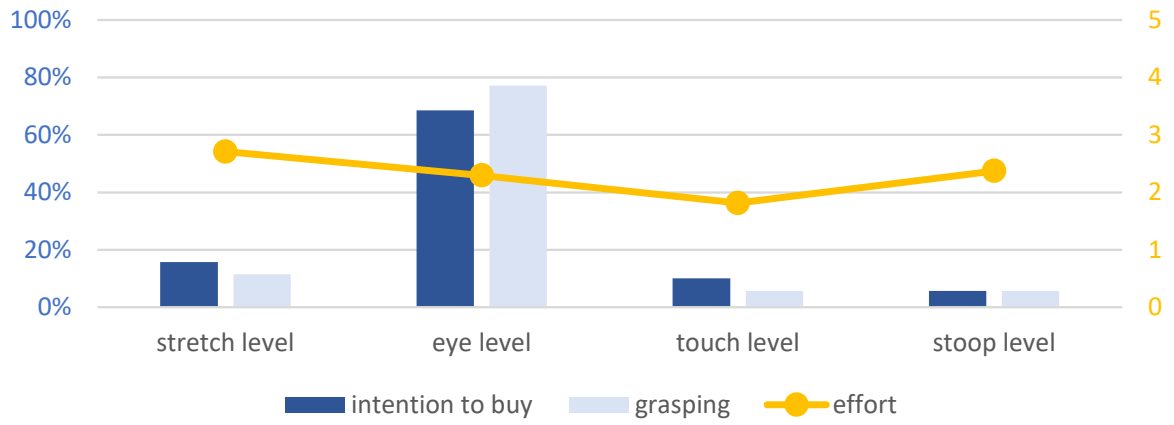

Fig. 3. Comparison of the intention to buy, grasping and the felt effort in relation to the four different levels.

4.2 Quantity

Artificial scarcity is part of an innovative brand strategy. This strategy means the artificial reduction of products, in order to increase the attractiveness for the customer and to positively influence the purchase decision to influence the shelf space. For instance, retailers only fill half of their shelves, to artificially illustrate the strong demand for certain products. Or they limit their product offerings in time to keep customers under pressure to buy the products already before expiration. Due to scarcity, the value of a product and its perceived quality can vary. [3]

The intention to buy and the felt value are shown in Figure 4. In contrast to online shopping where only a single product is shown in our experiments the *intention to buy** was higher if a couple or many products of the same type have been shown. The *value* ($p \approx 0.15$) attributed to a product is only slightly reduced if shown in a large quantity.

4.3 Relative Size

Figure 5 shows that the participants chose an object which was scaled by 10% as the best fit to the original or *real size**. This is consistent to the findings by Saleeb which, as already discussed in the introduction, has demonstrated that there is a perceived reduction in size which is being compensated in our experiments by deciding for a larger version of the original size. This choice towards larger than real size directly translated to the product with the highest *intention to buy**. It is interesting to note that the intention to buy was shifted even further to larger product sizes. This suggests that products should be presented in exaggerated sizes.

4.4 Surrounding

Figures 10 and 11 give the influence of the different surrounding, as given in Figures 6 until 9, on the perception of the two products, milk pack and wine

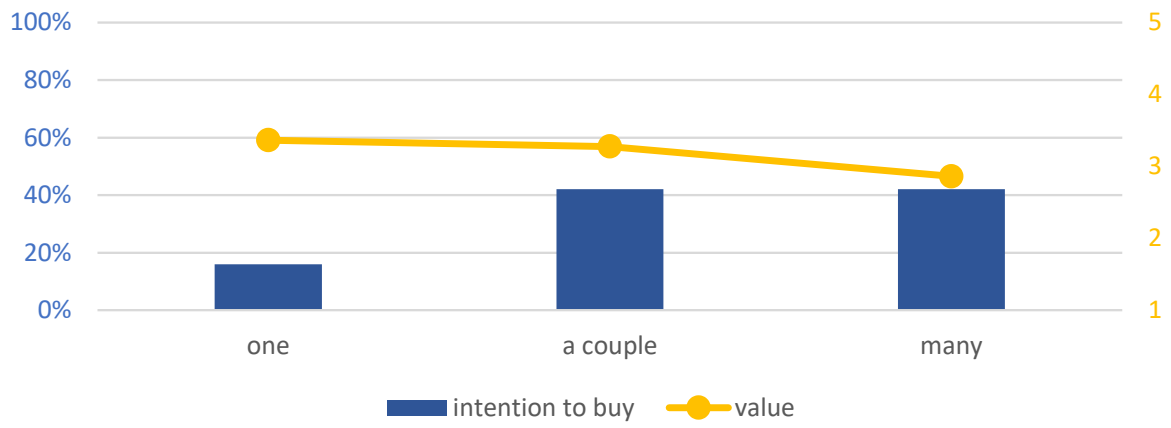

Fig. 4. Comparison of the intention to buy and the felt value in comparison to the presented amount.

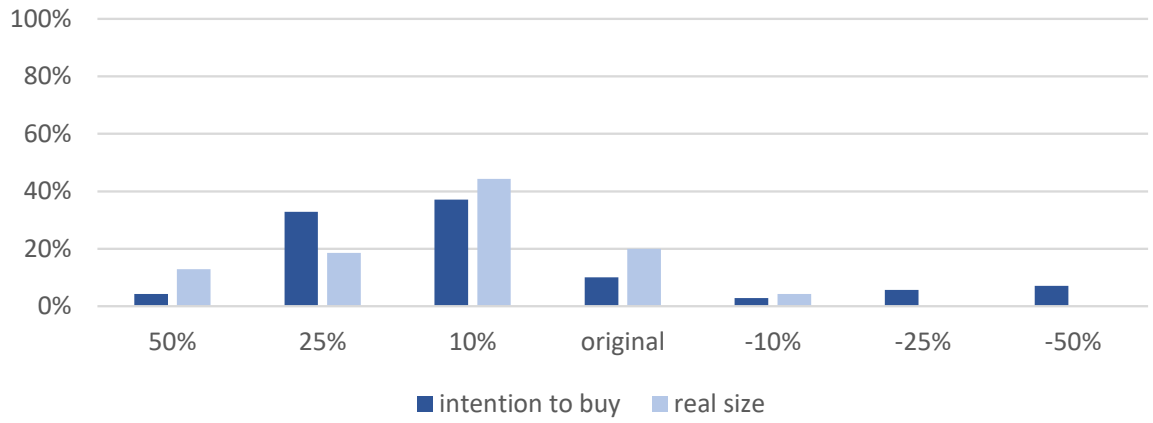

Fig. 5. Comparison of the intention to buy and the estimated size in comparison to various scales of the object.

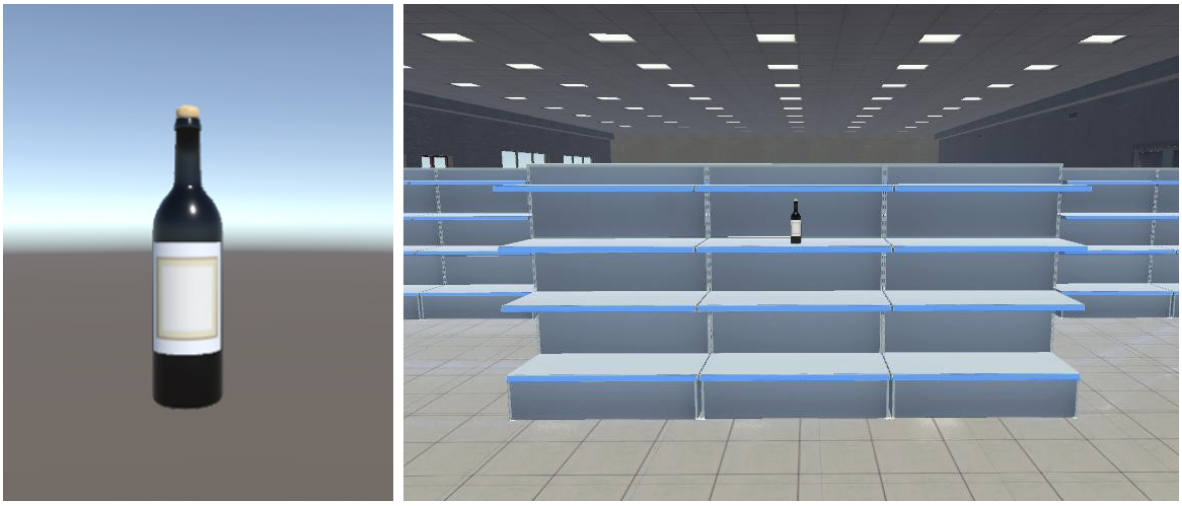

Fig. 6. A wine bottle in an empty and store environment.

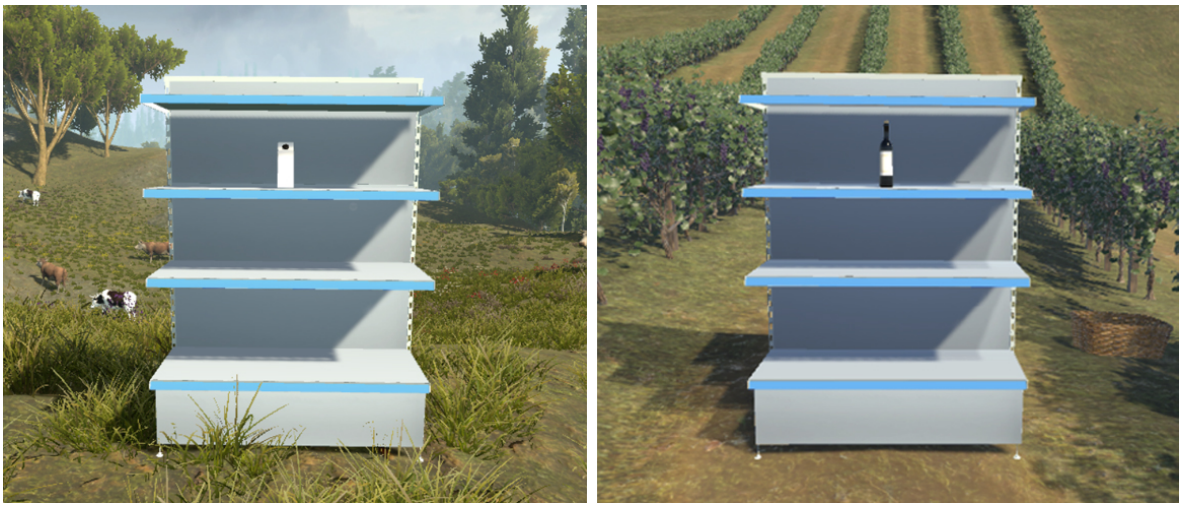

Fig. 7. A milk or a wine bottle standing in a shelf in accordingly adjusted environments.

Fig. 8. A milk or a wine bottle in accordingly adjusted environments.

Fig. 9. A milk or a wine bottle in environments which are not good matches.

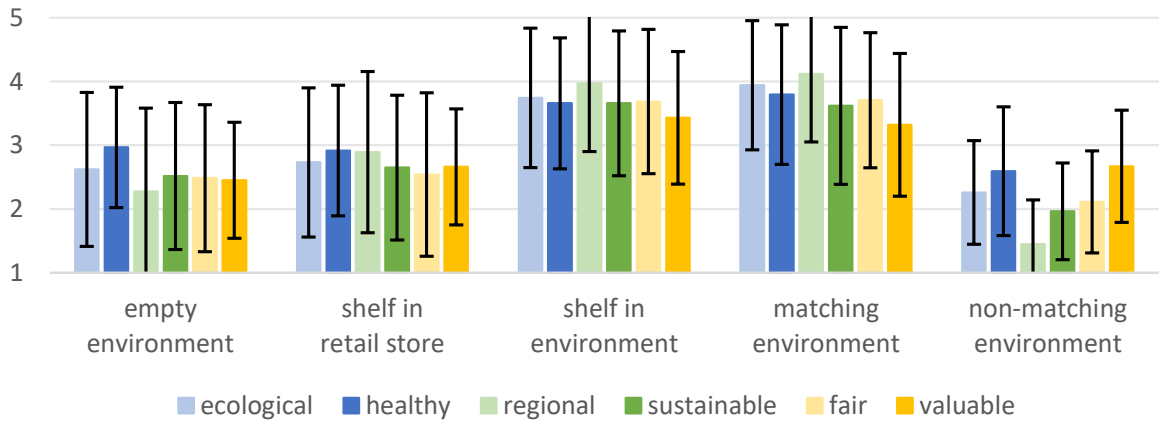

Fig. 10. Different attributes according to a *milk package* in different environments.

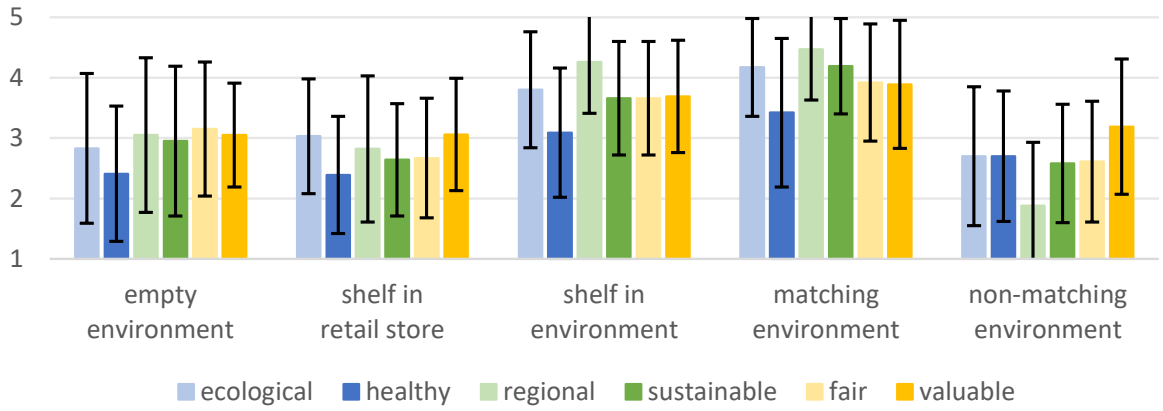

Fig. 11. Different attributes according to a *wine bottle* in different environments.

bottle, according to the attributes ecological, healthy, regional, sustainable, fair, valuable.

It can be observed that the surroundings have a similar effect on both products and a clear chronological order exists: the least average score over all attributes and products is the 'non-matching environment' (2,39), followed by 'empty environment' (2,73) and 'shelf in retail store' (2,75) which are rated equally, and last but not least the final group 'shelf in environment' (3,69) and 'matching environment' (3,88). It can, therefore, be concluded that an environment which fits to the presented product can promote the product. This is similar to the effect that more French wine is sold in a retail store if French chansons are played.

By comparing the individual attributes between the two presented products it becomes obvious that some preassumptions about the products are applied; e.g. wine is rated less healthy than milk while it is rated more valuable. Some attributes are influenced heavily according to the surrounding; e.g. ecological (max. difference between the environments 2,63) while others are more stable such as valuable (0,67).

Due to the relatively small sample size for sub-groups the results presented in this paragraph need to be verified in further research. We want to share our insights nevertheless because we think they might be at least helpful to show tendencies: The participants without VR experiences (n=19) felt more uncomfortable compared to participants with previous experience. The ones with VR experiences assessed the environments more realistically and rated the interactions as more natural than the test persons without experience. This is in line with results we have previously published. [12] If the test persons felt comfortable in the environment, they usually rated the characteristics of the products better and valued the price level higher. If the environment was evaluated realistic and visually appealing it also had a positive influence on the evaluation of the products regarding their characteristics. If the user did not feel as part of the virtual environment, the product characteristics tended to be rated worse. This confirms that the presence can have a positive as well as a negative influence on the product rating.

5 Conclusion and Outlook

We have investigated the presentation of goods in virtual reality. We found that the assigned values to the different shelf zones can be taken over to immersive shopping environments. Products should not be presented individually as is common today on web-pages, but rather should be presented in a group that is not too large and not too small. The shifted perception of size, independent of the product, should be particularly taken into account in order to be able to guarantee the customer a realistic image of the product.

On the web customers receive only 2D content, while in a virtual environment they can view the products 3D from all perspectives and thus get a better impression of the size and shape of the respective product. The quality of the food can be better derived from a realistic visualization of the products and their characteristics than from images or text.

Immersive virtual retail has the potential to overcome some of the drawbacks associated with e-commerce or brick-and-mortar retail stores. It offers shopping experiences which can go far beyond known path in particularly if one is not relying on common shop layouts which are usually restricted in many ways: space, expenses, number of visitors, physical laws, etc.

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