

Received April 28, 2022, accepted May 23, 2022, date of publication May 27, 2022, date of current version June 8, 2022.

Digital Object Identifier 10.1109/ACCESS.2022.3178371

# Using Virtual Reality to Demonstrate and Promote Products: The Effect of Gender, Product Contextualization and Presence on Purchase Intention and User Satisfaction

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This work is financed by National Funds through the Portuguese funding agency, FCT—Fundação para a Ciência e a Tecnologia, within project LA/P/0063/2020.

**ABSTRACT** Virtual Reality (VR) and its capability to replace real stimuli for synthesized ones as if they were real opened several research lines over the years. Many of those consist of trying to validate whether or not VR replicates the same user behaviours seen in reality. In this study, we investigated whether or not product contextualization and gender could influence users' intention to purchase as well as their satisfaction with the application and how presence levels correlate with purchase intention and user satisfaction. The product tested was a double door refrigerator with a touchscreen. We considered two independent variables: Contextualization (Context - The refrigerator was displayed in a kitchen and filled with food products and Neutral - The refrigerator was empty and displayed in an empty room) and gender (male and female). The results indicated that contextualization and gender had no effective impact on purchase intention, user satisfaction with the VR experience nor the sense of presence. A positive correlation was found between presence and user satisfaction. Evidence indicates that it is not necessary to represent products in their context, saving computational power and human resources.

**INDEX TERMS** Virtual reality, immersive, context, gender, user perception, purchase intention, product evaluation.

## I. INTRODUCTION

Product Contextualization is a widely used concept in commerce. It is defined as the placement of a focal product and other complementary products in a scenario that replicates a situation where the user would use the same product. Product Contextualization can be further divided into three factors [1], [2]: Functional - products that can be consumed together with the focal product. For example, a user buying popcorn at the cinema is also likely to buy a beverage, or a user buying a new phone is also likely to buy a phone cover. These complementary products have a close relationship with

The associate editor coordinating the review of this manuscript and approving it for publication was Charalambos Poulis<sup>1</sup>.

the focal product that can lead to a simultaneous purchase. Aesthetic - complementary products that create a pleasant aesthetic relationship with the focal product. For example, a classic car is fitted with classic rims or a piece of old furniture placed in an old house. Sociocultural - complementary products that have no direct relationship with the focal product employing activities or usage but instead are related through sociocultural processes of association. For example, associating a beer with being together with friends or associating a candle with a romantic dinner. It is important to investigate product contextualization because users usually prefer to examine products within the context [3] while also being able to influence the consumer's attitude towards the product [2].

### A. VIRTUAL REALITY

Virtual Reality (VR) is defined by Fuchs *et al.* [4] as: “a scientific and technical domain that uses computer science and behavioural interfaces to simulate in a virtual world the behaviour of 3D entities, which interact in real-time with each other and with one or more users in pseudo-natural Immersion via sensorimotor channels.” VR offers an immersive experience by completely isolating the user from real-world stimuli and replacing it with a totally rendered virtual environment [5]. VR brought us a wide range of research and development possibilities by allowing us to experience a virtual world as if it was real. Today, immersive VR is present in almost any mobile device, such as smartphones, laptops, desktop computers, or stand-alone VR headsets such as the Oculus Quest. Ultimately immersive VR started to be used in many fields, such as entertainment, video games, education [6], [7], medical [8], [9], marketing [10], rescuers [11], among others. Collaboration in real-time or asynchronous further adds to more efficient use of the available time and funds by having multiple users interacting in a virtual environment, each one using different platforms and being in different places [12], [13]. On top of these points, it also adds layers of safety in many fields as it allows experiences to be run where users can train or simulate several scenarios without endangering themselves or others. [14], [15]. In e-commerce, for example, the possibility of previewing a product in immersive VR can not only reduce time constraints by doing so from any place while not having to travel to a physical store with that product on display as well as costs by not having users returning items because online descriptions did not fully inform them.

Delarue *et al.* [16] in their book entitled “Context,” discussed the potential of VR in contextualized product testing and its limitations: (1) requires developers with specific artistic and computer skills which usually prefer to work in entertainment fields rather than in consumer research and (2) realism in VR remains unnatural. Indeed, we agree that developing immersive VR requires a certain skill set. However, game engines are starting to become more and more user-friendly, and their integration with VR is straightforward. Combined with the evolution of technology and research in computing graphics and related fields, achieving higher levels of realism in immersive VR is becoming easier each day, helped by the substantial widespread of VR.

In e-commerce, product contextualization is widely used as 3D simulations offer a large variety of ways that a focal product can be visualized together with other complementary products, ultimately being used in several product advertisements. Examples such IKEA app allowing the users to visualize beforehand their products within the context of the users’ homes [17], or applications that allow the user to check how clothes would fit them using augmented reality (AR) [18], [19]. However, when compared to other media, VR is the one that is more likely to have the most impact due to its ability to replicate multisensory stimuli in product experiences, broader capability for interaction in several

stages of product development and usage, the contextualization of product experiences and all the social components through virtual avatars/telepresence [20]–[22].

Presenting products within the context in immersive VR setups could further reduce possible item returns (a process that involves costs by the retailer and sometimes the buyer [23]) by giving potential buyers the ability to test the product in its context and become better informed about if it meets their needs [24], [25], and ultimately increase trust.

### B. IMMERSION AND PRESENCE

When talking about virtual environments, we also need to refer to the level of immersion and the sense of Presence. Immersion (sometimes confused with Presence) refers to the technical capability of isolating the user from the real physical reality while displaying a rendered visual or other stimuli [26]. Higher levels of immersion facilitate higher levels of Presence. Previous research indicates that the more the virtual experience’s immersiveness, the more they evoke physiological and subjective responses similar to those evoked by the analogous experience in real life.

The sense of Presence has been used throughout the literature as a metric to evaluate the virtual environment. Several authors give multiple similar definitions, however, in this work, we use the Slater and Wilbur [26] definition of “a state of consciousness, the (psychological) sense of being in the virtual environment.” This sense of Presence is likely to occur when stimuli from the real world are substituted by virtual sensory stimuli, which can result in users behaving similarly to the virtual experience events as they would if it is a real situation [21]. This sense of Presence seems to be related to the concept of flow from Csikszentmihalyi [27]. This flow concept is described as a highly focused mental state in the task, leading to time loss and awareness of surroundings. Wedel *et al.* [20] discussed the relation between Hoffman & Novak [28] conceptual framework for digital consumer environments (where attention is considered an important antecedent of flow) and the sense of Presence. Their framework considers two types of flow: Goal-oriented (extrinsically motivated) and experiential flow (intrinsically motivated). The latter is thought to improve memory and task performance while reducing the perception of consciousness and notion of time. Transference (knowledge gathered inside VR experiences is translated to real-world experiences) happens when task performance and the associated cognitive and emotional states correspond to those found in the real world. Therefore, higher levels of Presence indicate higher effectiveness of the VR experience [29], [30].

### C. GENDER DIFFERENCES

Previous studies indicate that gender differences are still poorly understood in e-commerce [31]. In a study conducted by Wolin *et al.* [32], concluded that females have less positive attitudes toward online shopping. There is also a difference in how both genders perceive security while shopping online [33]. Another example is from

**TABLE 1.** List of hypothesis (*H*) being tested.

<i>H</i>	Description
<i>H1</i>	Contextualization will impact Purchase Intention.
<i>H2</i>	Contextualization will impact User Satisfaction.
<i>H3</i>	Gender will impact Purchase Intention.
<i>H4</i>	Gender will impact User Satisfaction.
<i>H5</i>	Purchase Intention is correlated with Presence.
<i>H6</i>	Purchase Intention is correlated with User Satisfaction.
<i>H7</i>	Presence is correlated with User Satisfaction.

Pascual-Miguel *et al.* [34] that used the extended unified theory of acceptance and use of technology (UTAUT2) [35] to integrate two variables: perceived risk and trust. Results indicated that gender affected the relationships between effort expectancy (the extent the technology is perceived to be easy to use) and purchase intention and between social influence (the extent to which the technology is valued in the social network relevant to the user) and purchase intention. Product type also affected the relationship between perceived risk and purchase intention, digital goods, where women were the most influenced.

The Selectivity Hypothesis can further help explain gender differences as it explains how both genders process information differently [36]. Shortly, it describes how men and women evaluate a product using different amounts of information and different product information. Men have higher elaboration thresholds, meaning they are likely to purchase without analysing all the available information. In contrast, women will analyse the information in more depth before making a purchase [36].

There is no consensus on whether gender affects Presence or not, as different studies present opposing results [37], [38]. For example, Felnhofer *et al.* [39] conducted a study where participants had a presentation in front of a virtual audience and verified a tendency for higher spatial Presence, experienced realism and overall Presence scores in males. Another study performed by Melo *et al.* [40] arrived at another conclusion where female participants reported higher experienced realism scores than males.

#### D. HYPOTHESIS

Literature states that product contextualization plays an important role in marketing and that immersive VR experiences bring novel ways for this contextualization to happen efficiently, through higher levels of Presence and from where transference can occur. Similarly to what is reported in studies conducted in the real world, we hypothesize that (*H1*) contextualization will influence Purchase Intention and User Satisfaction (*H2*).

Literature also indicates differences between genders and how each one processes information differently. Therefore, the same hypothesis mentioned before was also tested comparing female with male genders (*H3* and *H4*).

We also hypothesized that Purchase Intention was correlated with Presence (*H5*) and User Satisfaction (*H6*), due to Presence being a variable connected to digital consumer environment [20], with potential to improve the effectiveness of the VR experience [29], [30]. Because Presence also seems to be linked to the state of Flow [27] (which describes an activity so enjoyable that users become so deeply focused on what they are doing that they lose awareness of time and their surroundings), we also hypothesized that Presence would be correlated to User Satisfaction (*H7*).

To the best of our knowledge, no other work explored these aspects in immersive VR. Therefore, to address the proposed hypothesis, we considered a refrigerator with an interactive digital screen as the product and a kitchen in a house apartment as the exterior context environment and the same house apartment but without any furniture as the neutral exterior context environment. Likewise, products such as milk, wine and water bottles, yoghurts, frozen meat and fish were included inside the refrigerator in the contextualized condition and an empty refrigerator in the neutral contextualized condition. These data will help create a body of knowledge resulting in better strategies for online shoppers, benefiting both researchers and practitioners in the field. Table 1 displays all the hypotheses being tested.

## II. METHODOLOGY

This study consisted of an experimental cross-sectional study of comparative character using a within-group design.

### A. SAMPLE

The sampling technique was based on a non-probabilistic method. It consisted of 38 volunteers (21 male and 17 female) aged between 28 and 18 years ( $M = 31.370$ ,  $Std.Dev = 2.541$ ). The majority of participants were university students (86.800%). The remaining were workers (13.200%), and one was a worker student. The largest percentage of them have had previous experiences with VR technologies (57.900%). A large part of the participants reported having never purchased a refrigerator (the product being tested in this study) (73.700%). No sample mortality was verified; thus, every participant who initiated the study finished it.

### B. VARIABLES

The considered dependent and independent variables are displayed in Table 2. The dependent variables are Purchase Intention, User Satisfaction and Presence. There are two independent variables with two levels: Contextualization (Context and Neutral Context) and Gender (Male and Female).

### C. INSTRUMENTS

Purchase Intention was based on a question from Spangenberg *et al.* [41] rated on a 7-point Likert scale from very unlikely to very likely: "If you were going to purchase a refrigerator/this type of product, how likely would you be to purchase this particular product." Presence was evaluated using the translated and validated version of the

**TABLE 2.** Description of the dependent and independent variables considered in this study and their sub-scales.

Dependent Variables	Description	Sub-Scales
Purchase Intention	The extent to which the user is willing to purchase the product.	None
User Satisfaction	Measure the satisfaction of users with the virtual experience.	None
Presence	Measures the sense of Presence, the feeling of 'being there'	Spatial Presence, Involvement, Experienced Realism, Overall Presence
Independent Variables	Description	Levels
Contextualization	Defines if refrigerator are presented within the context of a kitchen and filled with food products or in a empty white room and refrigerator.	Context and Neutral
Gender	The biological gender of participants.	Male and Female

Igroup Presence Questionnaire (IPQp) [42]. It consists of 14 questions using a 5-point Likert scale. Subscales included are Presence (overall sense of Presence), Spatial Presence (sense of being physically present in the VE), involvement (attention given to the VE), and experienced realism (subjective experience of realism in the VE).

To evaluate the User Satisfaction with the virtual experience and the product, we based some questions (all measured on a 5-point Likert scale) in the after scenario questionnaire (ASQ) [43] while adding the following ones: "I enjoyed the experience I just had," "The experience demotivated me" and "I felt discomfort during the experience." The final score consisted of the mean score for each question.

#### D. MATERIALS

To run the virtual experience, we used a computer running Windows 10 equipped with an Intel Core i7-8700K processor, 32 GB RAM, and an NVIDIA GeForce RTX 2080ti graphics card. The VR headset used was an HTC Vive Pro equipped with a wireless module and two HTC Vive controllers for interaction with a resolution of  $1440 \times 1600@90\text{hz}$  per eye.

The VR application was built using the Unity 2022 high-definition render pipeline. The product tested was a double door refrigerator with a freezer (Fig. 1 and 2), an ice and water dispenser, and an interactive touchscreen (Fig. 3). The touchscreen interaction capabilities were: see and change freezer and refrigerator temperatures, see and change current date and time, change open doors alarm settings, change between water and ice dispenser mode, and lock and unlock the touchscreen. Participants could walk in an area of  $4\text{m} \times 4\text{m}$  physically.

For the Context condition, the refrigerator was presented in a kitchen, with several contextual appliances and furniture. The refrigerator had various food items, such as milk or wine, in standard sizes that can serve as a size reference for participants. The neutral condition consisted of the same room but without any textures (white room), furniture, and other objects. Because there was an instruction manual and a cup used in the interaction with the refrigerator, a pedestal



**FIGURE 1.** Top: Neutral Context condition. Bottom: Within Context condition.

was added at the left of the refrigerator where this object rested.

#### E. PROCEDURES

Participants started by signing a consent form followed by sociodemographic questionnaire and were informed that the data collected was anonymous and that they could withdraw from the study at any time. Next, they were informed how the controllers worked before a researcher helped them equip the VR headset. Participants were divided into two groups: Contextualized and Neutral. In both conditions, participants were balanced by gender. Participants in the Contextualized condition were placed in the virtual kitchen facing the refrigerator. Firstly, they were told to inspect the exterior of the refrigerator. Then they were instructed to open its doors and check the insides by opening and closing drawers. Then they



**FIGURE 2.** Left: Refrigerator filled with contextual products in Context condition. Right: Empty refrigerator in Neutral Context condition.



**FIGURE 3.** The touch screen UI of the refrigerator.

opened the freezer drawer and looked inside. Then they were instructed to close all the drawers and doors. By the left side of the refrigerator, there was an instructions manual on how to operate the touchscreen, which they could consult at any time. Participants were then told to do the following task on the touchscreen: (1) change the temperature of the refrigerator to 3°C, (2) change the temperature of the freezer to its minimum, (3) change the time and date to the present date (given by the researcher), (4) set open door alarm to 1m30s, (5) deactivate the alarm, (6) lock the touchscreen, (7) unlock the touchscreen, and lastly (8) change dispenser to ice mode and finally grab a cup near the manual to dispense some ice cubes and put it back in the same place.

After a researcher helped remove the equipment, participants filled the rest of the questionnaires.

#### F. STATISTICAL PROCEDURES

For one-way ANOVAs, we verified the existence of outliers through boxplots. Data normality distribution was verified through the Shapiro-Wilk test. Homogeneity of variances was assessed by Levene's test of homogeneity of variances. If not met, a Welch ANOVA was instead performed. In cases where normal data distribution is not reached and sample sizes are equal between groups (which was the case for the Neutral and Context conditions), we proceed with the one-way ANOVA. Literature shows that non-normality does not affect Type I

error rate substantially in one-way ANOVAs, mainly when sample sizes are equal [44].

For Kruskal-Wallis H, the distributions of scores were assessed by visual inspection of boxplots. If similar, judgements about medians' differences would be made; if not, then judgements based on differences in mean ranks would be made.

A Person Correlation test was performed to find correlations between variables. Linearity assumptions and outliers were verified through visual inspection of scatter plots. Data normality was assessed through the Shapiro-Wilk test. If assumptions for Person Correlation were not met, then a Spearman Correlation test was instead run. The assumption of a monotonic relationship was verified by visual inspection of scatter plots.

### III. RESULTS

All data regarding means, standard deviations, medians, mean ranks and level of significance for each dependent variable between Neutral and Context conditions, Female and Male genders, users experiencing VR for the first time and users with past experience with VR can be found in Tables 3, 4, and 1. The means for dependent variables between conditions and gender can be visualised in Fig. 4.

#### A. PURCHASE INTENTION

A one-way ANOVA was performed to verify if the context a product is presented has influence over the user's Purchase Intention. No outliers were found. Data were not normally distributed for both conditions. There was homogeneity of variances. Results indicated no statistically significant differences in Purchase Intention between Neutral and Context conditions ( $F(1, 36) = 0.733, p = 0.398, \eta_p^2 = 0.020$ ). Another one-way ANOVA was done to investigate if gender had an impact on Purchase Intention. There were no outliers. Data were not normally distributed for both genders. A Kruskal-Wallis H test was instead performed. Distributions were not similar between conditions. Purchase Intention mean ranks were not statistically different between genders ( $\chi^2(1) = 2.614, p = 0.106, d = 0.374$ ).

#### B. USER SATISFACTION

A one-way ANOVA was conducted to determine differences in User Satisfaction scores between Neutral and Context conditions. No outliers were found, and data was not normally distributed for both conditions. There was homogeneity of variances. Usability scores were not significantly different ( $F(1, 36) = 0.104, p = 0.749, \eta_p^2 = 0.003$ ) between Neutral and Context conditions.

Due to no statistical differences between conditions, we considered all the female samples vs the male sample to identify possible differences in User Satisfaction between genders. No outliers were found, but data was only normally distributed for the female sample. Because samples are not equal, we performed a Kruskal-Wallis H test instead. Distributions of user Satisfaction scores were not similar for

**TABLE 3. Descriptive statistics of all dependent variables and sub-scales between Context (n = 19) and Neutral (n = 19) conditions and significance level (eta partial square for ANOVAs and Cohen’s D for Kruskal-Wallis).**

Dependent Variables	Mean		Std.Dev		Median		Mean Ranks		Sig.	Eff. Size
	Neut.	Cont.	Neut.	Cont.	Neut.	Cont.	Neut.	Cont.		
Purchase Intention	5.680	5.370	1.003	1.257	6.000	6.000	20.550	18.450	0.398	$\eta_p^2 = 0.020$
User Satisfaction	6.510	6.447	0.625	0.544	6.667	6.667	20.420	18.580	0.749	$\eta_p^2 = 0.003$
Spatial Presence	4.254	4.178	0.409	0.696	4.170	4.330	19.000	20.000	0.386	$\eta_p^2 = 0.005$
Involvement	3.290	3.658	0.787	0.596	3.500	3.500	16.760	22.240	0.804	$\eta_p^2 = 0.068$
Experience Realism	3.368	3.276	0.704	0.849	3.500	3.250	20.340	18.660	0.344	$\eta_p^2 = 0.004$
Overall Presence	3.637	3.775	0.450	0.510	3.640	3.810	18.03	20.970	0.597	$\eta_p^2 = 0.021$

**TABLE 4. Descriptive statistics of all dependent variables and sub-scales between Male (n = 21) and Female (n = 17) groups Context conditions and significance level (eta partial square for ANOVAs and Cohen’s D for Kruskal-Wallis).**

Dependent Variables	Mean		Std.Dev		Median		Mean Ranks		Sig.	Effect Size
	Male	Female	Male	Female	Male	Female	Male	Female		
Purchase Intention	5.330	5.760	0.913	1.348	5.000	6.000	16.980	22.620	0.106	$d = 0.374$
User Satisfaction	6.580	6.353	0.616	0.520	6.833	6.500	22.190	16.180	0.091	$d = 0.398$
Spatial Presence	4.289	4.127	0.392	0.728	4.330	4.170	20.210	18.620	0.683	$\eta_p^2 = 0.021$
Involvement	3.500	3.441	0.576	0.873	3.500	3.500	19.600	19.380	0.113	$\eta_p^2 = 0.002$
Experience Realism	3.214	3.456	0.686	0.867	3.500	3.500	18.050	21.290	0.718	$\eta_p^2 = 0.025$
Overall Presence	3.668	3.753	0.424	0.550	3.640	3.780	18.290	21.000	0.383	$\eta_p^2 = 0.008$

both groups, as assessed by visual inspection of a boxplot. The distributions of scores were not statistically significantly different between genders,  $\chi^2(1) = 2.859, p = 0.091, d = 0.398$ .

**C. PRESENCE**

A one-way ANOVA was performed to verify if context influenced the sense of Presence scales (Spatial Presence, Involvement, Experience Realism and Overall Presence). No outliers were detected. Data was normally distributed for each scale and condition. There was homogeneity of variances for all scales. Results indicated that context had no effect on Spatial Presence ( $F(1, 36) = 0.770, p = 0.386, \eta_p^2 = 0.005$ ), Involvement ( $F(1, 36) = 0.062, p = 0.804, \eta_p^2 = 0.068$ ), Experience Realism ( $F(1, 36) = 0.921, p = 0.344, \eta_p^2 = 0.004$ ), nor overall Presence ( $F(1, 36) = 0.284, p = 0.597, \eta_p^2 = 0.021$ ). As for the gender differences, no outliers were found for any scale between genders and data was not normally distributed only for the Spatial Presence scale in the female group. The homogeneity of variances assumption was met for all scales. Results show that gender had no effect on Spatial Presence ( $F(1, 36) = 0.170, p = 0.683, \eta_p^2 = 0.021$ ), Involvement ( $F(1, 36) = 2.644, p = 0.113, \eta_p^2 = 0.002$ ), Experience Realism ( $F(1, 36) = 0.132, p = 0.718, \eta_p^2 = 0.025$ ), nor overall Presence ( $F(1, 36) = 0.781, p = 0.383, \eta_p^2 = 0.008$ ).

**D. CORRELATIONS**

**1) PURCHASE INTENTION–PRESENCE**

A Pearson Correlation test was performed to investigate correlations between Purchase intention and the scores of

Satisfaction and Presence subscales. No outliers were found, the assumption of linearity was met, but not all variables were normally distributed. Spearman’s correlation was instead run. The monotonic relationship assumption was met. There was no statistically significant correlation between Spatial Presence ( $r_s(36) = 0.072, p = 0.667$ ), Involvement ( $r_s(36) = 0.042, p = 0.803$ ), Experienced Realism ( $r_s(36) = 0.188, p = 0.259$ ), overall Presence ( $r_s(36) = 0.220, p = 0.184$ ), and Purchase Intention.

**2) PURCHASE INTENTION–USER SATISFACTION**

The Pearson Correlation test was considered to verify correlations between Purchase Intention and User Satisfaction. One outlier was found, the assumption of linearity was not violated, but both variables were not normally distributed. Spearman’s correlation was instead performed. No statistically significant correlation between Purchase Intention and User Satisfaction was found ( $r_s(36) = 0.118, p = 0.481$ ).

**3) USER SATISFACTION–PRESENCE**

Another Pearson Correlation test was conducted to verify correlations between User Satisfaction and the scores of Presence subscales. One outlier was found (between overall Presence and User Satisfaction), the assumption of linearity was met, but not all variables were normally distributed. Spearman’s correlation was instead considered. The monotonic relationship assumption was met. A significant positive correlation between Spatial Presence and User Satisfaction was found ( $r_s(36) = 0.374, p = 0.021$ ). There was no statistically significant correlation between Involvement ( $r_s(36) = 0.040, p = 0.814$ ), Experienced Realism

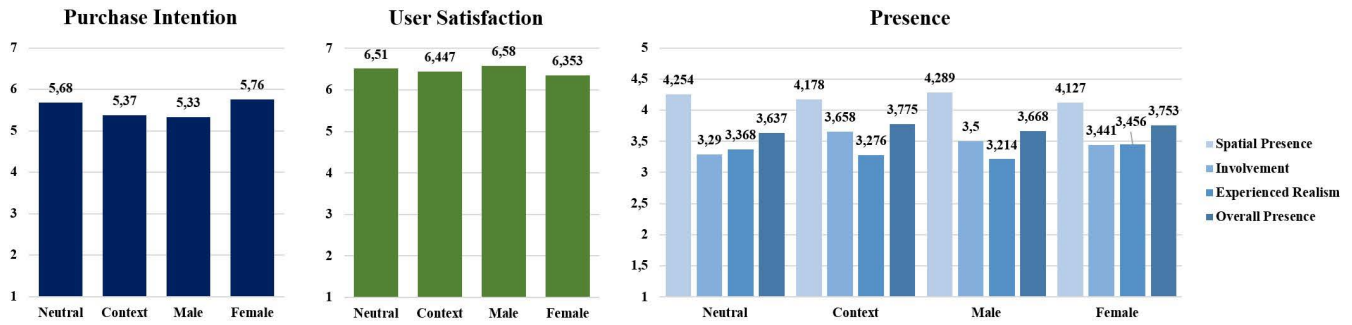


FIGURE 4. Mean values for each dependent variables between Neutral and Context conditions and Male and Female genders.

( $r_s(36) = 0.320, p = 0.050$ ), overall Presence ( $r_s(36) = 0.296, p = 0.071$ ), and User Satisfaction.

IV. DISCUSSION

This discussion is divided into three subsections, one for each dependent variable discussing results from the comparative study between independent variables and another subsection for discussion of correlations between dependent variables. Results are synthesized in Table 5.

A. PURCHASE INTENTION

State of the art indicated that Purchase Intention should increase when displaying a product in an environment the buyers would use. In this study, the refrigerator was presented to the users in the context of a kitchen vs in a neutral white empty room. In the context condition, the refrigerator was also filled with food products, just like it was meant to be used, instead of being empty, like what buyers are faced with seeing the product displayed in a physical store. We hypothesized in *H1* that this external and internal context would result in a higher Purchase Intention due to the user’s preference to examine products within the context [3]. However, significant differences were not found.

A possible reason for such results could be because participants might not be looking to buy a refrigerator; therefore, they did not pay the necessary attention to the details to make a proper decision. In addition, participants knew this was a study and that they would not be able to buy the refrigerator in question even if they were looking to buy one. Such could have led participants to overlook aspects that they otherwise would be paying attention to if it was an actual purchase possibility.

Another possible reason could be that even though the refrigerator was depicted in a kitchen, they just did not imagine it being in their kitchen. So, in other words, although it was contextualized, it was not presented in their specific context, their specific homes, where they would effectively use it.

Maybe if it was a new product with functionalities that users were unsure how to impact their lives, then seeing it in a contextualized environment could help them better

TABLE 5. Results for each hypothesis. R = Rejected, A = Accepted.

H1	H2	H3	H4	H5	H6	H7
R	R	R	R	R	R	A

understand it. Thus, contextualization could have had a statistical effect.

The VR application tested could be used for online shopping, where users, instead of seeing pictures, videos and instruction manuals, users could use a VR headset and try the product first-hand. Previous studies indicate that there is an underlying difference between genders in e-commerce that is being studied today [31]. There is also evidence that men and women differ in what information they must acknowledge before choosing to purchase [36]. Thus, we hypothesized that gender would have an effect on Purchase Intention *H2*, which was not verified and thus, the hypothesis was rejected. We speculate that participants knew the experience was not a real e-commerce situation where they could actually purchase the equipment in addition to their unwillingness to look and buy such a product at that time could have led them to ignore what they would otherwise be looking for when buying a refrigerator (ultimately emphasizing the differences between genders).

B. USER SATISFACTION

On *H2* we hypothesized that the Contextualization of the product would influence User Satisfaction. This hypothesis was rejected due to the results of this study. Although the environment was visually different, with the Neutral context stripped of every element (except the product itself) that could paint a mental picture of a kitchen, the main focus was still the same (task and refrigerator). We speculate that if participants were engaged in tasks using the whole environment, differences between Context and Neutral Context could surge. These results show evidence that contextualization should not interfere with User Satisfaction as long as the focus is on the product being tested.

In its turn, *H4* was also rejected as there were no differences between Genders. We speculated that Selectivity Hypothesis could support how genders process information differently while evaluating a product for purchase and thus engage each

gender distinctively. The same justification for the lack of differences in Purchase Intention between genders could also explain this result. Because participants were aware this was a laboratory experiment and that the displayed refrigerator could not actually be purchased at the end of the experiment, participants might not have been looking to buy such a product at the time of the experiment could have influenced the results.

### C. PRESENCE

The sense of presence is suggested to highly influence the user's experience in ways still being studied by researchers. It is an important metric as the literature indicates that the higher the sense of presence, the most likely it is for users to behave similarly in a virtual environment as they would in analogous situations in the real world. Its relation to a conceptual framework for the digital consumer environment [20], [28] leads us to evaluate and therefore keep track of the sense of presence of each participant to evaluate if differences between conditions could have impacted the results. The results indicated that between conditions and gender, sense of presence and all its sub-scales did not differ. A possible justification for the lack of differences between Contexts could be that, even though the environment had a higher visual complexity, coherent with what reality would look like in normal use of the product, both the neutral and contextualized display of the product made sense and was possible to happen in the real world. The fact that rendering quality between context conditions was the same and the VR equipment that isolates the user from the real world stimuli (level of immersion) and the tasks could have mitigated possible differences in the sense of presence. Literature shows different results regarding whether gender impacts presence and whether male or female users tend to have higher presence scores. The conditions of this experiment resulted in no significant differences between gender and, thus, further studies will be required to understand which factors might have contributed to this result.

### D. CORRELATIONS

Presence seems to be linked to Csikszentmihalyi [27] theory of flow. Therefore, a higher sense of presence should result in a higher focus in the task at hand and loss of time and awareness of surroundings, which would help knowledge transfer. Users should then become more aware of the product characteristics and functions, which could help to improve Purchase Intention. Presence would therefore help to dictate how effective the VR experience was [29], [30]. We hypothesised in *H5* that Purchase Intention should be correlated with Presence, a hypothesis that was rejected following the results found. The objective of the VR application is to inform users of the characteristics of a product by having a hand-on experience with it so they can then take a informed decision whether to buy it or not. Presence could, therefore, lead to better awareness of the product. However, it is not guaranteed it would be accompanied by higher Purchase Intention as this would imply that users getting to know a product better meant

they would like it more and find the will to purchase it, which might not be the case.

Similarly, on *H6* we hypothesised that Purchase Intention and User Satisfaction would also be correlated. However, this hypothesis was also rejected as no evidence of correlation was found. The same reasoning for the *H5* could be applied to *H6* result. Even though a user might present a higher level of satisfaction with the VR application, the same does not imply a higher Purchase Intention as users could dislike the product they experienced but still enjoy the VR experience itself.

As already discussed, literature shows evidence that Presence is related to Csikszentmihalyi [27] theory of flow, a state of mind achieved by individuals that are so deeply focused on what they are doing that they lose awareness of time and surroundings. This is provided by an activity that is enjoyable for users. Thus, in *H7* we speculated that User Satisfaction would be correlated with Presence scores. The positive correlation between Spatial Presence and User Satisfaction led us to accept this hypothesis and corroborate the literature. Because the correlation between these variables does not imply causation, we cannot be sure if the User Satisfaction increased the Spatial Presence scores or the other way without further studies. However, we speculate that because Spatial Presence measures how physically present an individual feels in the virtual world, one would assume that such would be the cause for a higher User Satisfaction.

## V. CONCLUSION, LIMITATIONS, AND FUTURE WORK

This study aimed to explore the known advantages of contextualization in the literature but under an IVE setup while also investigating possible gender differences. Of all the hypotheses put forward, one was accepted (*H7* - Correlation between User Satisfaction and Presence). We concluded that contextualization in IVE does not increase Purchase Intention, User Satisfaction and Presence. Although further work is needed to corroborate such results, this shows that it could be preferable to display products under a neutral environment and, therefore, with less visual complexity, because contextualization does not compensate for the added computational costs and human resources needed to contextualize products. Likewise, we also concluded that gender does not impact such variables. Purchase Intention was also found not to be correlated with Presence and User Satisfaction, showing evidence that focusing resources to increase Presence and the User Satisfaction with the application (although it could have other benefits [29], [30]) does not guarantee an increase in Purchase Intention. User Satisfaction was, however, positively correlated with Presence, corroborating the literature and indicating a connection between these two metrics.

This work had limitations, such as participants not being looking actively to purchase a refrigerator at that point in time. Such could lead them to "simulate" as if they were, which could change significantly what they pay attention to and look for in such a product. Even if they were looking for such a product, they would still know this was an experiment and not a real VR application where they actually could

proceed with the purchase. Involving real money and logistics included in the compromise of purchasing a product could have increased the extent participants take such actions more seriously and therefore changed how participants behave and acknowledge the information.

More measures and data could be included in future work, such as verifying differences between Context and Gender regarding the Usability of the product, how clarified users were about its functionality and size, and how much they remembered the product's characteristics after the experiment and the mental workload. In addition, a comparison between analysing the same product in VR or *in-situ* with and without context, as well as within the context of the user's home (by means of augmented reality, for example) would be valuable. A non-coherent context (such as displaying the refrigerator in a bathroom) could also be investigated to analyse the thresholds of what users are willing to ignore/accept.

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