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Using Virtual Reality and Mood-Induction Procedures to Test Products with Consumers of Ceramic Tiles[1]

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Abstract

This work describes a Virtual Reality Environment (VRE), through which users are able to view and test ceramic tile products. Users' virtual interfacing with the products generated emotional experiences that allowed them to feel "engaged" with the products. Users could choose between different kinds of products and test them out in order to know how they would look in a real-world context. In the VRE several Mood-Induction Procedures for inducing relaxation were included. The VRE was tested with respect to its ability to induce relaxation and sense of presence in 26 participants. It was also analyzed the level of satisfaction. Measures included the Visual Analogue Scale, the Self-Assessment Manikin, the Presence Self-Assessment Manikin, and a Satisfaction Scale. The results showed that the VRE was effective among participants in inducing relaxation and high sense of presence. In addition, participants' satisfaction with the experience in the VRE was high. The VRE thus could be a useful tool for showing and testing products and for evoking a positive emotional association while users are interacting.

Keywords: Virtual reality; Product testing; Mood-induction procedures; Relaxation; Sense of presence; Consumers

1. Introduction

Virtual Reality (VR) is a computer-based technology that creates a synthetic reality using 3D graphics. VR Environments (VREs) are generated in which a person can interact in real time with different elements and can experience the feeling of being present in that place, otherwise known as "sense of presence." VR is interactive because users are not limited to being passive observers of the environment, they can interact with different objects found in the VREs, while the system responds in real time to their actions. VR is immersive, because with the help of some devices, users have the feeling of being present in the virtual world (Baños, et al., 1999).

Virtual Reality provides consumers with the ability to interact with products without needing to be physically in a store (Ottosson, 2002), some industries are integrating VR technologies into the product-value chain but its inclusion is quite slow, and its use has been predominantly to provide information about products.

Few works have studied other advantages of VR. Söderman (2005) used a VR system for testing car prototypes; he compared different prototypes using VR, hand-made sketches, and a physical car. He propose that while a physical prototype is superior for realism, it is also very costly to produce, difficult to modify, and expensive and fragile to transport.

Therefore, VR might be useful because it could help to reduce costs of developing different physical prototypes. He notes that a higher degree of realism in the product representation did not necessarily bring about a better understanding of it, because participants already had previous experiences with each product.

Kim and Forsythe (2008) analyzed the acceptability of a Web-based VR system, whose aim was to show and test some features of a product. The VR system allowed for the rotation of the product or the changing of its color, among other possibilities. They found that the VR system was useful, something participants attributed to its pleasant characteristics. They concluded that the interactivity of the VR system could add value to the shopping experience through the Web.

In another work, Bruno and Muzzupappa (2010) studied the feasibility and efficacy of a VR interface for comparing real-product interactions and virtual-product interactions. They suggest that in VREs, it is possible to design, simulate, analyze, and test virtual prototypes in a very user-friendly way, and that amongst its advantages, virtual prototypes may replace the physical mock-ups with a notable reduction of costs and market-distribution time.

In a more recent study, Kim, Lee, Lehto, and Hwan Yun (2011) compared the efficacy of a VR system for testing car prototypes. They used virtual objects and images of prototypes on a VR Web-based system. Their results suggest that participants could easily observe details of the design because they could see them from different perspectives. Other works related to use of VR in consumer research have focused on studying the shopping experience.

Lee and Chung (2008) assessed participants' satisfaction in shopping online through a VR shopping mall and compared it with an ordinary online shopping mall. The ordinary shopping mall consisted of an HTML interface and hyperlinks, the VR shopping mall consisted of 3D graphics and an avatar. Their results reported a significantly increased level of satisfaction in the VR shopping mall. In summary, overall these studies have reported that the physical world representation through VR can provide consumers with an avenue of assessment and identification of preferences with regard to their expectations of products. However, these studies also have some limitations: 1) their use has focused mainly on showing virtual prototypes of products; and 2) in most studies, interaction was limited to a few actions (e.g., to show or change the color of products).

About of impact of emotions in consumer behavior few empirical researches have studied the relation between emotions and product evaluation. Gorn, Goldberg, and Basu (1993) studied the effects of emotions on product evaluations. They used music for inducing positive or negative emotions and then asked participants to evaluate a product. They hypothesized that emotions can bias the evaluation of a product because some participants evaluated the product more favorably when the mood-induction was positive.

Fedorikhin and Cole (2004) analyzed the evaluation of products after positive or negative mood-induction through film clips. They found that consumers with a positive mood-induction perceived lower probabilities of incurring losses when purchasing a new product than did consumers with a negative mood-induction. These authors indicated that understanding how emotion influences consumers' behavior is important because consumers bring a variety of emotions into decision-making and that the shopping experience itself can induce different emotions. A good alternative for study the impact of emotions in consumers' behavior are the Mood-Induction Procedures (MIPs) which are methods designed to instill a transitory emotional state in a controlled way. The most used are pictures, videos, self-statements, and music.

Lang, Bradley, and Cuthbert (2008) developed a picture system capable of eliciting emotions, which has shown that affective evaluations are trustworthy and stable. Gross and Levenson (1995) developed a standardized system of videos capable of eliciting different emotions. They found a high correlation between the videos and the emotions that they wanted to elicit. Emotional self-statements is a MIP developed by Velten (1968) to induce emotions through statements written in first-person and relative to a particular emotion. The use of music for inducing emotions is another of the most studied MIPs; works such as those by Baumgartner, Lutz, Schmidt, and Jäncke (2006) have proven the usefulness of music in mood-induction. MIPs have proven to be effective in eliciting different emotions in a laboratory, but they do have some limitations. Studying a phenomenon as complex as an emotional change in a controlled environment such as the laboratory can translate into a loss of external and ecological validity; even though in field studies, unlike in laboratory testing, the control of the variables is often more limited. This is where the use of VREs could represent a good alternative in helping to reduce the limitations of the field studies without sacrificing the accuracy of the laboratory studies.

Some controlled studies have evaluated the use of VREs along with MIPs. Baños et al. (2004, 2008) and Riva, et al. (2007) have used VREs that changed progressively depending on the emotion (relaxation, joy, sadness, anxiety, or neutral) it intended to evoke. In order to build different emotional VREs, they included self-statements, pictures, video-clips, music, and autobiographical recalls. Baños, et al. (2004) studied the affective valence of two VREs (one for inducing sadness, and the other without specific emotional elements) and tested the role of immersion and media content on the sense of presence. The results suggest that the VRE with emotional content seemed to be more engaging and real than the non-emotional VRE. They concluded that both emotional contents and immersion have an important effect on sense of presence. In a later study, Baños, et al. (2008) used VREs to induce positive emotions (relaxation and joy); they measured both positive and negative emotions. After mood-induction, participants reported an increase in the positive emotions and a decrease in the negative emotions (sadness and anxiety). In addition, a correlation existed between the sense of presence and the intensity of positive emotions.

Riva, et al. (2007) used VREs to induce relaxation and anxiety, and then they compared the results with those derived from a neutral VRE. Their results confirmed the efficacy of VREs in mood-induction, because each one was successfully able to induce the intended emotion. In addition, the sense of presence was stronger in the VREs with emotional content. Their data showed a bidirectional relationship between emotions and sense of presence. Moreover, they also suggest that sense of presence is influenced not only by the graphic realism of VREs, displays, or other technological features, but also to a great degree by the characteristics of the experience, including the emotional traits provided by the technology. Although, some works have focused on evaluating the effectiveness of VREs for inducing some emotions, a review of the literature does not reflect controlled studies that combine the use of VREs and MIPs to apply to consumers' behavior research. Thus, in research, the possibility of using VREs for study emotions in consumers has received scarce attention.

Considering the previous studies, this work aims to describe a flexible and highly interactive VRE suitable for showing and testing different products and to evaluate its capability to induce relaxation and sense of presence while users interact with products. The following hypotheses were tested:

H1: The VRE will be able to induce relaxation. Scores on relaxation will increase after the mood-induction.

H2: The VRE will be able to induce a high sense of presence.

H3: Participants will report a high degree of satisfaction.

2. Material and Methods

2.1 Participants

The sample consisted of 26 participants, 18 women and eight men, whose ages ranged from 18 to 63 years (M=29.5, SD=12.2). Participants were recruited using different strategies. They received a financial reward of 12 Euros.

2.2 Measures

Visual Analog Scale (Gross & Levenson, 1995): four VASs were used to evaluate sadness, joy, anxiety, and relaxation. Participants were asked to rate how strongly they were experiencing each of the emotions evaluated. This was done on a 0 to 10 point Likert scale.

Self-Assessment Manikin (Bradley & Lang, 1994): this is a non-verbal pictorial-assessment method that measures the affective valence, arousal, and dominance associated with a person's affective reaction to a stimuli. Participants could select any of the five figures in each scale, or between any two figures, which resulted in a nine-point Likert scale for each

dimension. Semantic differential correlation for the factor scores was high for affective valence (r=0.97) and arousal (r=0.94); dominance correlation was not significant. SAM data also indicates that these ratings are stable when assessing within or between participant reliability.

Presence Self-Assessment Manikin (Schneider, Lang, Shin, & Bradley, 2004): this is a nine-point pictorial scale adapted from the SAM measure. The authors designed the scale to be moderately correlated (r=0.50) with a verbal sense of presence scale.

Satisfaction Scale: this measure was developed to evaluate the satisfaction with the VR experience. Participants were asked to rate their satisfaction on a 10-point Likert scale. In addition, they were asked if they would use the VRE customizations and decorations in their own homes, and then they were asked to provide their reasons.

2.3 Virtual Reality Environment

The VRE was represented by a two-story house, called "House of Relaxation" (Figure 1) located in the field. The VRE included different areas (living room, kitchen, bedroom, bathroom, and terrace) in which users could interact with different products and other virtual objects. Different ceramic tile industry products were included in the VRE (e.g., floor tiles, coverings); they were provided by manufacturers and were adapted to VR technology.

-FIGURE 1 AROUND HERE-

Additionally, with the VRE were used self-statements for inducing relaxation, affective pictures, a video of a beach scene, relaxing music, sounds of nature, and a narrative for inducing relaxation. The interaction interface allowed users to perform different actions such as modifying the affective pictures and the self-statements that were included as part of the decoration of the house. Therefore, it was possible to realize the following interactions: watching a video, changing the intensity of the lights, opening or closing doors, and windows, moving up or down stairs, moving or adding furniture, changing ceramic tiles, changing the color of the walls, and changing the exterior landscape (e.g., beach or snow). For further details, see Table 1. The interactive elements were displayed in drop-down menus (Figure 2). In the VRE, the contents could be easily changed; it was also very flexible and made it easier to include different products and to induce other emotions (e.g., joy). The VRE was created using *IPF de Brainstorm eStudio* which allows developers to generate interactive 3D objects. The logic of the products was replicated within the code of the VRE using an object-oriented approach, which allows creation of different product prototypes.

-TABLE 1 AROUND HERE-

-FIGURE 2 AROUND HERE-

2.4 Hardware devices

It was used a PC with an Intel Core 2 Quad processor (2.33 GHz, 3.50 GB of RAM, and Nvidia GeForce 8400 GS video card), navigation and interaction devices (Wiimote remote control and a wireless receiver bar, in which a driver for communication between the remote and the VRE was developed). The visual and audio display consisted of a methacrylate screen (4x3 m), an HD video-projector with a resolution of 1280x720 pixels at 1400 lumens, and a 5.1 surround-sound system.

2.5 Procedure

A within-subjects design with two evaluation moments (pre-test and post-test) was used. The duration of each experiment was approximately 60 minutes, and all participants did it individually. Participants signed a written Informed Consent and filled in a Personal Data Sheet in order to take part in the study, then completed the pre-test VAS and SAM measures. Next, they were trained in the use of the navigation and interaction device in order to be able to interact with the VRE. Starting the experiment, participants simultaneously listened to a relaxing narrative and a relaxing music. The initial appearance of the VRE was neutral, but participants were able to change it to a relaxing environment and customize it.

During the experiment, a narrative guided participants through the following tasks: moving within the house and opening or closing doors and windows; customizing the house with the ceramic tile products; changing the furniture; changing the color of the walls; viewing a relaxing video; changing the exterior landscape; and changing the decoration of the walls using affective pictures and affective self-statements. Next, participants were asked to contemplate the relaxing context and to think about their personal meanings. Finally, participants were asked to fill in the post-test VAS, SAM, the Satisfaction Questionnaire and the Presence-SAM measures.

3. Results

For testing the first hypothesis, differences before and after VRE experience were analyzed. Student's t-tests for related samples were applied with the VAS and SAM measures. Results showed statistical increases in relaxation, and statistical decreases in arousal, anxiety, and sadness. Table 2 presents descriptive statistics and t-test results. In order to

analyze the effectiveness of MIPs in the VRE, we calculated the percentage of participants for whom the mood-induction was effective (those who showed changes in scores of emotional variables in the expected direction). This was considered as the increased number of points related to relaxation, joy, and affective valence, as well as the number of decreased points related to arousal, anxiety, and sadness variables. Table 3 shows the percentage of participants who increased their level of relaxation, joy, and affective valence, and decreased their level of arousal, anxiety, and sadness by than one point. Relaxation was the emotion most elicited in the participants.

-TABLE 2 AROUND HERE-

-TABLE 3 AROUND HERE-

In order to test the second hypothesis, the sense of presence was calculated. The mean was 5.61 (SD=2.98) on a nine-point scale.

Regarding the third hypothesis, the descriptive statistics of the Satisfaction Scale shows a mean of 7.31 (SD=1.66) on a 10-point scale, in which 84% of participants indicated that they would like to use the VRE customization into their own houses. Participants indicated reasons such as: *"It seemed to be a warm and welcoming environment," "I felt a lot of tranquility,", and "It reflected my emotions.*"

4. Discussion

The premise defended in this work is that it is possible to create a VRE in which users can interact with different products, and that the interaction generates an experience in which users feel "engaged" with products. To accomplish this, a VRE was designed with the aim of inducing relaxation while users interact with products, choosing and combining them with other elements of the VRE to see how products would look in the context of a real home. The VRE would be useful in user-centered designs to not only consider the needs of users by designing and engineering products specifically "for" them, but also by providing a tool to design products "with" them. The central issue is not to evaluate the "affective appeal" of the products, but to create an emotional and very interactive experience in which users are involved. It is not important to "evaluate" the affective experience that users have with products, but rather to "create" an affective experience "with" the products. Further, the objective is not for the products to induce an emotion, but to create an experience that induces emotions. From this work there is data suggesting that the VRE is useful for this.

The first hypothesis has been confirmed. After mood-induction, the relaxation level was increased significantly. The results show that more than half of participants changed their level of relaxation by more than four points; likewise, results show changes in others emotions. Anxiety and sadness were reduced by more than two points in more than half of the participants. Joy was increased, and arousal was reduced. These results show that it is possible to induce emotions in a controlled way, and to envelop products in an emotional context capable of generating associations between products and a positive emotion. The results coincide with Baños, et al. (2008) who similarly induced relaxation but also increased other positive emotions while decreasing the negative emotions. The results also coincide with Riva, et al. (2007) who confirmed the efficacy of VR as an affective medium and where the VREs showed their effectiveness for inducing relaxation. Regarding the utility of mood-induction in product testing, some works have studied their effects. Gorn, et al. (1993) suggest that emotion biased the evaluation of products; in their work, some participants evaluated a product more favorably when the emotion associated was positive. Fedorikhin and Cole (2004) found that consumers with a positive emotion perceived lower probabilities of incurring losses from purchasing a new product than did consumers experiencing a negative emotion. These works concluded that consumers behave differently depending on their emotion and that, while a positive emotion has a propensity to generate more favorable evaluations, a negative emotion has a propensity to generate less favorable evaluations. However, it should be noted that no work has been done using both aspects (VR and mood-induction) in a controlled study that focuses on consumer behavior.

The second hypothesis was also confirmed. The results show that participants experienced a high sense of presence in the VRE; in other words, they felt as though they were actually there. Therefore, the data supports the notion that the VRE can emulate experiences, which may be similar to reality. This opens the possibility of using a VRE to test the preferences of consumers for new products in a controlled setting, while maintaining a high ecological validity. It is important to note that participants did not use a head-mounted display; therefore, the VRE was not fully immersive. However, the VRE was very interactive, and it was possible to perform more actions and interactions in it than in the VREs used in other studies for showing or testing products. In this context, Slater and Wilbur (1997) indicate that “interaction” seems to be a more important factor than immersion in achieving sense of presence.

The third hypothesis regarding participants’ high satisfaction with the experience in the VRE was confirmed. Participants were able to change the ceramic tiles of the floors and walls or combine them with the walls’ color and the house decor, visualize different products from the ceramic tile industry and thus to have clearer ideas of how the products could look within their house. Moreover, most participants indicated they would use the customized and personalized environment within their own houses. These results are similar with the data of Lee and Chung (2008) who found that

satisfaction was significantly enhanced in a VRE shopping mall in comparison with an ordinary shopping mall. Some other studies have also proven the utility of VREs. Likewise, Kim, and Forsythe (2008) found that their VRE was valued as useful, and participants attributed this to its pleasant characteristics. Bruno and Muzzupappa (2010) consider that with VREs it is possible to design, simulate, analyze, and test virtual prototypes in a very user-friendly way because virtual prototypes may replace the physical mock-ups with a notable reduction of cost and time-to-market.

However, despite the advantages mentioned in this work, VR is not problem free. The costs of development and hardware necessary for VREs could be high. However, nowadays the costs are significantly lower than ten years ago. In this study, we use as visual display a 4x3 metres methacrylate screen, but it could be adapted to be used with other visual less expensive displays (e.g. standard flat screens). Regarding this, it is important to note that in some cases and with certain products, the development and implementation costs of physical prototypes to show different kinds, varieties, or characteristics of a product, remain higher than the costs of developing and implementing VREs.

Another point to be considered is that VR has not succeeded stimulating all five senses. However, Hoffman, García-Palacios, Carlin, Furness, and Botella (2003) suggest that stimulating the sense of sight through realistic graphics that capture in detail the physical properties of a real object, would facilitate the indirect stimulation of the other senses and the subjective perception of interacting with the object.

In addition, some people may experience initial difficulties in using VREs. That is the reason why a previous training is always recommended. In this specific study, we have found that the learning curve after the previous training was short and the participants were adapted to using the system.

Another disadvantage to be taken into consideration is that some people may experience secondary effects or not very pleasant sensations (e.g. nausea, disorientation, or vertigo) defined as “cybersickness.” But from our experience, this only happens to about 1% of participants, and these effects disappear within a short period of time.

Regarding the use of VREs to induce emotions, the main controlled studies (Baños et al., 2004, 2008; Riva et al., 2007) have focused on the study of mood-induction of four basic emotions: relaxation, joy, sadness, and anxiety; whereby further controlled studies are needed to prove their efficacy to induce other emotional states.

It should be noted that this work has a number of limitations. First, the study engaged a small sample of participants, and so we would recommend a controlled study with a larger sample. Second, in this work, relaxation was the only emotion induced, so future studies could induce other emotions to test if the results are confirmed regardless of the emotion. Third, it would be interesting to evaluate the specific role of emotional content within VREs. Fourth, because the

study used only one kind of display device, future studies should compare different kinds of display devices across different levels of immersion and different costs.

In any case, this work provides data about the utility of a VRE for inducing an emotional experience for the users while interacting with a product and generating a sense of presence. This means that VR not only emulates reality, but also has the potential to change consumers' emotions, and therefore could be a useful tool in consumer research.

5. Conclusions

Few works have focused on studying the relationships among mood-induction, product testing, and consumers' behavior. Therefore, this work aims to contribute to this field using a VRE capable of inducing emotional experiences in the users and useful for testing different products prior to their development. In this work, the VRE was tested using products from the ceramic tile industry; however, it is possible to apply it to other products and industries because it is a generic setting (i.e., a "typical" house), flexible, and highly interactive VRE. The VRE can be useful for testing different products and evaluating consumers' preferences, while providing a positive engagement with products or while creating an association between a product and an emotional state. We think that VREs that include emotional contents could be a useful tool in researching the emotional responses of consumers, thanks to the flexibility and control it allows. Finally, results suggest that VREs are a valid alternative to traditional methods for product testing and mood-induction. One of the direct and immediate applications for this kind of VRE is consumer-oriented design, as it could provide information on the users' product preferences and insights into the best way to organize real environments (e.g., store layouts, urban spaces, museums, etc.).

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Figure 1. Virtual Reality Environment

Table 1. Interactions in the Virtual Reality Environment

Object	Action-Interaction
TV	-Turn on and off
	-Watch a video (length of 1'40'')
Music player	-Turn on and off
	-Listen to music ("Heavenly theme" by Michael Lindh)
Floor	-Change the ceramic tiles
	-Change the floor to a natural element (e.g., sand or grass)
Walls	-Change the color
	-Change the ceramic tiles
	-Change pictures and self-statements
	-Watch a video
Furniture	-Move and add
Doors and windows	-Open or close
	-Go outside
Lighting	-Turn on and off, or regulate its intensity
Exterior landscape	-Change the exterior landscape (beach or snow)

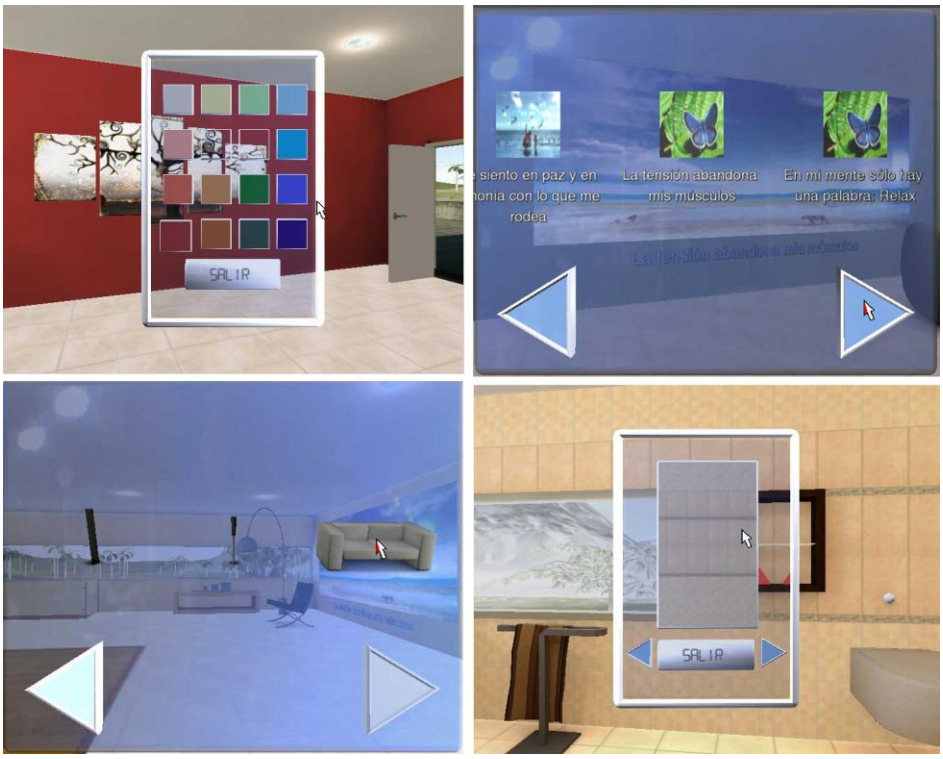

Figure 2. Some interactions in the Virtual Reality Environment

Table 2. Student's t-test results (N=26)

	M (SD)		t	p
	Pre-test	Post-test		
Relaxation	6.19 (2.24)	7.88 (1.94)	-5.10	0.000
Anxiety	1.96 (2.32)	0.96 (0.87)	2.29	0.031
Sadness	2.04 (1.88)	1.31 (1.32)	2.83	0.009
Joy	6.54 (1.70)	6.62 (1.96)	-0.35	0.723
Arousal	3.08 (1.19)	2.31 (1.59)	2.18	0.039
Affective Valence	7.00 (0.80)	7.31 (1.22)	-1.44	0.161

Table 3. Observed changes in emotions (N=26)

	% Total participant changes	+/- 1 point	+/- 2 points	+/- 3 points	+/- 4 points
Relaxation	76.9%	11.5%	19.2%	23.1%	23.1%
Joy	38.5%	30.8%	7.7%		
Affective Valence	26.9%	26.9%			
Arousal	50%	50%			
Anxiety	65.4%	26.9%	38.5%		
Sadness	53.9%	15.4%	38.5%		