ANALYSIS OF THE INFLUENCE OF USING NEW TECHNOLOGIES ON THE PERCEPTION OF A PORCELAIN PRODUCT

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ABSTRACT

The significant increase in electronic sales over the last few years means that the way in which product and customer interact nowadays needs to be reinterpreted. Companies push the sale of their products not only through physical shops but also via their websites. Among those sales, the attention of this paper focuses on a product that includes ceramic materials, namely a piece of furniture with porcelain stoneware.

Within this new selling scenario, it is vital that the information given about a product in these new virtual showrooms is capable of generating a suitably subjective impression in the consumer to inspire the confidence and security required to conclude the purchase. In this sense, online sales portals study the best ways of presenting details about a product and are constantly developing new forms of display. Static images of the product from different angles, zooms and enlargements to show details are some of the standard solutions used to provide the potential customer with more information about the product.

However, new ways of presenting a product are beginning to be rolled out that involve the application of new technologies. Examples include virtual reality, augmented reality or 360º rotation, which enable the viewer to see the product in settings that are fully or partially virtual, immersive or displayed on a screen and with varying degrees of interaction.

This presentation describes a study that compares the way the various characteristics of a piece of furniture with porcelain applications were perceived depending on the display technique used (2D rendered images using an application with virtual reality, augmented reality, or 360º rotation) and also through physical interaction with the porcelain materials in the product. The study identifies the level at which the various characteristics of the item of furniture and its porcelain materials, such as texture, colour, strength or size, were perceived and assesses the degree of confidence generated and whether the information would be sufficient to incite a decision to buy.

The results obtained show significant variations in how product characteristics are perceived and in the actual purchasing experience between different display techniques. This paper also discusses whether the ceramic material used is generally perceived from these displays.

1. BACKGROUND

The way new product design and development processes have evolved and markets have become globalised has led to a huge widening of product ranges, which now more than meet customers' functional needs, and to a situation in which a small differentiating factor may be the key to success. Customer preferences change depending, among other factors, on their location, their own criteria or reference values, the particular point in time (when in vogue or fashion), and the subjective impressions that the product creates [1]. The term "subjective impressions" refers to the significance commonly associated with a product (such as: an elegant mobile phone, a ladies' car, versatile shoes), and even the emotions that it causes (we are proud to wear a watch, we feel modern or attractive with those sunglasses). Consumer perception is measured through different tools, one of the most widely used being Semantic Differential (SD). This procedure is geared towards determining the significance for the consumer generated by certain images or objects [2] using Likert-type numerical scales, generally expressed in pairs of opposite terms. What is known as emotional design or affective design [3] studies the emotional needs that may bear upon the decision to purchase. These are the highest needs in the hierarchy proposed by Jordan [4]; product designers are therefore changing their focus from functionality and usability to enjoyment and pleasure.

Models for generating product significance and/or emotions [5-8] study the factors involved in the consumer–product interaction to explain how product design can subjectively influence the user or the buyer.

The sharp rate of increase in electronic sales in recent years has led to a point in which the context of interaction between the product and the customer needs to be reinterpreted. Companies no longer proffer their wares in physical shops but also through their websites. In addition, a number of web portals exist that connect manufacturers and consumers by offering products for a limited period of time. Although they were initially conceived as a means of emptying stocks of impulse-bought products, nowadays they offer more complex or higher-range products. Of these, this study focuses on products that incorporate ceramic materials, such as furniture with porcelain applications.

As part of this new sales scenario, it is vital for the information given about the product in these new virtual showrooms to be capable of generating an appropriate subjective impression in the consumer to inspire the confidence and security required to decide to make the purchase. In this regard, online sales portals study the best ways of presenting product details and are constantly developing new types of displays. Static images of the product from different angles, zooms and enlargements to show details are some of the standard solutions used to provide the potential customer with more information about the product.

Studies have shown that the type of sensory perception and the level of interaction with the product influence the user's perception [9]. Therefore, it is vital for the information given about the product in these new virtual showrooms to be capable of generating an appropriate subjective impression in the consumer to inspire the confidence and security required to decide to make the purchase.

In this sense, more innovative display techniques are beginning to be used that rely on the application of new technologies. Examples include virtual reality, which enables the viewer to see the product in settings that are fully or partially virtual, immersive or displayed on a screen, augmented reality, which offers the possibility of superimposing a virtual layer over a physical setting in real time, or "360º" product displays, which show it from all possible points of view.

The purpose of this presentation is to describe a study that compared how the various characteristics of a piece of furniture with porcelain material applications were perceived depending on the display technique used. Four types of display (2D imagery, 360º, augmented reality and virtual reality) were used, comparatively evaluating the level at which participants in the study perceived the features of the piece of furniture and the porcelain material, such as the overall dimensions, texture, colour or strength, as well as the degree of confidence generated and whether the information would be sufficient to drive a decision to purchase. Participants were also able to interact with the actual materials used to build the piece of furniture and thus revise the perception of the material they had previously held.

2. METHOD APPLIED

The study involved a sample group of 18 participants, all adult men (66%) and women (44%). By age range, 27.8% were aged between 18 and 25 years, 22.2% between 26 and 40 years, 38.9% between 41 and 54 years, and 11.1% were 55 or older.

The item chosen for the study was a sideboard made with inserts of porcelain material. Different depictions of the piece of furniture were generated, modelled and rendered, before being displayed on a 10.5-inch tablet and a smartphone as indicated below:

- 2D imagery: two pictures were used; a rendering of the piece of furniture standing alone, along with another picture showing the sideboard in a decorative setting. Both pictures were shown to the participants on a tablet.
- 360º display: The sideboard was displayed on its own using an app on the tablet that allowed it to be rotated in any direction the user interacting with the device liked.
- Augmented reality: The virtual sideboard was displayed on the tablet using an app which showed it in the actual setting selected. The participant chose a specific location and the furniture was added to that actual setting on screen.
- Virtual reality: The entire setting on display, which comprised a decorated room with the piece of furniture in it, was virtual. On this occasion, participants were able to use both the tablet (the virtual environment was displayed on screen and mirrored the individual's own movements) and on a smartphone, fitted with basic virtual reality goggles for a more immersive experience.

Figure 1 shows the 2D pictures used in the study, as well as the rendered setting displayed in the virtual reality.

Fig. 1. *Pictures used in the 2D (top) and virtual reality (bottom) displays. The realistic and immersive conditions of the virtual display technique cannot be appreciated in this figure.*

First of all, the participants had to rate on a scale of 1 (Not important) to 5 (Very important) the degree of importance they assigned to their perception of the following product features:

- General physical characteristics (e.g. size, weight).
- Physical characteristics in detail (e.g., colour, texture).
- Functional aspects, such as strength, durability or ease of maintenance.
- Aesthetic features, such as product attractiveness.

After that, they viewed the 2D images on the tablet and were asked to rate - again on a scale of 1 (not at all suitable) to 5 (fully suited) - the standard of the display technique in regard to the following:

- Its suitability to enable perception of general physical features (e.g. size, weight)
- Its suitability to enable perception of physical characteristics in detail (e.g., colour, texture).
- Its suitability to enable perception of functional aspects, such as strength, durability or ease of maintenance.
- Its suitability to enable perception of aesthetic characteristics, such as product attractiveness.
- Whether it provides additional information about the product.
- Whether it gives the user a feeling of confidence and security to purchase.
- Whether it helps to make a decision (willingness to buy).
- Whether it improves user experience and satisfaction.

Subsequently, each participant was shown the sideboard using the other means of display. After each new showing, participants were asked to rate the suitability of the technique at issue for the above 8 questions, indicating a score of between 1 (not at all suitable) to 5 (fully suited) for each one. The order the various product display techniques were presented after the 2D pictures was varied according to a pre-selected random order. Participants were able to re-visit their previous answers if they felt the need to amend the score given earlier after evaluating a subsequent display technique.

Finally, each participant was allowed to see and touch a sample of the porcelain materials in the piece of furniture under study (Figure 2) and change their earlier answers again, if considered necessary.

Fig. 2. *Photograph of the porcelain tiles shown to participants, corresponding to the material used to design the sideboard.*

After the experiment, the scores awarded by the participants were analysed statistically to search for possible differences in how the characteristics of the sideboard and its materials were perceived with each different display technique. To do that, analysis of variance (ANOVA) was applied to detect possible significant differences in average scores, taking the scores for different aspects relating to the displays as the dependent variable, and the actual technique used as the independent variable. For the post-hoc analysis, Bonferroni was used when an equality of variances could be assumed, and Games-Howell when that was not the case. Kruskal-Wallis was applied to determine possible significant differences in the distribution of scores.

3. RESULTS AND DISCUSSION

First, to be noted were the mean values given by participants for importance in regard to their perception of each of the characteristics of the sideboard. As shown in Figure 3, the highest value corresponds to the importance of properly perceiving the general physical characteristics of the product (mean score of 4.56), followed by its functional characteristics (4.33), and its detailed and aesthetic features, with a mean score of 4.28.

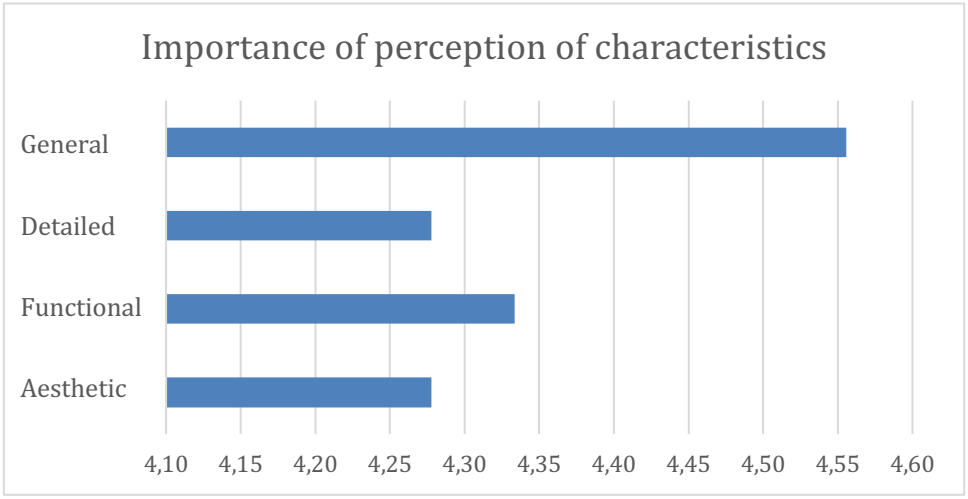

Fig. 3. *Average scores assigned by participants in the study to the importance of perceiving different product characteristics.*

In regard to their rating of the features and suitability of each display technique, the results of applying ANOVA revealed significant differences in the average perception of the item's general physical characteristics, $F(3.68)=3.523$, $p=0.019$, and in the score for improved purchasing experience, $F(3.68)=3.495$, $p = 0.026$.

Additionally, by applying Kruskal-Wallis, we were able to detect significant differences in the distribution of those same perceptions: the item's general physical characteristics ($p=0.015$) and assessment of improved overall purchasing experience ($p=0.027$).

Specifically, as far as suitability for perceiving general physical characteristics was concerned, a significant difference was detected in the mean scores between the display of 2D pictures and display with virtual reality ($p= 0.011$), and between the 360º display and virtual reality ($p=0.018$). With regard to the difference in the distribution of variables, a significant difference was detected between the 360º and virtual reality displays ($p=0.030$).

In scores for improved purchasing experience, a significant difference was detected in the averages for 360º and virtual reality displays ($p=0.018$), and the distribution of variables between 2D pictures and virtual reality ($p=0.020$).

Figure 4 shows those results graphically. As previously seen, perception of general physical characteristics, such as the product's size, was valued as the most important perception among all those analysed. This perception benefitted when there were other elements with which to compare the product under study, as was the case with its display in virtual reality, compared to the 360º display, where the product stood alone away from any background setting.

As far as improved purchasing experience was concerned, once again virtual reality stood out above more classic methods of displaying or presenting products.

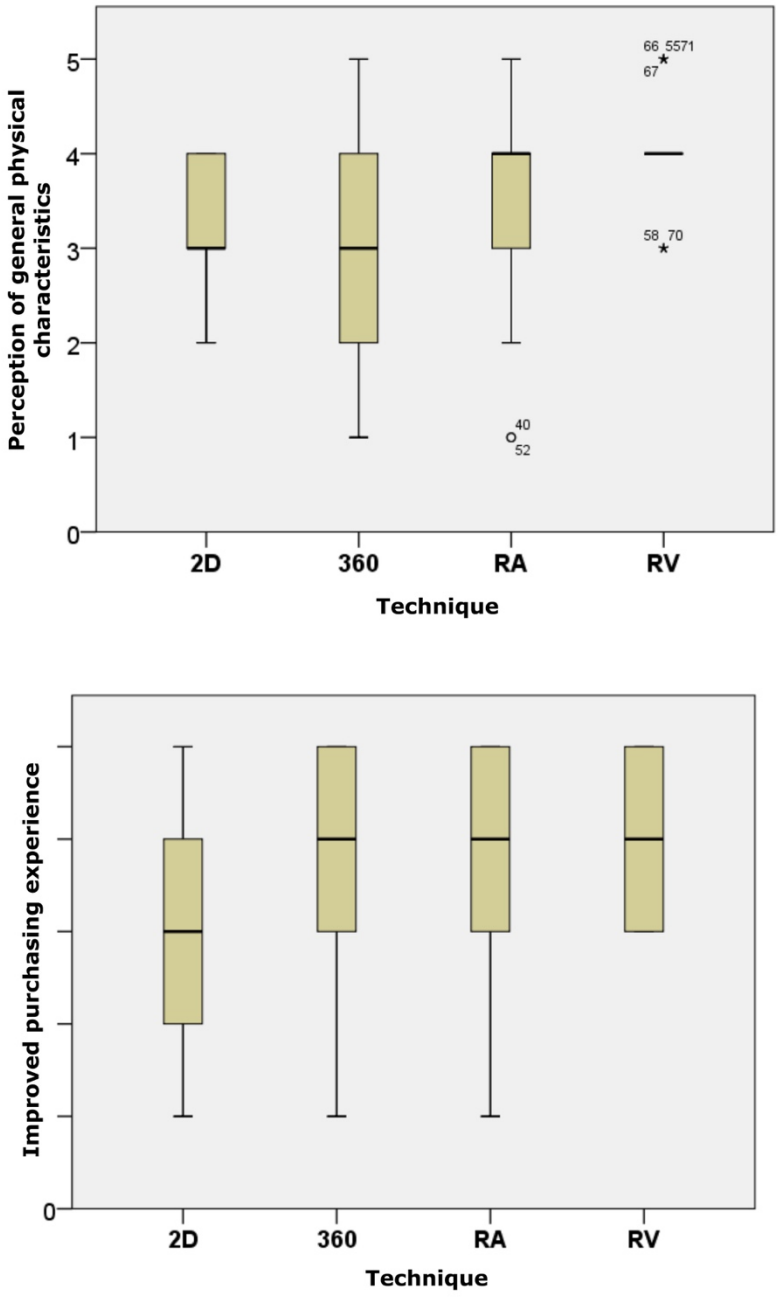

Fig 4. *A box plot of scores for suitability of perceiving the general physical characteristics (top) and for improved purchasing experience (bottom), depending on the display technique used.*

Regarding perception of the actual materials, note that the vast majority of participants (16 out of 18) were surprised by this stage of the study, as hitherto they had imagined the sideboard was made of wood or of a similar material rather than porcelain stoneware.

Of the 18 participants, 9 chose to lower their score at that stage on how detailed product characteristics were perceived (specifically, they lowered the score for assessment of the perception of texture). Six of these 9 participants lowered their score

for perception of detailed characteristics by one or two points for all the display techniques seen, while the remaining three brought it down in just two display techniques (two in 2D and 360º, and one in 360º and virtual reality). Another 4 participants lowered both perception of both detailed and general characteristics by one or two points on the scale, arguing that the weight of the sideboard would be much greater than initially imagined. Of these four participants, 3 lowered their score in all display techniques, while the fourth did so only for the 360º display.

Finally, three participants decided not to change their initial rating for perception of characteristics in the various display techniques, arguing that the fact that they had not perceived the porcelain material earlier should not be attributed to the actual display technique but rather to the fact that ceramics are still seldom used for such purposes and so the item of furniture was perceived to be made of wood simply because, until then, that was what they had always seen.

4. CONCLUSIONS

The main conclusions to be highlighted in this study are, first, that significantly better assessment was detected for perception of general product characteristics (considered by the participants to be the most important) and for the purchasing experience when virtual reality was used as the display technique, compared to more frequently used techniques such as 2D imagery or 360º rotation.

In addition, it was found that the porcelain material had not been generally identified with the display techniques used and was therefore a surprise to participants when they were shown actual samples of the materials in the sideboard. Future studies need to delve more profoundly into the question of whether such an outcome is because the techniques studied are not able to display material characteristics properly or whether it was due to their automatic perception of materials traditionally used in furniture making.

5. ACKNOWLEDGEMENTS

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