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The effects of background color, shape and dimensionality on purchase intentions in a digital product presentation

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Abstract. The presented study explores diverse ways of demonstrating the product in a digital way, e.g. in big digital outdoor telebims, monitors situated in supermarkets or electronic shops available on the Internet. Three different factors were examined in a laboratory based experiment: product presentation background colors (red, green, and blue), presentation shape (sharp versus rounded edges) and presentation dimensionality (two and three dimensional). The potential customers expressed their purchase intentions towards various product presentation variants by means of pairwise comparisons. The analysis of data collected from 51 persons revealed the statistical importance of all three examined factors along with the significance of dimensionality and shape interaction. Subjects preferred rounded options more than these with sharp edges only. The three dimensionally looking package was better liked than its two dimensional counterpart. Participants favored also blue background color over the red and green ones.

Keywords: digital signage · two and three dimensions · package design · roundedness ·purchase intensions · AHP

1 Introduction

In today's digitized world people more and more often come across virtual presentations of products rather than real objects. It frequently happens, especially in electronic shops, that customers make their buying decisions based only on a digital appearance of an article. There were numerous studies in a marketing field regarding traditional ways of demonstrating goods and many of them concerned products packages (e.g. Richardson, et al. 1994 and lately Valajoozi and Zangi 2015 or Werle et al., 2016). The general review in this area may be found in the work of Azzi et al. (2012). Among basic packaging functions one may find the following (Rundh, 2005; Robertson, 2006): containment, protection, convenience, and communication. Naturally, the last role is crucial in a digitized product presentation and has recently also been sub-

ject to scientific investigation (e.g. Deliza et al., 2003; Harris et al., 2011 and recently Grobelny and Michalski, 2015).

There is a variety of package features that may influence the consumer preferences and as a result purchase intentions. It seems that one of the most important characteristics in this context may be connected with the application of specific color schemes. The color has been identified as an important factor influencing peoples' perception in various fields, for instance, in general psychology (Granger 1955; Guilford & Smith, 1959), or in human factors (Christ, 1975). The importance of the background color in a digital presentation was also examined in the work of Middlestandt (1990) or Grobelny and Michalski (2011). One may also find a few papers in the marketing area dealing directly with the product digital presentation. For instance, Rebollar et al. (2012) examined the impact of various artificially prepared chewing gum packages involving warm, cold and grey colors on consumer expectation and willingness to buy whereas Grobelny and Michalski (2015) focused only on two colors: pink and grey. In light of Schloss et al. (2013) findings this direction is worth following as the color effect is frequently moderated by other experimental factors.

The shape of packages is considered as important factor influencing customers' product perception as well and was subject to examination by multiple researchers. Particularly intriguing is the general effect of preferring curved contours and shapes over the edgy ones which was observed in a series of previous experiments (e.g. Becker et al., 2011; Westerman et al., 2013).

In real environment the packages presenting products to consumers have always three dimensional shapes. However, in a digital space articles are usually demonstrated as two dimensional pictures. These images may depict products or services either in a flat two-dimensional way or mimics three-dimensional objects. Thus, it is noteworthy to verify if such factor influences subjects' willingness to buy. It is quite hard to find research articles that investigate this dimensionality effect in the digital product presentation context however, some studies from a general psychology suggest that people could prefer 3D looking versions over the 2D ones. Murrey et al. (2002) showed by means of the brain imaging technique that the perception of 3D shapes results in lower activity in human primary visual cortex. This suggests that such an object is easier processed which can lead to higher preferences. Similar results were provided by Norman et al. (2004).

In view of the brief literature review presented above, this study focuses on the influence of virtual product presentation differentiated by the background color, shape, and dimensionality on the perceived willingness to purchase a smartphone.

2 Method

2.1 Participants

There were 24 (47%) males and 27 females (53%) voluntarily engaged in the current investigation. All of them were undergraduate students of the Wrocław University of Technology (Poland), aged from 18 to 24 years with the average of 20.6 years and standard deviation equal to 1.5.

2.2 Variables and experimental design

A number of pictures presenting a fictitious smartphone on a digital package prototype were created for the purposes of the present investigation. For clarity, the design included only basic components that are associated with the packaging, that is: the product picture and its imaginary name. These items were identical for all conditions. The prepared digital product presentations were differentiated by three independent variables, namely the background color of the presentation, two or three dimensional appearance, and sharp or rounded edges. Exemplary conditions are shown in Fig. 1.

Fig. 1. Exemplary experimental conditions used in the current study.

The background color was specified on three basic colors: blue, green, and red. The specific color parameters were selected in such a way that the perceptual differences between them were comparable. Thus, we took advantage of the CIE Lab color system (Robertson, 1977) to choose colors with a similar Euclidean distance between them. The detailed color characteristics for these colors both in the CIE Lab space and in RGB system are provided in Table 1.

Color name	Color sample	RGB	CIE Lab
Blue		#AFD9E2	(84,-12,-9)
Green		#CDD796	(84,-11,30)
Red		#FFC1C1	(84, 23, 9)

Table 1. Detailed specification of background colors used in the present experiment.

A mixture of the three independent variables Background color (Blue, Green, Red) × Dimensionality (Two and Three dimensional appearance) × Shape (Rounded versus Sharp presentation) gives twelve unique experimental conditions. As the within subjects design was employed each subject assessed all the product presentation variants.

2.3 Apparatus, dependent measures, and experimental procedure

Custom made software supported the whole experimental procedure which involves pairwise comparisons of stimuli within the framework of Analytic Hierarchy Process (AHP, Saaty, 1977; 1980).

The examination started with informing subjects about objectives of the research. After the consent of participating in the experiment they provided some basic data about themselves. Then, participants were asked to rate which of the two presented at a time product digital presentations would increase their willingness to buy. The conditions' pairs were displayed in a random order. The condition's left-right location was also set randomly. An example of such a comparison is demonstrated in Fig. 2.

Fig. 2. An exemplary, single comparison displayed by the experimental software.

Apart from presenting digital versions of product packages, the application registered subjects' responses in the database and computed the final subjective hierarchy of examined conditions. The calculations were performed according to the AHP procedure and resulted in obtaining two types of dependent measures, that is, preference weights used for determining conditions' priorities and consistency ratios (CR) allowing for controlling the coherence of subjects' responses.

The experiments were conducted on personal computers and monitors with software and hardware having the same technical characteristics and settings, located in teaching laboratories under the same lighting conditions. Specific procedures of eliciting users' preferences applied in this study may be found in Michalski (2011).

3 Results

3.1 Basic statistical characteristics

Out of 51 subjects participating in this study the results of two were excluded from further analysis since their responses' inconsistencies measured by CR were higher than .25. Additionally, a one way analysis of variance was apply to test whether there are any differences between consistency levels for males and females. Although the mean CR values for women were slightly lower than for men, the discrepancy was not statistically significant $F(1, 49) = 1.62$, $p = .21$.

Hierarchy	Condition		Mean weight (SD)	
1.	**1. Blue Round 3D**		.1491	(.0597)
2.	**9. Red Round 3D**		.1072	(.0569)
3.	**5. Green Round 3D**		.1031	(.0559)
4.	**2. Blue Round 2D**		.0951	(.0379)
5.	**3. Blue Sharp 3D**		.0931	(.0419)
6.	**10. Red Round 2D**		.0789	(.0537)
7.	**6. Green Round 2D**		.0695	(.0372)
8.	**7. Green Sharp 3D**		.0679	(.0372)
9.	**4. Blue Sharp 2D**		.0673	(.0338)
10.	**11. Red Sharp 3D**		.0673	(.0330)
11.	**12. Red Sharp 2D**		.0508	(.0240)
12.	**8. Green Sharp 2D**		.0507	(.0264)

Table 2. Final hierarchy of examined conditions based on mean weights of the purchase intentions. Standard deviations in brackets.

A final hierarchy of the examined product presentations is put together in Table 2 and graphically illustrated in Fig. 3. The ranking is based on the average scores of the perceived purchase intentions called weights. The bigger is the mean weight the higher positive impact has the specific condition on the willingness to buy.

The obtained data shows that the three dimensionally looking, rounded presentation with a blue background was decidedly best with the mean value higher by almost 40% percent than the condition in the second place. One may notice that the first three places in the hierarchy are occupied by three dimensionally looking presentations. It can also be observed that conditions with rounded shapes both two and three dimensional seem to be generally better perceived than their sharp counterparts.

Figure 1 demonstrates that in all cases the three dimensionally looking presentations received higher rates than their corresponding flat variants. The performed LSD Fischer pairwise comparisons tests, given in Table 3 show that these differences are statistically significant at least at the level of .01. The results also reveal that variants with sharp edges having green and red background colors are the worst perceived.

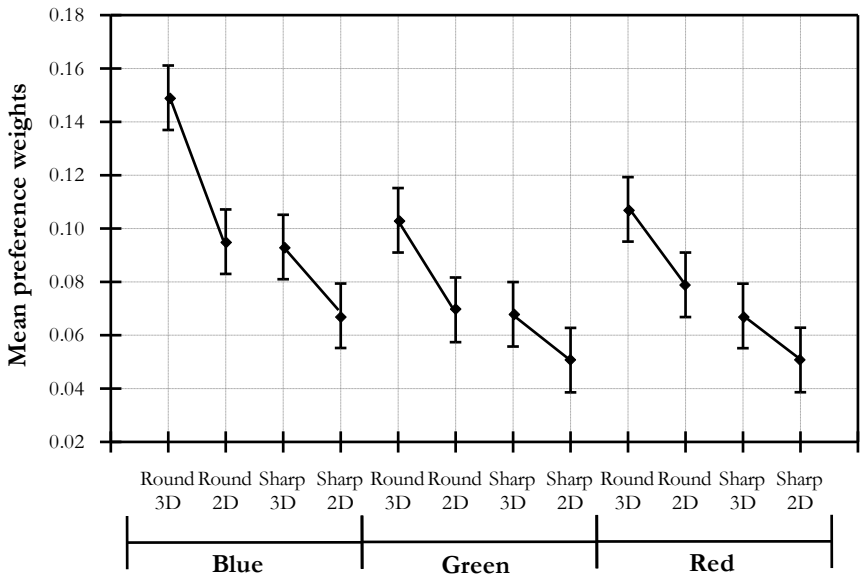

Fig. 3. Average purchase willingness weights for all experimental conditions. Vertical bars denote 0.95 confidence intervals.

Presenting the outcomes of LSD Fischer statistics in Table 3 in such a way that the experimental conditions are decreasingly ordered by their weights one may easily identify four groups separated in the table by horizontal lines. The first one contains only one member *Blue background color–Sharp edges–Three dimensional shape* which was meaningfully better rated than any other condition. There is a similar pattern in the second, third, and fourth group. The differences within a group are statistically irrelevant while differences between members of a given cluster differ considerably with members of other groups.

	BR3	RR3	GR3	BR2	BS3	RR2	GR2	GS3	BS2	RS3	RS2	GS2
BR3	×	.001*	.001*	.001*	.001*	.001*	.001*	.001*	.001*	.001*	.001*	.001*
RR3		×	.64	.17	.11	.001*	.001*	.001*	.001*	.001*	.001*	.001*
GR3			×	.36	.25	.006*	.001*	.001*	.001*	.001*	.001*	.001*
BR2				×	.82	.064**	.003*	.002*	.001*	.001*	.001*	.001*
BS3					×	.10**	.007*	.004*	.003*	.003*	.001*	.001*
RR2						×	.28	.205	.183	.18	.001*	.001*
GR2							×	.85	.80	.79	.031*	.031*
GS3								×	.95	.94	.050*	.049*
BS2									×	.99	.057**	.057**
RS3										×	.059**	.058**
RS2											×	.99
GS2												×

*p < .05; **p < .1; df–degrees of freedom; MS–mean sum of squares; First character denotes the background color, the second: sharp or rounded edges, and the number: 2 or 3 dimensional shape

Table 3. LSD Fischer pairwise comparisons probabilities between all experimental conditions. (Between MS = .00186, df = 576)

3.2 Analysis of variance

A classic, three-way analysis of variance (Color × Shape × Dimensionality) was used to formally test whether the examined factors statistically significantly influence potential customers' mean purchase intentions. The obtained Anova outcomes are put together in Table 4. The data show statistically meaningful effects of all three investigated factors and a considerable impact of the *Shape×Dimensionality* interaction on the average willingness to buy level.

Effect	SS	df	MS	F	p	η^2
Color	.094	2	.047	25	< .0001*	.081
Shape	.17	1	.17	93	< .0001*	.14
Dimensionality	.13	1	.13	68	< .0001*	.10
Color × Shape	.0054	2	.0027	1.5	.24	
Color × Dimensionality	.0086	2	.0043	2.3	.101	
Shape × Dimensionality	.013	1	.013	7.0	.0085*	.012
Color×Shape×Dimensionality	.002	2	.00087	.47	.62	
Error	1.1	576	.0019			

*p < .05; df–degrees of freedom; SS–sum of squares; MS–mean sum of squares; η^2–partial eta-squared

Table 4. Three-way (Color × Shape × Dimensionality) analysis of variance results.

Mean weights for all significant effects are graphically demonstrated in Figs. 4–7 where vertical bars denote .95 confidence intervals. The mean weights visible in Fig. 4 clearly suggest higher purchase intentions for presentations with a blue background color as compared with the variants having either green or red background colors.

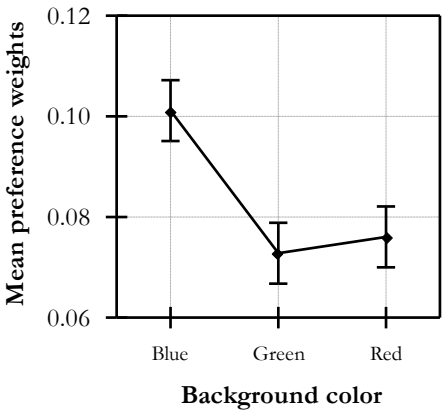

Fig. 4. Mean weights for the *Background color* effect. F(2, 576) = 25, p < .0001.

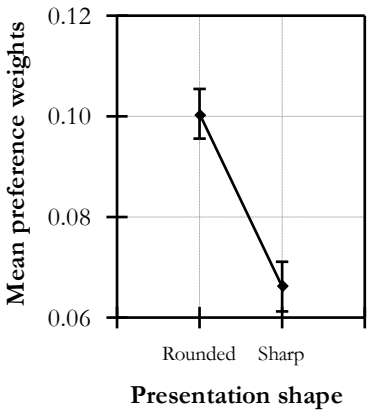

Fig. 5. Mean weights for the *Presentation Shape* effect. F(1, 576) = 93, p < .0001.

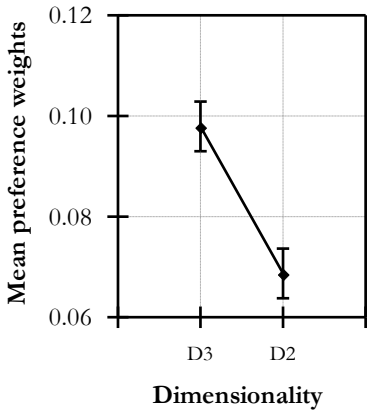

Fig. 6. Mean weights for the *Dimensionality* effect. F(1, 576) = 68, p < .0001.

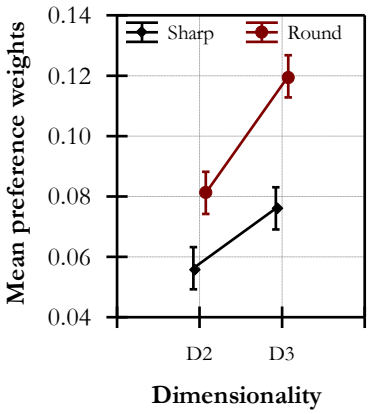

Fig. 7. Mean weights for the *Dimensionality×Shape* interaction. F(1, 576) = 7.0, p < .012.

In order to check if the differences between individual factor levels are meaningful, an additional LSD Fischer' post-hoc analysis was conducted. Its results are given in Table 5 and indicate statistically significant discrepancies between blue-green and blue-red background colors whereas there is no difference between conditions with green and red background colors.

	Blue	Green	Red
Blue	×	< .0001*	< .0001*
Green		×	.46
Red			×

* p < .0001

Table 5. LSD Fischer post-hoc analysis probabilities for the *Background color* factor. (Between MS = .00186, df = 576)

Figure 5 and 6 confirm initial observations made in the previous section and indicate considerably higher mean scores for rounded shapes of product presentations versus the sharp ones, and decidedly better perception of three dimensionally looking presentations as compared with their two dimensional counterparts. The *Dimensionality*×*Shape* interaction shown in Fig. 7 reveals that the roundedness effect is stronger for three dimensionally looking presentations than for the 2D ones.

4 Discussion and conclusions

The current study explores various ways of demonstrating the product in a digital way, which is nowadays very common e.g. in outdoor telebims, monitors showing digital signage messages to potential consumers in supermarkets or electronic shops operating through Internet. The outcomes presented in this paper suggest that the way of product digital presentation significantly affect the expressed willingness to buy an article. More specifically, all of the main examined factors including *Background color*, *Shape*, and *Dimensionality* considerably influenced the subjects' product perceptions.

The best scores received for the blue background color are consistent with the results provided by Middlestandt (1990) where pens presented on a blue background were higher rated than demonstrated against a red background. The bigger willingness to buy products with blue backgrounds was also reported by Ngo et al. (2012) in relation to bottles of still and sparkling water.

This effect is also partly in concordance with investigations conducted in the field of general psychology by Granger (1955) and Guilford and Smith (1959) that showed the general preference of blue over green and green over red. In the present investigation the red background color was more preferred than green, but the difference was statistically insignificant (Table 5). Moreover, so decisive blue background preference over other examined colors may be connected with associating this color with competence (Labrecque and Milne, 2012) which may suite the perception of the smartphone.

Rebollar et al. (2012), in turn, presented that subjects preferred chewing gum packaging in warm (red and yellow tints) colors, more than the cool once (purple-green tints). However, these finding cannot be fully compared with the current study because they used a combination of two colors and smooth transitions between them for a particular package design while we applied uniform background colors.

Rebollar et al. (2012), in addition, showed that purchase willingness is more influenced by the color of the packaging than by its format. This is in contrast with findings of the present experiment indicating that the background color effect is the least important (compare partial eta-squared values from Table 4). The difference may probably be attributed to different natures of the examined products.

The presentation *Shape* factor significantly differentiated the perceived willingness to buy revealing much higher mean rates to rounded conditions. This outcome was rather expected and is consistent with previous studies reporting bigger preferences both for two dimensional curved lines (Ngo et al. 2012; Westerman et al., 2013) as well as three dimensional shapes (Becker et al., 2011). They also support findings derived on the general psychology ground (e.g. Bar and Neta, 2006). Such a result may be explained by anthropological associations of edgy objects with a threat posed by knifes, axes, spears etc.

The *Dimensionality* effect revealed markedly bigger purchase intentions for three dimensionally looking presentations.

Such a result is in concordance with the neurophysiologic findings showing reduced activity in the primary visual cortex while recognizing three dimensional looking shapes (Murray et al., 2002). It seems that real life experiences, where packages are three dimensional objects, could have affected consumers' expectations regarding product digital presentation. On the other hand, the obtained result may be to some degree surprising. One could presume that two dimensional curvatures as simpler objects would require less attentional effort than 3D shapes and thereby be better liked. Favoring the three dimensional conditions could be explained to some extent in light of the results reported by John et al. (2011). The authors, by examining 2D and 3D objects demonstrated that shape understanding is better in a 3D perspective view, whereas manipulating and judging objects relative positions were better performed in 2D views. Thus, probably, consumers could faster identify 3D-like presentation as a real product package than in case of two dimensional variants. This smaller perceptual endeavor could have translated to higher purchase intentions.

It is worth noticing that the obtained in the current investigation Shape ($\eta^2 = .14$) effect size can be categorized according to Cohen (1988) as large while Dimensionality ($\eta^2 = .10$) and Color ($\eta^2 = .081$) effect sizes as medium. The lowest importance is attributed to the Shape × Dimensionality effect size ($\eta^2 = .012$) which can be described as small. Despite this, the significant interaction between Dimensionality and presentation Shape is still interesting since it indicates that the examined factors may be interdependent. In this case, the Shape factor influence is amplified by the Dimensionality effect.

One should take into account various limitations concerned with the presented results when extending or generalizing them on other situations. First, the participants represented a very specific group of people: young, undergraduate students and the obtained finding may not apply to other populations. It should be also noted that though the number of males and females was comparable, this effect was neither controlled nor analyzed. This could have had some impact on the subjective responses especially regarding the Background color factor since there are studies showing gender differences in this regard (e.g. Grobelny and Michalski, 2015).

Some future investigations may be directed to compensate the abovementioned drawbacks and extend the ecological validity of the obtained outcomes by conducting experiments with real packages and in real circumstances. Some additional studies can be focused on different types of products to whether the results would be similar.

Despite these shortcomings, the current study results increase our knowledge about human visual behavior in a specific marketing context. It may also be assumed that subjective responses examined in the present experiment will affect the real purchase decisions. Therefore knowing the described in the current study findings and applying them during the design process would not only extend our knowledge about processing visual information by potential consumers but also be beneficial for practitioners.

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