UNDERSTANDING THE EFFECT OF SPATIAL COLORS ON GUESTS' PERCEPTION OF THE HOTEL ROOM USING VIRTUAL VISUALIZATION TECHNIQUES

By

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Abstract: Color is one of the key visual dimensions of the environment. The investigation of the effects of color schemes in public places showed that color has an impact on behavior and emotions. The emotional effect of color is particularly important in the hospitality industry because emotions comprise a strong affective component of customer satisfaction. However, no empirical research on the role of color in shaping hotel guests' perceptions has been done so far. The purpose of the current study was to understand the relationship between color attributes and the perception of colors in the hotel room. The differences between two contrast hues (blue and red) with two levels for saturation and brightness were analyzed in this study. The Pleasure-Arousal-Dominance (PAD) scale was used to measure the emotional response of the participants. In addition, cultural differences between Eastern and Western cultures in the color perception were tested.

In total, 141 participants took part in the study. Each participant was randomly assigned to one of eight 3D models of the hotel rooms that they further viewed using the Virtual Reality Head-Mounted Displays. The data on the participants' color perceptions were collected using the survey.

The results show that red hotel rooms were associated with the highest arousal levels among participants. However, participants enjoyed staying in blue hotel rooms more than in the red ones. The individual color preferences had an important relation with the perception of the hotel room. Participants who indicated blue as their favorite color had a significantly higher pleasure level in blue rooms than subjects with color preferences other than red and blue. In the same way participants that preferred the red color perceived red rooms as more pleasant. Significant differences in dominance levels were found in the red group of treatments. Differences between Western and Eastern cultures were also found. The Eastern culture group had a higher arousal level in the low brightness settings than the Western culture group. Thus, it can be concluded that representatives of the Eastern culture are more sensitive to the brightness of the color than the Western culture group.

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CHAPTER I

INTRODUCTION

The atmospherics defined as the environment where the product is consumed or purchased has long been acknowledged as an important marketing tool (Kotler, 1973). According to Kotler (1973) color is one of the key visual dimensions of the environment. The influence of interior and interior color schemes on customer perception of the environment in stores, malls, restaurants, and hospitals has been a popular research topic (Chebat & Morrin, 2006; Dijkstra, Pieterse, & Pruyn, 2008; Kuller, Mikelllides, Janssens, 2008; Kwallek, Woodson, & Lewis, 1996; Yildrim, Akalin-Baskaya, & Hodayetoglu).

However, color related research was only recently systematized within one unifying color-in-context theory that is aimed at explaining all various previous research on the topic. According to the color-in-context theory the psychological influence of color on emotions and behavior is non-conscious and is both biological and culturally learnt (Elliot & Maier, 2007). The investigation of the effects of color schemes of public places go in line with the color-in-context theory indicating that color has an impact on behavior and emotional states (Chebat & Morrin, 2007; Valdez & Mehrabian, 1994; Yildrim, Akalin-Baskaya, & Hodayetoglu). The major color attributes causing emotional and behavioral response are saturation, lightness (brightness), and hue (chroma). In particular, Valdez and Mehrabian (1994) found that there was a strong relation between combinations of hue, saturation, and brightness: the three major components of color and the emotional response in terms of arousal, pleasure, and dominance. With regard to behavioral

impact of colors, the feelings of arousal and pleasure stimulated by interior environment were found to be significant "mediators" influencing customer's shopping behavior (Donovan & Rossiter, 1982). In multiple field and lab experiments interior color was proven to impact time spent in the store and retail sales (Bellizzi & Hite, 1992). Finally, research on culture-based impact of color gave mixed results. Yet, multiple studies proved that there were culture-related differences in color perception (Chebat & Morrin, 2007; Ralph, Zaleski, Otto, Reidl, & Tarabrina, 1997).

So far no empirical research on the influence of color on hotel guests' perceptions has been done (Countryman & Jang, 2006). The exploratory study by Countryman and Jang (2006) showed that color had the most significant impact on the perception of the ambience in the hotel lobby (Countryman & Jang, 2006; Jani & Han, 2014). Also previous studies found that hotel ambience and interior color in particular had impact on customer satisfaction in restaurants, hotel bars, satisfaction with hotel stay and future loyalty (Jani & Han, 2014; Ryu & Jang, 2007; Lin, 2009). Most noteworthy, a study by Lin (2009) showed the relationship between the color and customer satisfaction was fulfilled through the moderating role of emotions. At the same time previous color related research in the hospitality industry was limited to the analysis of color hue and did not control for other color attributes such as brightness and saturation, which have been previously shown to have significant effect on emotions (Valdez & Mehrabian, 1994; Countryman & Jang, 2006; Lin, 2009). Consequently, the effects of all three major color attributes (hue, saturation, and brightness) were analyzed in the current study.

Multiple studies showed that customers' arousal and pleasure levels have strong correlation with satisfaction in hotel and restaurant settings (Lin, & Mattila, 2010; Lin, 2009). These findings go in line with the previous research on customer satisfaction, which states that customer satisfaction has a strong affective component (Mano & Oliver, 1993; Westbrook, 1987; Westbrook & Oliver, 1991). Westbrook and Oliver (1991) state that customers refer to emotions

developed during the consumption process when they assess their satisfaction level. Thus, emotional response can be considered a proxy for such post consumption response as customer satisfaction and will be used in the context of the current study.

The Pleasure-Arousal-Dominance (PAD) model introduced by Meharabian and Russel (1974) is commonly used to measure emotional response in the satisfaction context (Oliver, 2010). According to the classical view, satisfaction is associated with pleasant and low arousal emotions, while dissatisfaction is associated with unpleasant/high arousal affects (Oliver, 1997). Based on the previous research the following model, presented in the Figure 1, was suggested.

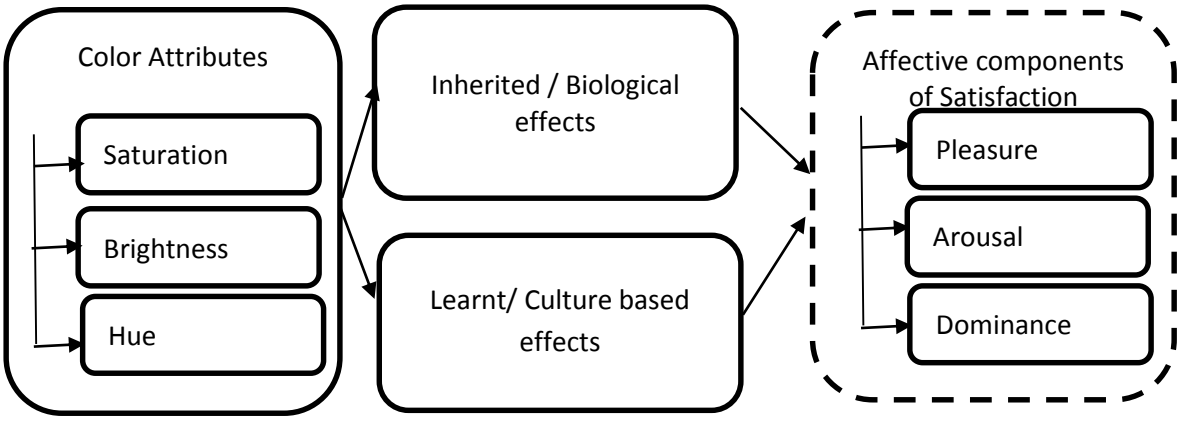


Figure 1. The model of the relationship between color attributes and emotions

The purpose of the current research is to understand how color attributes of spatial colors influence guests' perception of the hotel room's colors. The emotional response to colors was measured with help of the PAD model. The model has been used in the multiple studies analyzing emotional response to colors, including spatial colors (Valdez & Mehrabian, 1994; Bellizzi & Hite, 1992). The model is using bipolar adjective groups to evaluate the psychological effect of color on the feelings of arousal, pleasure, and dominance.

Though the primary goal of the current study was to analyze the perception of the hotel room's colors, it also examined the cultural differences in the perception of color. In particular,

the study analyzed the differences in color perception between the Eastern (including Asian and Middle East countries) and Western (comprising countries of Americas and Europe) cultures.

The major research questions of the current study are:

1. Which combination of color attributes will produce the most favorable perception of a hotel room according to PAD dimensions?

2. Are there significant differences in the perception of color among the Eastern and Western cultures?

Understanding effects of color attributes will help hotel managers and designers to enhance guests' experiences through improving hotel's ambience and, thus, guests' emotional state. The findings of the study will help hotel managers in selecting color schemes that will result in pleasant low arousal emotions, which were associated with customer satisfaction in the previous literature (Oliver, 1997).

CHAPTER II

LITERATURE REVIEW

Color and Its Attributes

Color is a critical component of the visual dimension, one of the four major dimensions of the spatial environment that have the most significant effect on the customer together with aural (volume), olfactory (scent), and tactile (softness) dimensions (Kotler, 1973). Color-in-context theory was proposed by Andrew Elliot and Markus Maier and it provides a broad model explaining color perception and its influence on behavior and the physical state of a person (Elliot & Maier, 2007). The theory is based on the premise that each color is associated with some meaning and that people obtain color associations in two major ways: by learning or as a part of the biological "heritage" (Elliot & Maier, 2007). Also, according to the color-context theory the response to color is always non-conscious (Elliot & Maier, 2007). This means that a person cannot control the emotional and physiological effects of color. At the same time, Elliot and Maier (2007) recognize the existence of reciprocal relations between color perception, behavior, and cognition. This means that the emotional state that a person had prior being exposed to color has an impact on how the person perceives the color. Also the results of study examining color preferences of 98 college students showed that perception of color highly depends on the previous experience with color (Kaya & Epps, 2004).

Finally, the theory places a great role on the context in which the color is being observed (Elliot & Maier, 2007). Thus, a new environment can change the effect of color and prompt a different association with it. For instance in the study of Meier, D'Agostino, Elliot, Maier, and Wilkowski (2012) showed that the red color had a different effect on subject's behavior in romantic settings in comparison to the "achievement-related context".

The most challenging aspects in the research related to color are the methodological differences in defining the color included in the experiment (Elliot & Maier, 2007). The two most popular color models are the RGB and the LHS models (Lewkowitz & Herman, 1993). According to the RGB model all colors can be derived by combining the three basic hues: blue, green, and red. While the RGB model is more technical and is commonly used in computer graphics, the LHS model is more intuitive for humans. The LHS model looks at color in terms of its lightness (brightness), hue, and saturation. Hue is attributed to the wavelength of color and essentially is what people usually refer to as color. Saturation, also known as chroma, refers to the intensity of the hue in terms of how different it is from gray and can be defined as "the ratio of the projected color vector to the length of the longest color vector in the same direction" (Lewkowitz & Herman, 1993, p.274). Lightness is similar to brightness and refers to the "white-to-black quality of a color" (Elliot & Maier, 2007, p.66). Lightness also is sometimes referred to as value that is defined as a relative darkness or lightness of a hue. The manipulation of color in the LHS model is conducted by adding tints (white color), shades (by adding black color), and tones (a mix of white and black) (Lewkowitz & Herman, 1993).

The current study is aiming at understanding the effects of saturation, brightness, and hue of the hotel room wall color on emotional response of the guest. Thus, above mentioned attributes are the primary independent variables in this study, while the three measures of emotional response serve as the dependent variables and were based on the PAD-scale (pleasure, arousal, and dominance).

Physiological and Psychological Effects of Color

Physiological effects of color

Colors were found to have a significant effect on heart rate, pulse, blood pressure, and brain wave activity (Ueda, Hayashi, Kuroiwa, Miyoshi, Kashiba,Takeda, 2004; Shimagami and Hihara, 1991; Shimagami and Hihara, 1992; Yoto, Katsuura, Iwanaga, Shimomura, 2007). According to the classical view proposed by Goldstein (1942), warm (long-wave) colors lead to increased activity while cool (short-wave) colors lead to the opposite effect. However, several modern studies indicate the opposite results (Yoto, Katsuura, Iwanaga, Shimomura, 2007; Shimagami and Hihara, 1992). In addition colors were found to affect other functions of body including those related to the sensation of hunger and appetite. Red and yellow colors were shown to influence the metabolism. In particular, subjects tended to consume more food in the red room (Caan, 2007). Exposure to yellow environment intensified the feeling of hunger in subjects (Caan, 2007).

Spatial colors were found to have effect on work productivity and the quality of task performance (Mehta & Zhu, 2009; Yildirim, Akalin-Baskaya, & Hidayetoglu, 2007). Cool colors like blue boosted creative thinking, while warm colors like red facilitated performance of tasks requiring attention to details (Mehta & Zhu, 2009). Interestingly, Verma, Mittal, Mittal, Singh, and Munjal (2010) show females in general are more capable at distinguishing between different shades of colors than males.

Tsutsumi, Kitamura, Kozaki, Ueda, Higashihara, Horinouchi, Noguchi, and Ishibashi (2002) state that exposure to high color temperatures (warm colors) prior to sleep leads to increased autonomic nerve activity in the sympathetic nervous system at night. Thus, colors may indirectly influence the quality of sleep at night through their impact on the sympathetic nervous system and heart rate. Furthermore, Johnson (2013) identified increased activation of the

sympathetic nervous system and the variability of heart rate as the major reasons for poor sleep. Thus, it can be assumed that warmer temperature colors (red, yellow, orange) may have negative impact on the quality of sleep in the hotel room.

Psychological effects of color

According to the color-in-context theory the psychological effect of color is attributed primarily to hue, lightness, and chroma (Elliot & Maier, 2007). Thus, it can be assumed that the attributes of the wall color of the hotel room in terms of hue, lightness, and chroma would impact the psychological state of guests.

A number of independent experiments showed that certain colors were consistently associated with particular mood-tones which gave grounds to the claim that there were universal color-mood relationships between some colors and mood-tones (Chebat, & Morrin, 2007; Countryman, & Jang, 2006; Dijkstra, Pieterseb, & Pruyn, 2008; Kuller, Mikellides, & Janssens, 2009; Yildirim, Akalin-Baskaya, & Hidayetoglu, 2007). Therefore, it is possible to predict and even manipulate the effect of color on a person's mood. Previous research has shown that color may have arousing and calming effect on emotions (Dijkstra, Pieterseb, & Pruyn, 2008; Valdez & Mehrabian, 1994). For example, green was proved to have soothing and stress-reducing properties (Dijkstra, Pieterseb, & Pruyn, 2008). On the other hand, exposure to the red wall color in the office caused the increased feeling of dysphoria among workers (Yildirim, Akalin-Baskaya, & Hidayetoglu, 2007).

The study by Camgöz, Yener, and Güvenç (2002) and (2004) analyzing the effect of saturation and brightness on color perception of 123 students found that the colors with highest levels of saturation and brightness such as yellow, yellow-green, cyan, red, and magenta were most preferred and attracted the highest attention levels.

Color preferences were found to be also affected by gender. In particular, Hurlbert and Ling (2007) found significant differences in the "hue preference curves". In particular, women preferred the colors in the "reddish-purple region", while men most preferred hues belonging to the "blue-green" region. In addition, Zenter (2001) stated that changes in emotional reaction to colors appear with the increase of age.

While many researchers examine intuitional color-emotion associations of responders, Valdez and Mehrabian (1994) attempted to create a comprehensive system of measures to assess color-emotion relations. In particular, Valdez and Mehrabian (1994) explored the effect of color hue, its saturation, and brightness on emotional response using Pleasure-Arousal-Dominance model. Pleasure can be defined as the "positive versus negative evaluation of affective states" (Meharabian, 1996, p.262). The findings of Valdez and Mehrabian (1994) show that colors with higher levels of brightness and saturation lead to higher pleasure levels in subjects with brightness having a higher effect on the feeling of pleasure than saturation. Beach, Wise, and Wise (1988) conclude that environmental colors with high levels of lightness and low levels of saturation are considered the most pleasant. Kuller, Mikelides, and Jansens (2008) state that blue color wall color was considered less pleasant than red color in the office settings.

Arousal refers to the "level of mental alertness and physical activity" (Meharabian, 1996, p.262). High saturation levels and low brightness levels of a color was associated with higher arousal levels (Valdez & Mehrabian, 1994). Blue was found to have a calming effect while red is associated with an arousing effect (Stone, 2003).

Dominance is defined as "a feeling of control and influence over one's surroundings and others versus feeling controlled or influenced by situations and others" (Meharabian, 1996, p.263). Colors with low levels of brightness and high levels of saturation were found to affect the feeling of dominance (Valdez & Mehrabian, 1994).

Table 1 summarizes the major findings on the psychological effects of color.

Table 1

The summary of psychological effects of color

Hue		Saturation		Brightness		Results
Blue	Red	Low	High	Low	High	
			■		■	• High pleasure (Valdez & Mehrabian, 1994) • The most preferred colors (Camgöz, Yener, & Güvenç, 2002 & 2004)
		■				• High pleasure (Beach, Wise, & Wise,1988)
			■	■		• High arousal and dominance (Valdez & Mehrabian, 1994)
	■					• Has arousing property (Stone,2003) • More pleasant in the office settings (Kuller, Mikelides, & Jansens, 2008)
■						• Has soothing property (Stone,2003)

Based on the described above facts, it can be expected that colors with higher levels of saturation and brightness will result in higher level of pleasure in the hotel room settings and the following hypotheses can be derived:

H1a: Colors with high levels of saturation and high levels brightness will result in the higher levels of pleasure when compared to the other color treatments.

H1b: Colors with high levels saturation and low levels of brightness will result in the higher levels of pleasure in the hotel room when compared to the other color treatments.

Additionally, it is expected that participants will show higher arousal levels in rooms with wall color having high saturation and low brightness levels.

H1c: Colors with high levels of saturation will result in the higher levels of arousal in the hotel room settings when compared to the other color treatments.

H1d: Colors with low levels of brightness will result in the higher levels of arousal in the hotel room settings when compared to the other color treatments.

Finally, participants exposed to hotel room models less bright and more saturated colors will have a stronger feeling of dominance.

H1e: Colors with high levels of saturation will result in the higher levels of dominance in the hotel room settings when compared to the other color treatments.

H1 f: Colors with low levels of brightness will result in the higher level of dominance in the hotel room settings when compared to the other color treatments.

The effects of red and blue colors

The Best Western color samples were used in this study. The Google Image search was used to find the pictures of hotel rooms and the examples of the hues. Blue and red colors were popular hues used in the Best Western hotel chain. Also blue and red were selected as the analyzed hues in this study due to their interesting contrast nature. Red and blue colors are highly researched colors in the area of color psychology. Zentner's (2001) investigation of color-mood associations in children showed that red was the most preferred color for children in the early childhood. At the same time blue was most commonly associated with sadness. The same study also acknowledges the change in color preferences with age from red to blue. Though Silver and Ferrante (1995) found significant differences in color perception between college students and older adults, blue color was identified as the most preferred color by both age groups regardless

of gender. The findings of Koch and Koch (2003) state that red and blue colors have significant associations with tastes. Red color has a positive association with sweet or non-citrus fruit taste and is negatively associated with bitter. Blue color was negatively associated with sour and bitter.

Blue and red color were found to have an important impact on physiological functions. Blue is considered to have a calming effect while red is considered to have an arousing effect (Stone, 2003). Ueda, Hayashi, Kuroiwa, Miyoshi, Kashiba, and Takeda (2004) in their study of difference in EEG responses among colors found that blue color had a higher relaxing effect than red and white. Shimagami and Hihara (1991) and (1992) results show that participants had highest blood pressure and the lowest values for pulse and skin temperature when exposed to blue illumination. These finding were supported for the blue and red colors in the study of Kuller, Mikelides, and Jansens (2008). In particular participants had lower heart rate in the red room in comparison to the blue room. At the same time participants had the lowest arousal level under the blue light and the highest arousal under the red light. On the contrary, Yoto, Katsuura, Iwanaga, Shimomura (2007) and Bommel and Beld (2004) state that cool colors and blue light in particular had higher physiological arousing effect than warm colors like and red light in particular. Yoto and al. (2007) propose an explanation for this paradox suggesting that physiological calming effect of blue may be not related to the physiological activating effect of blue. The major purpose of a hotel room is to provide guest with a comfortable place to sleep, thus soothing effects of the blue color are of the great interest in the current study. Thus, the following hypothesis was developed.

H2 The use of the blue color in the hotel room will be associated with the lower level of emotional arousal than the use of the red color.

With regard to applications of red and blue color in office settings, the results of Kwallek, Woodson, and Lewis (1995) show that red color is also associated with increased feeling of

dysphoria among workers in comparison to blue environments. However, the effect of room color on workers productivity was only significant when individual characteristics such as screening abilities were taken in consideration. In the experiment by Kuller, Mikelides, and Jansens (2008) comparing emotional response to office wall colors, blue office was found to be significantly less pleasant than a red room. On the contrary, in the retail setting, blue color was found to be a more favorable shopping environment than a red store environment (Bellizzi & Hite, 1992). This finding was also supported by results of Valdez and Mehrabian (1994) that state that short-wavelength hues like blue are in general considered as more pleasant.

In addition, Bellizzi and Hite (1992) found that customers tent to purchase more expensive products from blue displays. As well as customers were less likely to postpone purchase in a blue store in comparison to a red store. Finally were more willing to walk around and explore a blue store's environment. Middlestadt (1990) conducted an experiment in which he presented to participants a picture of the same pen on red or blue background. The results of the study show that people viewing the pen on the blue background were more willing to purchase the product.

Despite, the vast body of research on blue and red colors in marketing there is only a limited number of studies examining the effects of red and blue colors in hospitality. The effect of red color was mostly analyzed in application to restaurant settings as one of the color stimulating the feeling of hunger. In hotel environment blue and red colors were used as a part of tranquil & dynamic bar designs respectively (Lin, 2009). The bar design with red color was associated with higher levels of arousal among participants than the color scheme using blue color.

The summary of the effects of blue and red color is presented in Table 2.

Table 2

The comparison of the effects of blue color versus. red color

Effect	Blue color	Red color	Source
Age	Blue is the most preferred color among adults	Red is the most preferred color for children.	Zentner (2001)
Soothing/ Relaxing versus Arousing effects	Blue color has a calming effect and relaxing effect.	Red is less relaxing and more arousing.	Stone (2003);Ueda, Hayashi, Kuroiwa, Miyoshi, Kashiba, and Takeda (2004);
Physiological activation	Participants had higher pulse and heart rate under the blue light than red.	Participants had lower pulse and heart rate under the red light than blue.	Yoto, Katsuura, Iwanaga, and Shimomura (2007); Kuller, Mikelides, and Jansens (2008).
Taste	Blue color is negatively associated with sour and bitter.	Red has a positive association with sweet or non-citrus fruit taste and is negatively associated with bitter.	Koch and Koch (2003)
Differences in color perception in the office settings	Blue office was found to be significantly less pleasant than red room	Red color increased the feeling of dysphoria among office workers.	Kwallek, Woodson, and Lewis (1995); Kuller, Mikelides, and Jansens (2008)
Differences in color perception in the retail settings	Blue shopping environment was considered more favorable than the red environment.. Customers purchase more expensive products from blue displays. Customers spend more time blue store than the red store.	Customers were more likely to postpone purchase in a red store in comparison to a blue store.	Bellizzi and Hite (1992)

Color in Retail and Hospitality Environments

Color has influence on the customer behavior and the perception of the environment in multiple ways. For example, color has an impact on the intensity of human interaction. The study by Caan (2007) showed that subjects tended to stay in groups and interact with each other more when exposed to warm color environments. On the opposite subjects exhibited less grouping intention surrounded with cool colors. Multiple studies show that environmental colors have an important effect on the perception of store environment (Bellizzi & Hite, 1992; Babin, Hardestry, & Suter, 2003). Store colors were shown to have an effect on customer's purchase level and time spent in the store (Bellizzi & Hite, 1992). Customers found blue store environment more attractive than red environments. As well as customers tended to purchase more goods in blue shopping interiors.

With regard to the hospitality industry, elements of interior aesthetics such as interior colors were found to be one of the three most important environmental elements influencing customer's arousal and pleasure in the restaurant settings (Ryu & Jang, 2007). An exploratory study examining the impact of various elements of a hotel lobby environment found that color was one the most important elements influencing the perception of the hotel lobby (Countryman & Jang, 2006).

The emotional effects of color described earlier in detail is especially important in the retail and hospitality environments because emotions comprise a strong affective component of customer satisfaction (Mano & Oliver, 1993; Westbrook, 1987; Westbrook & Oliver, 1991). The findings from the study of Lin (2009) state that color has an important impact on customer emotions and satisfaction in hotel bars. Lin (2009) showed that different designs of the bar (and the color layouts) have different effect on the guests. The video about a bar designed with bright colors and vivid music led to higher arousal levels among participants and was related with a

higher satisfaction level with the bar's ambience, while the video of the bar designed with pale colors and tranquil music was associated with lower arousal levels in subjects and a lower satisfaction level. Jani and Han (2014) discovered that hotel ambience including interior colors, lightning, and layouts is an important factor that influences hotel guests' loyalty by moderating the impact of the hotel image and guests' satisfaction. Jani and Han (2014) found that the impact of satisfaction on hotel loyalty is the strongest in the group expressing the appraisal of the hotel ambience. In addition, Lin (2009) mentions that customers prior color associations and expectations about servicescapes may affect the perception of the servicescape. It will be also interesting to analyze if customers individual color preferences formed before visiting the servicescape (such as a hotel room) can also effect the perception of the environment. Thus, the following hypothesis was developed:

H3 There will be a relationship between individual color preferences and the perception of the hotel room's color.

Affective Components of Satisfaction

The impact of color on the emotional components of satisfaction found in the hospitality literature goes in line with findings of Westbrook and Oliver (1991). That is emotions obtained during the product consumption process later affect satisfaction evaluations through their affective footprints. The classical approach to the consumer satisfaction states that satisfaction is associated with pleasant / low arousal emotions, while dissatisfaction is associated with unpleasant/high arousal affects (Oliver, 1997). Oliver (2010) showed that emotions most commonly attributed to the pleasant and low arousal group in the previous research include joyful, cheerful, content, and relaxed. In particular, in the Affect Circumflex Model presented below in the Figure 2, among emotions of the pleasant and low arousal segment, "joyful" was indicated as the highest in arousal and "relaxing" was indicated as the lowest in arousal.

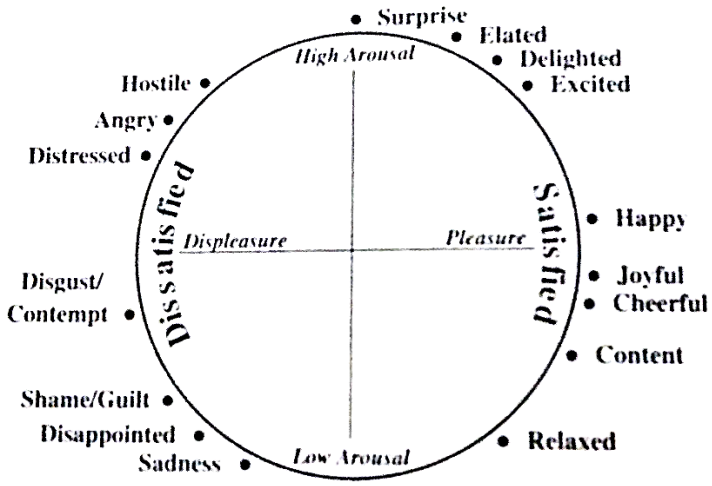


Figure 2. Synthesis of Affect Circumflex Models containing satisfaction and dissatisfaction

Source: Oliver (2010)

Based on the previous literature review, the blue color is commonly referred as more soothing and relaxing, while red color is commonly associated with high arousal levels (Kuller, Mikelides, & Jansens, 2008; Ueda, Hayashi, Kuroiwa, Miyoshi, Kashiba,&Takeda, 2004). The soothing and relaxing effect of cool temperature colors is particularly important for hotel room color design because an opportunity for relaxation is one of the primary factors of hotel choice (Wilensky, & Buttle, 1988). It will be interesting to test whether Oliver's classification stands in the hotel room settings. That is, whether the feeling of relaxation that Oliver (2010) classifies as low arousal and pleasant emotion, will be attributed to blue rooms rather than to red rooms.

H4: The use of the blue color in the hotel room will be associated with the higher level of relaxation among participants than the red color.

In addition, Oliver (2010) attributes the feeling of joy to the low arousal context. Thus, it is proposed to test whether participants will enjoy blue rooms, associated with low arousal in the previous literature, more than the red rooms, commonly associated with the opposite effect.

H5: Participants will enjoy room with blue hue more than rooms with red hue.

Color Preferences and Meanings in Different Cultures

According to color-in-context theory, emotional reaction to colors may be also influenced by cultural environment when a person learns some culture specific color association. A number of researchers emphasize a significant role of cultural factors on differences in color perceptions (Adams & Osgood, 1973; Chebat & Morrin, 2007; Tofle, Schwartz, Yoon, Max-Royale, 2004). For example, some colors may be disapproved of in some nations because they represent a traditional color of mourning (Adams & Osgood, 1973; Winick, 1963). The examples of that can be purple and white - mourning colors in some of the Asian countries (Winick, 1963). The color that is most commonly disapproved by the majority of the nations is black, and the color that is never disapproved is blue (Winick, 1963). Choungourian (1968) provides the evidence that nations exhibit different color preferences. The research on color preferences of 160 undergraduate students from USA, Lebanon, Iran, and Kuwait showed that red and blue are highly preferred by the US students but were not ranked high by responders from other countries (Choungourian, 1968). At the same time, green was the most preferred color for students from Iran and Kuwait and least preferred by the US responders (Choungourian, 1968). In addition, cross-cultural differences in color associations with such emotions as anger, envy, fear, and jealousy in Germany, Mexico, Russia, and Poland also point on differences among countries. Though the chosen nations shared common associations with jealousy (red) and anger (black), significant differences were found with regard to envy and fear (Ralph, Zaleski, Otto, Reidl, & Tarabrina, 1997). For example, the Russians and Germans associated envy with yellow, while the Americans associated it with green and the Mexicans and Poles related envy to purple (Ralph, Zaleski, Otto, Reidl, & Tarabrina, 1997). Also Ralph et al. (1997) state that language, mythology, and literature are the primary sources of color-emotion similarities and differences (Ralph, Zaleski, Otto, Reidl, & Tarabrina, 1997). Adams and Osgood (1973) show that there are some

cross-cultural similarities in color-meaning associations in their study of 23 teenage male groups in 20 countries. For instance, black was commonly referred as bad, strong and passive; yellow as weak; blue and green as good (Adams & Osgood, 1973; Tanaka, Oyama, & Osgood,1963).

The study of Madden, Hewett and Roth (2000) analyzing differences in color perception of 10 colors among 253 undergraduate students representing four cultures (Europe, East Asia, South America, and North America) found that there were no significant differences in color associations for black, red, green, and white. However, significant differences in color preference among cultures were found for blue, brown, gold, orange, purple, and yellow. In general, blue was the top most preferred color among all four cultures. Representatives of all analyzed cultures tend to cluster green, blue, and white together assigning to them the similar meanings related to peace, and calmness. Black and brown were commonly associated with sadness among all cultures and sometimes with masculinity (USA, Austria, Hong Kong). Red color had a lot of differences in meaning across the cultures. The most common association with red was as a hot and active color.

Finally, the study of Sakamoto (2013), analyzing the differences in color preferences between the Eastern and the Western Cultures, showed that there were no significant differences in color preferences between the two cultures. However, Eastern culture representatives showed an important preference toward the black color in products, while the Western culture countries had multiple popular colors for products (black, yellow, red, and blue). The literature on the cross-cultural differences in color perceptions is to some extent contradictive and further research on this topic is required. The findings about color emotions associations are summarized in Table3.

Table 3

The summary of the findings on color associations among cultures

Meaning	Color	Authors
Peace and calmness	Blue, Green, White	Madden, Hewett, and Roth (2000).
Most preferred	Blue, Black (products), Green	Choungourian (1968); Sakamoto (2013) Madden, Hewett, and Roth (2000).
Sadness	Brown, Black	Madden, Hewett, and Roth (2000).
Death	Purple, White, Black	Winick (1963).
Activity	Red	Madden, Hewett, and Roth (2000).
Jealousy	Red	Ralph, Zaleski, Otto, Reidl, and Tarabrina (1997)
Anger	Black	Ralph, Zaleski, Otto, Reidl, and Tarabrina (1997)
Envy	Yellow, Purple	Ralph, Zaleski, Otto, Reidl, and Tarabrina (1997)
Weak	Yellow	Adams and Osgood (1973)
Strong	Black	Adams and Osgood (1973)

Based on the discussed literature review, the following hypothesis was developed.

H6: Hotel room color perception will vary among Eastern and Western cultures.

Virtual Visualization Techniques

The Virtual Reality (VR) tools have undergone a long way from Morton Heilig's Sensorama in the 50s, to the first Head-Mounted Displays (HMD) in the 60s, and eventually to the modern day HMDs such as Oculus HMD (Boas, 2013). Oculus HMD provides 110 degrees

view of the virtual environment. It employs stereoscopic vision to create the 3D image of the environment, as well as it incorporates gyroscope, accelerometer and magnetometer for tracking user's moves and updating the images in the HMDs accordingly.

Over the recent years Virtual Visualization techniques have become popular instruments for testing visual perception of space (Wilson & Soranzo, 2015). The advantages of the Virtual Visualization techniques include higher ecological validity in comparison to the traditional tools, as well the higher control of the elements of the visual scene, such as illumination and location of the objects in space (Wilson & Soranzo, 2015). The ecological validity of the Virtual Environment implies that it is not significantly different from the physical environment. The previous research confirmed that subjects perform in a similar way in both physical and virtual settings (Heydarian, Carneiro, Gerbera, Becerik-Gerber, Hayes, & Wood, 2015). In particular, no significant differences among participants with regard to task performance, color and object recognition, and the feeling of presence were revealed in the physical room versus its virtual copy. The results of Martini, Perez-Marcos, and Sanchez-Vives (2013), examining the effects of color in the VR, go in line with results of Landgrebe, Nyuyki, Frank, Steffens, Hauser, Eichhammer, Hajak, Langguth (2008) obtained in the physical environment. This gives grounds to conclude that virtual environments provide adequate representation of the physical environments.

Soranzo and Wilson (2014) point out the particular advantages of Visual Virtualization techniques over traditional methods in color perception studies. In particular, Soranzo and Wilson (2014) emphasize that Visual Virtualization techniques helps to overcome the problem of color constancy phenomenon that color related studies face in the physical environment. That is, the perception of color can be affected by the illumination level. It can be hard to duplicate the light settings in the physical environment but it can be completely controlled in the virtual settings.

In addition, Virtual Visualization techniques help to address the issues related to the color contrast phenomenon, that colors observed against different background colors are perceived differently (Soranzo & Wilson, 2014). This quality of color is challenging when the printed pictures of the room, with manipulated colors, or the printed samples of colors are presented to participants to analyze their color perception. In this case researchers have low control over the effect of physical surroundings on the perception of the colors on the picture. Virtual environments on the contrary provide a complete visual immersion of participants in the experimental conditions.

Multiple factors can affect the level of the subject's presence in the VR. These factors can be related to subject's personal characteristics, as well the level of presence depends on the level of immersion, which is attributed to the characteristics of the VR equipment (Ling, Nefs, Brinkman, Qu, & Heynderickx, 2013; Wilson & Soranzo, 2015).

Some significant differences in the VR perception were found between models of HMDs (Li, Zhang, Nordman, & Kuhl, 2015). Thus, the manipulation check was conducted to examine the differences in the color perception between two models of HMDs used in the current study.

CHAPTER III

METHODS

Research Design

Quasi-experimental design was used to collect data in the current study. The goal of the experiment was to assess the impact of color attributes (saturation, brightness, and hue) of the wall color of the hotel room on emotions (pleasure, arousal, and dominance). Emotional response was measured in terms of pleasure, arousal, and dominance levels utilizing the PAD model (Mehrabian & Russel, 1974). The ethnicity information was collected to provide the comparison of the color perceptions between Eastern and Western cultures. The experiment also accounted for differences in demographic characteristics of participants in terms of gender, and age.

The Best Western Hotel Chain was used for samples of hotel rooms' wall color solutions. Two hues (blue and red) were selected based on Google search results for Best Western hotel rooms' designs. Blue and red were found to be among popular colors used in the Best Western hotels. As well, these colors were found to have strong contrasting effects in the previous literature, and thus were of high interest for research in the hospitality industry. Two levels of saturation and brightness were applied to blue and red hue samples obtained from the web search. Consequently, the experiment employed 2x2x2 design with two manipulated hues (red and blue) and two levels of saturation and brightness (high, low).

So far, the most common experimental designs for examining color impacts on emotional state included manipulations of environment such as building rooms with walls of different colors or adding decorations with a particular pattern or color to the existing environment (Caan, 2007; Chebat & Morrin, 2007). A simplified version of such approach focused on providing pictures of a room with manipulated colors (Countryman & Jang, 2006). The common drawback of this approach was the lack of control of environmental factors influencing respondents.

The current study overcomes the abovementioned drawback by means of the VR technology. In particular, participants were exposed to one of eight 3D models of hotel rooms using the Oculus HMDs. Each model had either blue or red hue, high or low level brightness, and high or low level of saturation assigned to it. The use of Oculus HMDs helped to implement better control over such environmental factors as the illumination of the room and the positioning of the elements of the room's interior.

The experiment consisted of the following procedures. The flow of the procedures is presented in the Figure 3. First, upon subjects' arrival to the experiment lab, they were asked to read and sign the Consent form to indicate that they agree to participate in this study. After that participants received the paper-based survey. At this point subjects only completed Part 1of the survey that contained questions about the demographic information such as age, gender, ethnicity, as well as the color preference and the familiarity with VR and VR HMDs. After completing it, all participants were randomly assigned to one of the experimental conditions (eight virtual models of a hotel room with two hues of wall colors manipulated and two levels of saturation and two levels of brightness). All participants were properly trained to use Oculus HMD according to official product instructions. The testing VR environment was not used. Finally, after the training, subjects were randomly assigned to the 3D hotel room with one of the manipulated color conditions for three minutes.

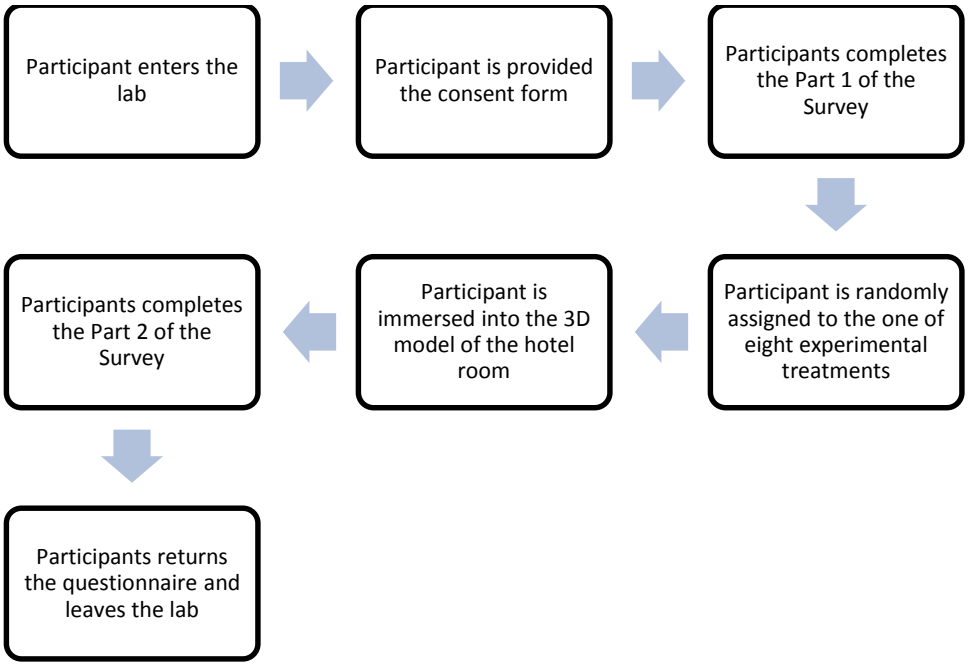


Figure 3. Experimental process flow

The time frame for the experiment was determined during the pilot study. Three minutes was the average amount of time that pilot study participants needed to build their impression about the model of the room and its colors. No vision calibration equipment was used but participants with impaired vision were allowed to wear glasses together with the Oculus HMD. After the end of the experiment, participants were asked to complete Part 2 of the questionnaire, which was measuring their emotional response to colors and the level of a participant's presence in the VR. The entire experiment process lasted on average 15 minutes. A research laboratory at a southern midwestern university was used as a physical location for the experiment. IRB approval was obtained to conduct all procedures included in the experimental process and described above (Appendix A).

Sampling

The sample size included 141 participants. A two-stage sampling was used in the study. First, the convenience sampling took place. That is, professors and students, their friends and family from a southern midwestern university were contacted in person and invited to participate in the study. The Recruitment Script is presented in the Appendix B. A consent form was explained to participants and signed by them prior to the experiment (Appendix C). All participants were included in the lottery with a chance to win one of eight Visa $50 Gift Cards. During the second stage randomized assignment of treatments was used. In particular, all participants were randomly assigned to one of the eight hotel room's models.

Experimental Treatments and Instruments

Questionnaire

The paper-based survey was used as the instrument in this study (Appendix D). Part 1of the survey consisted of questions about participant's demographic information (gender, age, favorite color, familiarity with VR). Participant's ethnicity information was obtained to measure the differences in color perception among subjects of Eastern and Western cultures. Questions measuring the subject's awareness of the VR concept and VR tools such as Oculus HMD helped to investigate the effect of technology on the perception of the VR. The information about the favorite color was useful in understanding if participant's emotional response to the room was effected by the color preference.

Part 2 of the survey was aimed at measuring participant's perception of colors and the level of their presence in the Virtual Environment. The emotional response to the hotel room's color was measured using the PAD scale. This scale was introduced by Mehrabian and Russel (1974) and has been widely used in multiple studies to measure emotional response to the store environments and colors (Valdez & Mehrabian, 1994; Bellizzi, & Hite,1992). The validity and

reliability of the scale was proven across multiple studies (Chebat & Morrin, 2007; Valdez & Mehrabian, 1994; Bradley & Lang, 1994; Bellizzi, & Hite,1992; Donovan & Rossiter, 1982). In particular, the previous studies utilizing PAD scale reported Cronbach's alpha of .82 (Chebat & Morrin, 2007). The 18 bipolar adjectives scales for the PAD model were adopted from Bradley and Lang (1994) with adjustments offered by Donovan and Rossiter (1982). The scales are measuring current emotional response to a color in terms of "After looking at the color scheme in the hotel room I feel..." and include the following adjective pairs: 1) pleasure related adjective pairs: unhappy-happy; annoyed-pleased; unsatisfied-satisfied; depressed-contented; despairing-hopeful; bored-relaxed; 2) arousal adjective pairs: relaxed-stimulated; calm-excited; sluggish-frenzied; dull-jittery; sleepy-awake; unaroused-aroused; 3) dominance related adjective pairs: controlled-controlling; influenced-influential; cared for-in control; insignificant-important; submissive-dominant; restricted-free (Bradley & Lang, 1994; Donovan & Rossiter, 1982). 7-point Likert scale ranging from one to seven was used to evaluate each bipolar pair (Park, & Farr, 2007).

Part 2 concluded with set of questions adopted from the Presence questionnaire, developed by Witmer and Singer (1994) and revised by Cyberpsychology Lab (2004), was used to measure the level of presence in the virtual environment between two models of HMDs. The presence questionnaire helped to provide the manipulation check between the HMD's ensuring that both of the models provided a similar level of presence in the VR environment. Thirteen applicable questions were adopted from the Presence scale in this study. The questions were measuring five dimensions of VR Presence: Realism, Possibility to Act, Quality of Interface, Possibility to Examine, Self-evaluation of Performance. The performance of the HMD for each question was measured using 7- point Likert scale.

3D models of the hotel room

The 3D model of the hotel room was used for color manipulations. The participants were immersed in the room environment using Oculus HMD. Virtual Reality technology allowed both changing characteristics of the virtual environment easily, as well as fully immersed individuals in a virtual environment. Hence, it reduced the number of external factors that could influence responder's emotional state or perception of a color and made the measurement of color perception much more accurate than in the previous studies. The model of the virtual hotel room was developed using Unity (Unity 5.4.0 Beta 9). The room had the basic attributes of the hotel room: a bed, a bedside table with a lamp, a closet and the armchair. The picture of the basic model of the hotel room is presented in the Figure 4.

Figure 4. The basic 3D model of the hotel room

Then the pictures of the sample Best Western hotel rooms were then imported in Photoshop. Photoshop was used to obtain the approximate values for hue, saturation, and brightness for each image. The Figure 5 presents the examples of images that were used in this procedure:

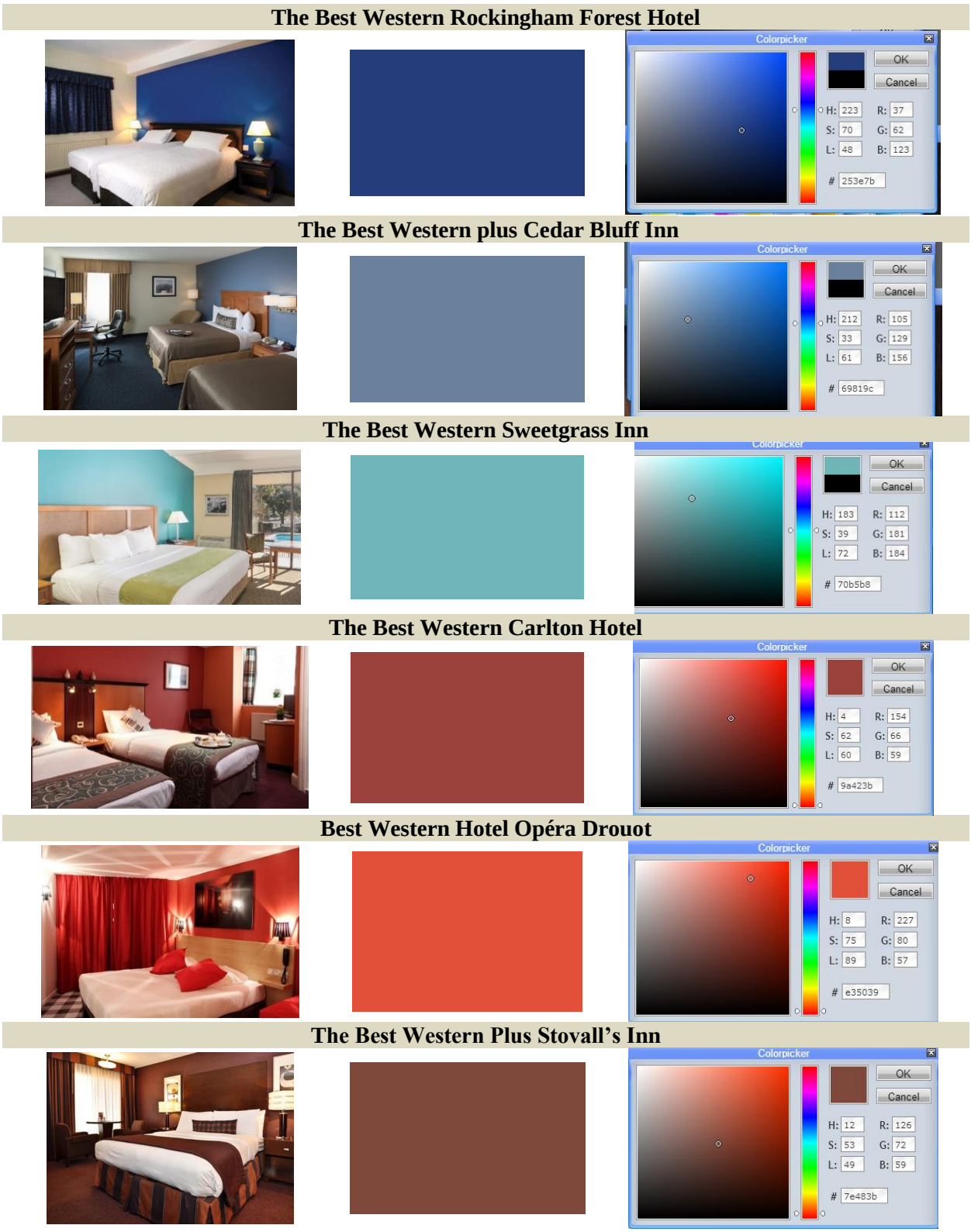


Figure 5. Color samples from the Best Western Hotels

The obtained hue values were used to calculate the average hue for red and blue room models. The average blue hue was 217 and the average value for red hue was 8. These averages were used in the hotel room models in the experiment. Then high (H) and low (L) levels were selected for saturation and brightness (L=30 and H=70). Finally, eight color conditions were created using these parameters as presented in Table 4.

Table 4

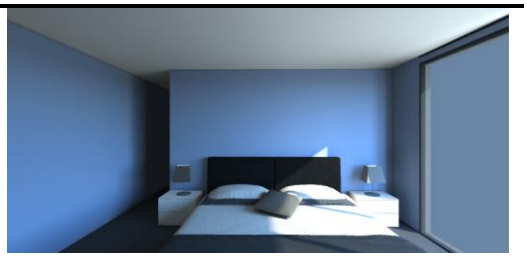
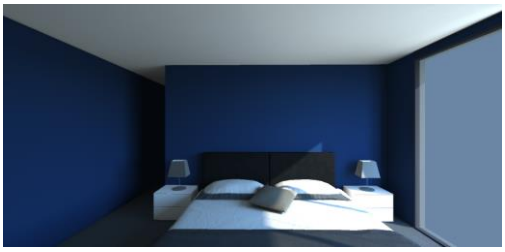
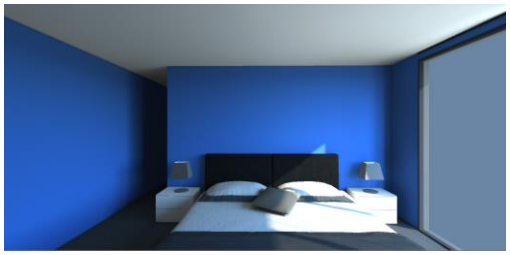
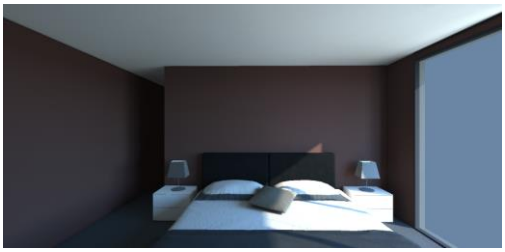
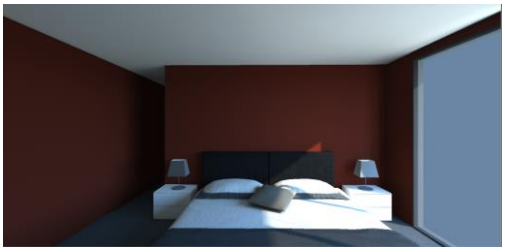
Color treatments used in the experiment

N	Code	Hue	Saturation (L,H)	Brightness (L,H)	Sample	RGB	Color Number
1	BLL	Blue	L	L		R53 G62 B77	#353e4d
2	BLH	Blue	L	H		R124 G145 B178	#7c91b2
3	BHL	Blue	H	L		R23 G44 B77	#172c4d
4	BHH	Blue	H	H		R53 G101 B178	#3565b 2
5	RLL	Red	L	L		R76 G56 B63	#4c3835
6	RLH	Red	L	H		R177 G131 B124	B1837c
7	RHL	Red	H	L		R77 G30 B23	4d1e17
8	RHH	Red	H	H		R178 G69 B53	B24535

The eight color combinations shown above were then applied as wall textures to the basic 3D model of the hotel room. Table 5 contains the screenshots of the eight color conditions applied to the 3D model rooms. The light condition was fixed at the same level in all eight cases.

Table 5

Screenshots of the 3D model environments with color treatments applied

Color Code	Room Picture	Color Code	Room Picture
BLL		BLH	
BHL		BHH	
RLL		RLH	
RHL		RHH	

Oculus HMDs

Two models of Oculus HMD were used in the study: Oculus HMD DK1 and DK2. Oculus HMD allowed users to immerse into and explore a 3D virtual environment. The advantage of this tool is that it allowed implementing higher control of the extraneous elements of the environment. In particular, all participants observed the same room with predetermined light conditions. Thus, all participants observed colors within same predesigned parameters. Also, the

"content" of the room, such as the location of the furniture and all elements of interior, were controlled. Finally, the effects of texture and smells were eliminated. Based on these facts, Oculus HMD can be considered a more reliable tool for this type of experiment than previously used techniques.

The picture of participants using the Oculus HMD is presented in the Figure 6. The oral permission of participants was obtained to use the picture in the study.

Figure 6. Participants wearing Oculus HMD

Data analysis

The measures of pleasure, arousal, and dominance were the dependent variables, and the measures of the saturation, brightness, hue, and culture were independent variables. ANOVA was conducted to test the hypotheses H1 (a-f) investigating the relationships between color attributes (hue, saturation, and brightness) and emotional response in terms of pleasure, arousal, and dominance. ANOVA was also used to test the hypothesis H3 investigating the relationship between individual color preferences and the perception of the hotel room's color. T-test was used to test the three following hypotheses: H2, stating that blue hue in the hotel room would be associated with the lower level of arousal than rooms with the red color; H4, testing whether the

use of the blue color in the hotel room will be associated with higher level of relaxation among participants than the red color; and H5, testing if participants enjoyed blue rooms more than rooms with the red hue. Finally, ANOVA was used to test the last hypothesis H6, stating that hotel room color-emotion associations among Eastern and Western cultures will be significantly different. Descriptive statistics were calculated for the demographics information. The T-test was used to conduct the manipulation check between the two models of HMDs. The analysis was conducted using SAS Enterprise Guide 6.1.

CHAPTER IV

RESULTS

Descriptive statistics

In total, 141 responses were obtained and 139 of them were usable. The sample was balanced gender wise with 76 females (54%) and 63 males (46%). Age distribution was skewed to the younger ages. Approximately 20% of the participants were below 20 years old, 52% were between 20 and 25 years old, 15% were between 25 and 30, 10% were between 30 and 35, and 14% were above 35 years old. With regard to ethnicity, the majority, 84 of the participants (61%), were Caucasians, 28 were Asians (20%), 10 participants identified themselves as Latino/Hispanic (7%), six belonged to Black or African Americans (4%), three were Native American or Alaska Native group (2%), and eight participants belonged to another ethnical group (6%). For the purpose of the hypothesis testing participants were broken down into two major groups based on their ethnicity as either representatives of Eastern or Western cultures. The Western culture group included all the participants from Europe and America (Greece, Montenegro, Germany, USA, Mexico, Belarus, Ukraine, Russia, Turkey), while the Eastern culture group included participants from Asian countries and the Middle East (India, China, Bangladesh, South Korea, Japan, Pakistan, Saudi Arabia). The rest of the participants were also included in the analysis as the third Other group (Ghana, Libya, Egypt, Madagascar, and participants that described their ethnicity as a mix of other ethnical groups).

The total of 54 (38.85%) participants indicated blue as their favorite color. Thus, the blue color was the most preferred color among participants of both genders. It was followed by green (12.23%), pink (10.79%), red (10.07%), and black (6.47%). However, there were some differences in the top five most preferred colors between genders. For females the top five colors included: blue, pink, green, purple, and red. For males they included: blue, red, black, green, and orange. Both genders showed similar preferences when they were asked to choose one the most preferred among eight pictures of the samples of experimental colors. The colors presented to participants were the same as the samples used for the hotel room models (Table 4). Both genders selected BHH (blue hue with high saturation and brightness) most frequently as their favorite color (Females: 34.25%, Males: 36.06%). BLH (blue hue with low saturation and high brightness) was selected by both genders as the second most preferred color (Females: 24.66%; Males: 18.03%). There were gender differences with regard to the third most preferred color. In particular, 13.70% of females preferred RLH (red hue with low saturation and high brightness) and 14.75% males preferred RHH (red hue with high saturation and brightness). The results of the Wilcoxon test in Table 6 show that no significant differences in the color preferences were found among genders (Chi-Square=0.02; p-value=0.88). The detailed responders' profile is presented in Table 7.

Table 6

Wilcoxon test results for differences in color preferences among genders

Color Preferences	N	SS	Expected SS	Chi-Square	*P*
Female	73	4895.0	4927.50	0.02	0.88
Male	61	4150.0	4117.50		

Table 7

Profile of survey responders

Characteristics	Percent of Total (n=139)
Gender	
Male	54.68%
Female	45.32%
Age	
18-19	19.42%
20-24	51.80%
25-29	15.11%
30-34	10.07%
35+	3.60%
Country (country of birth)	
Bangladesh	0.72%
Belarus	0.72%
China	4.32%
Egypt	0.72%
Ethiopia	0.72%
Germany	0.72%
Ghana	0.72%
Greece	0.72%
India	5.76%
Japan	0.72%
Madagascar	0.72%
Mexico	2.88%
Montenegro	1.44%
Pakistan	0.72%
Puerto Rico	0.72%
Romania	0.72%
Russia	3.60%
Saudi Arabia	2.16%
South Korea	2.16%
Taiwan	0.72%
Turkey	0.72%
UK	0.72%
USA	66.19%
Ukraine	0.72%
Ethnicity	
Asian or Pacific Islander	20.29%
Black or African American	4.35%
Caucasian	59.42%
Hispanic / Latino	7.25%
Native American / Alaska Native	2.17%
Other	6.52%

Table 7. (Continued)

Characteristics	Percent of Total (n=139)
Cultures	
Eastern	20.29%
Western	68.84%
Other	10.87%
Frequency of hotel stays	
Never	1.44%
Less than once a year	9.35%
1 or 2 times a year	35.97%
3 or 4 times a year	28.06%
5 times a year or more	25.18%
Favorite color	
Blue	38.85%
Green	12.23%
Pink	10.79%
Red	10.07%
Black	6.47%
Orange	6.47%
Yellow	1.44%
Teal	1.44%
Grey	1.44%
Other	10.8%
Color preferences	
BLL	5.97%
BLH	27.61%
BHL	10.45%
BHH	35.07%
RLL	1.49%
RLH	9.70%
RHL	4.48%
RHH	11.19%
Familiar with Virtual Reality	
Yes	56.83%
No	43.17%
Familiar with Virtual Reality HMDs	
Yes	40.29%
No	59.71%
Have experience of Virtual Reality	35.25%
Yes	64.75%
No	
Have experience of Virtual Reality HMDs	
Yes	28.78%
No	71.22%

Manipulation Check

Two models of Oculus HMD were used during the experiment (Oculus HMD DK1 and DK2) were compared for the differences in the feeling of presence in VR environment using the presence questionnaire (Witmer & Singer, 1994; Cyberpsychology Lab, 2004). The scores for the five categories of presence (Realism, Possibility to act, Quality of Interface, Possibility to examine, and Self-evaluation of performance) were obtained for each model. The results of non-parametric ANOVA showed that Oculus HMD DK1 was significantly different from Oculus HMD DK2 in such presence categories as Quality of Interface (Chi-square statistic for Kruskal-Wallis test was equal to 5.24 and significant at the 5% level), and Self-evaluation of performance (Chi-square statistic for Kruskal-Wallis test was equal to 3.08 and marginally significant (at the 10% level). However the differences between the two models were not significant in terms of the realism, the possibility to act and the possibility to examine the environment categories, comprising the core presence categories for this experiment. Thus it considered that the differences between HMDs' models did not affect participants' color perceptions in the VR environment.

Finally, the analysis of the effect of familiarity with VR and VR HMDs on the emotional response showed that there were significant differences between participants, who were familiar with VR and VR HMDs and those who were not. In particular, the familiarity had the relationship with the pleasure level. Subjects that indicated that they were familiar with the Virtual Reality had showed a significantly higher mean pleasure level (4.54 versus 5.25) in the rooms with the high brightness level of the color than participants that were not familiar with VR (Chi-Square=5.44, p-value=0.01). The results of the Kruskal-Wallis test are presented in Table 8 and Table 9.

Table 8

Kruskal-Wallis test results for the differences in pleasure scores in treatments with high brightness levels among participants familiar and unfamiliar with VR

Familiarity with VR	N	SS	Expected SS	Chi-Square	*P*
No	29	834.00	1029.50	5.44	0.01
Yes	41	1651.00	1455.50		

Participants that were familiar with Virtual Reality HMDs had a significantly higher mean pleasure level in the hotel rooms with the red hue than in the blue rooms (5.26 versus 4.66). The results of the Kruskal-Wallis test are illustrated in Table 9.

Table 9

Kruskal-Wallis test results for differences in pleasure levels between treatments with red hue among participants familiar and unfamiliar with VR HMDs

Familiarity with VR	N	SS	Expected SS	Chi-Square	*P*
No	43	1318.0	1483.50	4.44	0.03
Yes	25	1028.00	862.50		

Also subjects familiar with VR HMDs had higher mean pleasure levels in the rooms with high brightness levels (Chi-Square=4.62, p-value=0.03) than participants that were not familiar with VR HMDs (5.33 versus 4.67) as presented in Table 10.

Table 10

Kruskal-Wallis test results for differences in pleasure scores treatments with high brightness levels among participants familiar and unfamiliar with VR HMDs

Familiarity with VR	N	SS	Expected SS	Chi-Square	*P*
No	40	1239.00	1420.00	4.62	0.03
Yes	30	1246.00	1065.00		

Finally, participants familiar with VR HMDs were sensitive to saturation levels of the hotel rooms' colors. They had higher levels of pleasure than subjects that were not familiar with VR HMDs in both high and low saturation settings, however these results were only marginally significant (High saturation: Chi-square=3.11, p-value=0.07, Mean: 5.38 versus 4.82; Low saturation: Chi-square=3.11, p-value=0.07, Mean 5.18 versus 4.69). The results are presented in Tables 11 and 12.

Table 11

Kruskal-Wallis test results for differences in pleasure scores in treatments with high saturation levels among participants familiar and unfamiliar with VR HMDs

Familiarity with VR	N	SS	Expected SS	Chi-Square	*P*
No	40	1274.00	1414.00	3.11	0.07
Yes	27	1072.00	931.00		

Table 12

Kruskal-Wallis test results for differences in pleasure scores in treatments with low saturation levels among participants familiar and unfamiliar with VR HMDs

Familiarity with VR	N	SS	Expected SS	Chi-Square	*P*
No	42	1359.00	1512.00	3.21	0.07
Yes	29	1197.00	1944.00		

Hypothesis testing

First, the normality assumption was tested for the dependent variables: pleasure, arousal, and dominance to assure that the data met ANOVA assumptions. Anderson-Darling's A-Sq statistic (A-sq=1.92, p-value=0.005) and Kolmogorov-Smirnov's D (D=0.10 p-value=0.01)

statistic for the normality test for the pleasure data were significant at the 5% level, indicating that pleasure scores were not normally distributed. With regard to arousal scores, Anderson-Darling's A-Sq (A-Sq=0.54) and Kolmogorov-Smirnov's D-statistic (D=0.98) for normality test were not significant at the 5% level, thus arousal data distribution was not significantly different from the normal distribution. Finally, dominance scores were tested for normality. Anderson-Darling's A-Sq (A-Sq=0.33, p-value=0.25) and Kolmogorov-Smirnov's D-statistic (D=0.05; p-value=0.15) for normality test were not significant at the 5% level, thus dominance scores were normally distributed. ANOVA and T-test were used in the study to test the hypotheses for arousal and dominance levels, while the non-parametric alternative tests such as Kruskal-Wallis and Wilcoxon test were used to test hypotheses analyzing the pleasure levels.

Though some of the study results were only significant at the 10% level, they still were acknowledged as marginally significant as was previously done in the studies on color effects by Bottomley and Doyle (2006) and Babin, Hardesty, and Suter (2003).

Kruskal-Wallis test was conducted to test the hypotheses H1a, stating that colors with high levels of saturation and high levels of brightness would result in the higher levels of pleasure in the hotel settings when compared to the other color treatments, and H1b, stating that colors with high levels saturation and low levels of brightness would result in the higher levels of pleasure in the hotel room settings when compared to the other color treatments, were tested. The Chi-Square statistic was not significant at the 5% level (Chi-Square=5.11, p-value=0.64). Therefore, there were no significant differences between eight color conditions in terms of their impact on pleasure level of the participants. The hypotheses H1a and H1b were not supported.

ANOVA was used to test the hypothesis H1c, stating that colors with high levels of saturation would result in the higher levels of arousal in the hotel room settings when compared to the other color treatments, and the hypothesis H1d, stating that colors with lower levels of

brightness would result in the higher levels of arousal in the hotel room settings when compared to the other color treatments. The results of ANOVA, presented in Table 13, show the presence of significant differences among the eight tested conditions in the arousal levels among participants at the 5% level (F=2.98, p-value=0.0063).

Table 13

ANOVA results for the differences in arousal between color treatments

Source	*Df*	SS	MS	F	*p*
Between groups	7	22.42	3.20	2.98	0.0063
Within groups	131	140.97	1.07		
Total	138	163.40			

The Tukey HSD procedure was used to identify which specific experimental conditions were significantly different from each other. Table 14 includes all of the significantly different comparisons at the 5% level:

Table 14

Tukey Comparisons for the differences in arousal level between color treatments

Comparison	Difference Between Means	95% Confidence limits
RHH-BHH	1.17	0.17-2.17
RHH-BLH	1.17	0.17-2.17
RHH-BHL	1,52	0.52-2.52

The distribution of pleasure scores among the eight treatments is presented in Figure 7.

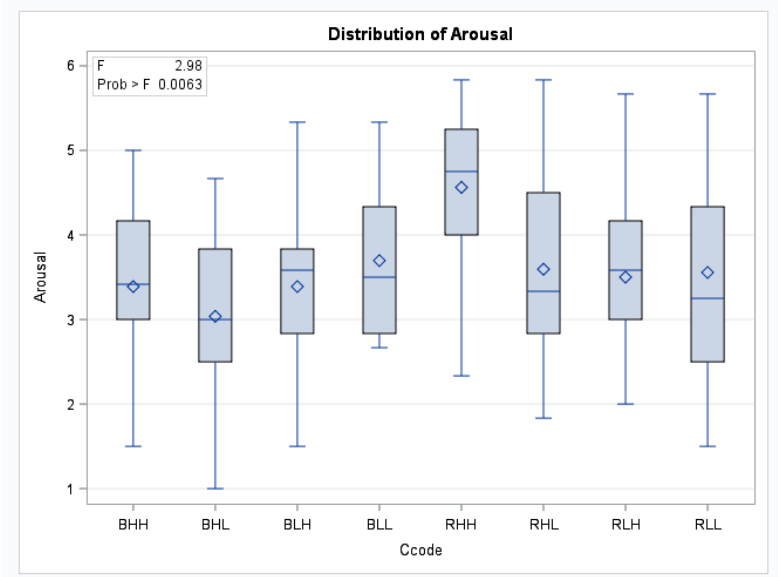


Figure 7. Arousal scores distribution among the eight tested conditions

The RHH (red hue with the high level of both brightness and saturation) condition had significantly higher arousal scores among participants than all other conditions except for BLL (blue hue with low saturation and brightness levels). Based on these results it can be concluded that hypothesis H1c was partially supported and the hypothesis H1d was not supported.

H1c was only supported partially because RHH was the only treatment with a high level of saturation that was associated with significantly higher arousal scores among the eight treatments. That is, other high saturation treatments did not show significant differences in the arousal response. H1d was not supported because none of the low brightness treatments were associated with significantly higher arousal scores.

Finally, hypotheses H1e, stating that colors with high levels of saturation would result in the higher levels of dominance in the hotel room settings when compared to the other color treatments, and H1f, stating that colors with low levels of brightness would result in the higher level of dominance in the hotel room settings when compared to the other color treatments, were tested. The ANOVA test for differences among eight treatments in dominance levels did not give

significant results (F=1.66, p-value=0.12). However, when eight comparisons were broken down by a hue (blue and red) marginally significant differences were identified within the red treatments' group (Table 15 and Table 16). Thus, it can be concluded that the relationship between saturation and the feeling of dominance was stronger in the red rooms than in the blue rooms.

Table 15

ANOVA results for differences in dominance scores among red color treatments

Source	*Df*	SS	MS	F	*p*
Between groups	3	7.30	2.4	2.47	0.06
Within groups	64	63.05	0.98		
Total	67	70.36			

Table 16

ANOVA results for differences in dominance scores among blue color treatments

Source	*Df*	SS	MS	F	*p*
Between groups	3	1.19	0.39	0.66	0.58
Within groups	67	40.80	0.60		
Total	70	42.00			

The distribution of dominance scores for red and blue conditions is visually represented in Figure 8.

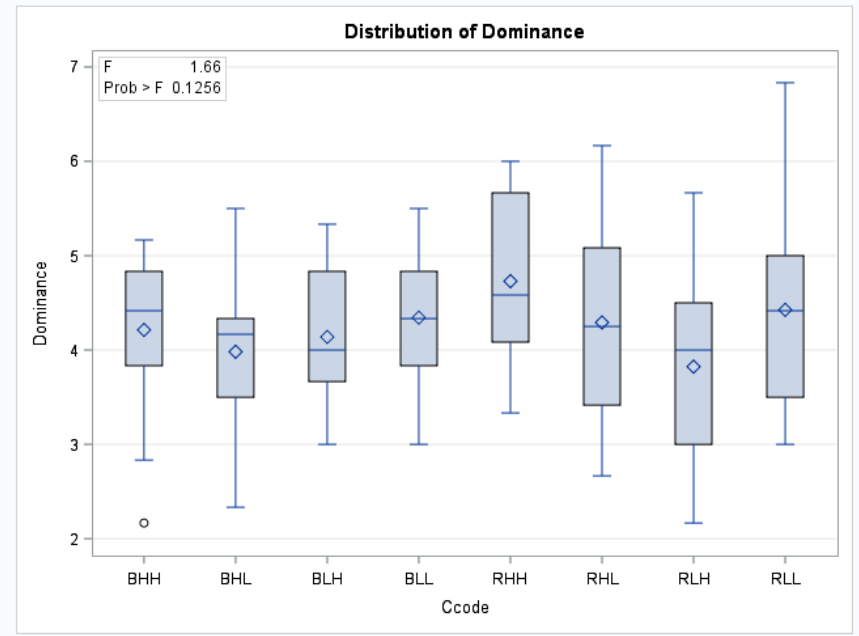


Figure 8. Distribution of the dominance scores

The only marginally significant pairwise comparison that was obtained using the Tukey procedure was between RHH and RLH (Table 17). The RHH treatment that had a high level of saturation was associated with a significantly higher level of dominance than the treatment with a low saturation level (RLH). However, the differences between only two of eight treatments were marginally significant, thus, the hypothesis H1e was only partially supported. The hypothesis H1f was not supported.

Table 17

Tukey Comparisons for the differences in the feeling of dominance between eight treatments

Comparison	Difference Between Means	90% Confidence limits
RHH-RLH	0.90	0.10-1.70

In order to understand the role of the feeling of dominance in the perception of the hotel room we conducted two additional tests analyzing the relationship between dominance scores and how much participants enjoyed and liked the hotel room that they saw. The results of ANOVA

(Table 18 and Table 19) show that the rooms where participants expressed a significantly higher feeling of dominance were the ones that participants described as, “I liked the room” and “I would enjoy staying in this hotel room”.

Table 18

ANOVA results for differences in dominance scores among the room models where participants would enjoy to stay

Source	*Df*	SS	MS	F	*p*
Between groups	1	19.56	19.56	28.68	0.0001
Within groups	137	93.47	0.68		
Total	138	113.04			

The distribution of dominance scores can be represented with Figure 9.

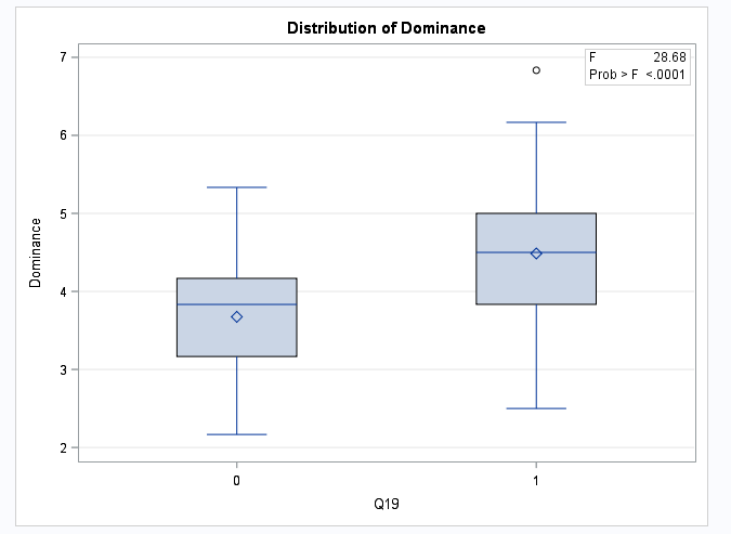


Figure 9. Distribution of the dominance scores between the rooms participants enjoyed (1) versus rooms they did not enjoy (0)

Table 19

ANOVA results for differences in dominance scores among the room models that participants liked and disliked

Source	*Df*	SS	MS	F	*P*
Between groups	1	26.28	26.28	41.48	0.0001
Within groups	135	85.55	0.63		
Total	136	111.83			

The distribution of dominance scores can be represented with Figure 10.

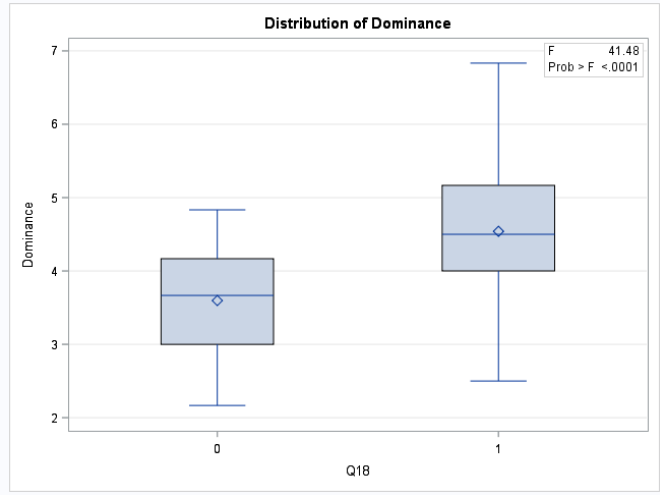


Figure 10. Distribution of the dominance scores between the rooms participants liked (1) versus rooms they disliked (0)

The T-test was used to test the hypothesis H2, stating that a blue hue in the hotel room will result in the lower level of arousal than the use of the red color. The results of T-test showed that blue and red wall hues used in the 3D models of a hotel room had significantly different effects on the arousal level of participants (Table 20).

Table 20

T-test results for the differences in the arousal scores between color treatments

Source	Blue		Red		T	*P*
	M	SD	M	SD		
Hue	3.37	0.98	3.78	1.14	-2.27	0.02

The difference in distribution of arousal scores is presented in Figure 11.

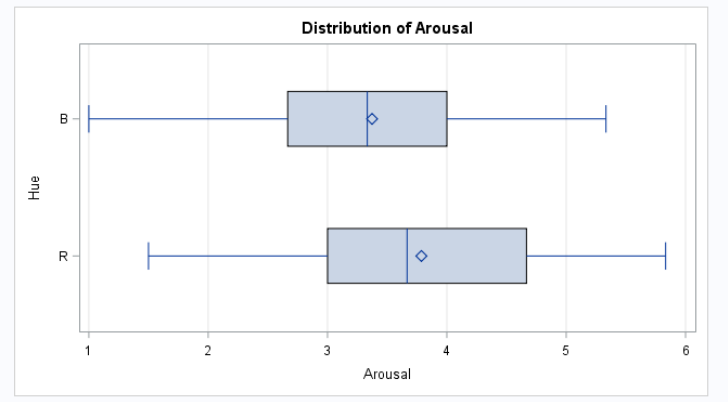


Figure 11. Distribution of arousal scores between red and blue rooms

The arousal levels of participants exposed to the red rooms were significantly higher than arousal levels of participants exposed to the blue rooms. The T-statistic for the test was equal to -2.27 and was significant at the 5% level. Thus, the hypothesis H2 was supported.

The hypothesis H3 was testing whether individual color preferences would have a relationship with the perception of the hotel room's colors. The differences between three groups were analyzed: Red (including participants that called red and pink as their favorite color), Blue (including those who called blue and teal as their favorite color), and Other group (including all other participants that had other favorite colors). The differences were analyzed on the hue basis. First, the differences between three groups of subjects exposed to rooms with a blue hue were analyzed. Then the same procedure was repeated for those who were immersed in the red hue

rooms. The results of ANOVA show that no significant differences in arousal scores were found (Blue experimental treatment: F=1.05;p-value=0.35; Red: F=0.75 p-value=0.47). At the same time significant differences in dominance and pleasure levels were found. The comparison of mean values for pleasure between the three groups showed that participants that indicated blue as their favorite color had higher mean pleasure level (5.46) in the blue rooms than the Other group (Red group: 4.85; Other group: 4.67). Participants that called red as their favorite color had higher mean pleasure level in red rooms (5.27) than the Blue group (Blue group: 4.84; Other group: 4.56). Kruskal-Wallis test was used to analyze the differences between the pleasure levels for the Red, Blue, and Other groups. The differences in pleasure levels were marginally significant within the blue treatments but not within the red ones (Table 21 and Table 22).

Table 21

Kruskal-Wallis test for the differences in pleasure levels in blue color treatments between subjects with Red, Blue and Other color preferences

Favorite Color	N	SS	Expected SS	Chi-Square	*P*
Blue	31	1285.50	1100.50	5.03	0.08
Red	9	302.50	319.50		
Other	30	897.99	1065.00		

Table 22

Kruskal-Wallis test for the differences in pleasure levels in red color treatments between subjects with Red, Blue and Other color preferences

Favorite Color	N	SS	Expected SS	Chi-Square	*P*
Blue	25	832.50	862.50	3.57	0.16
Red	21	859.00	724.50		
Other	22	654.50	759.00		

With regard to the dominance scores, the results of ANOVA indicate significant differences among both red and blue color treatments (Table 23 and Table 24). That is, the individual color preference had a significant relation with the feeling of dominance in subjects.

Table 23

ANOVA results for differences in dominance scores in blue color rooms between subjects with Red, Blue and Other color preferences

Source	*Df*	SS	MS	F	*P*
Between groups	2	4.60	2.30	4.19	0.01
Within groups	68	37.39	0.54		
Total	70	42.00			

Table 24

ANOVA results for differences in dominance scores in red rooms between subjects with Red, Blue and Other color preferences

Source	*Df*	SS	MS	F	*P*
Between groups	2	5.44	2.72	2.73	0.07
Within groups	65	64.92	0.99		
Total	67	70.36			

The Tukey procedure was run to identify the groups that were significantly different. The results show that subjects indicating blue as their favorite color experienced the highest level of dominance in the blue rooms, while subjects preferring colors other than red and blue had a significantly lower dominance feeling in blue rooms (Table 25).

Table 25

Tukey Comparisons for the differences in the feeling of dominance between groups with Blue, Red and Other color preferences in the Blue room

Comparison	Difference Between Means	95% Confidence limits
Blue-Other	-0.53	-0.99 - -0.09

Figure 12 presents the distribution of dominance among the three groups.

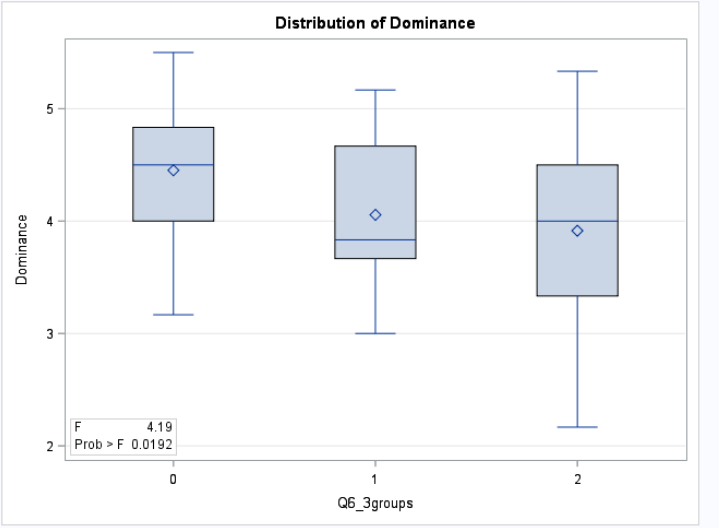


Figure 12. Distribution of the dominance scores between the rooms groups with Blue (0), Red (1) and Other (2) color preferences in the Blue room

The results of Tukey procedure for the red rooms show that participants indicating red as their favorite color had a higher feeling of dominance in the red hotel rooms than participants who preferred the blue color, though the results were only marginally significant (Table 26). Based on these facts it can be concluded that H3 was supported.

Table 26

Tukey Comparisons for the differences in the feeling of dominance between groups with Blue, Red and Other color preferences in the Red room

Comparison	Difference Between Means	90% Confidence limits
Red-Blue	0.65	0.02-1.28

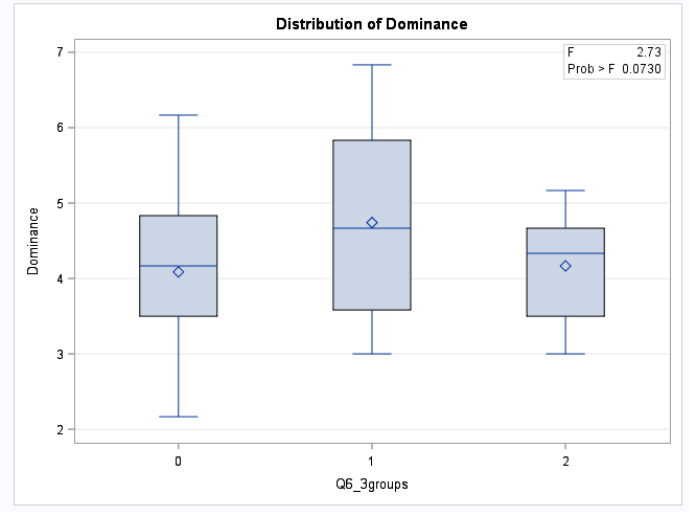


Figure 13. Distribution of the dominance scores between the rooms groups with Blue (0), Red (1) and Other (2) color preferences in the Red room

T-test was used for the hypothesis H4, testing whether the use of the blue color in the hotel room will result in a higher level of relaxation among participants. The Relaxed-Stimulated 7-point Likert scale was used to measure the feeling of relaxation among participants. On average, blue rooms were considered more relaxing than the red rooms (3.53 versus 3.94). However, the T-test results (Table 27) for the score differences were not significant (t-statistic=-1.43, p-value=0.15).

Table 27

T-test for the differences in the relaxation properties of the blue and red hue

Source	Blue		Red		T	*P*
	M	SD	M	SD	-1.43	0.15
Hue	3.53	1.62	3.94	1.69		

Interestingly, though subjects demonstrated significantly lower arousal levels (as was proved by H2) when exposed to blue hotel rooms than red rooms, at the same time a significantly lower arousal level was not accompanied with significant differences in the feeling of relaxation. Participants felt more relaxed in blue rooms and more stimulated in red rooms, but the differences were not statistically significant. Thus, H4 was not supported.

Wilcoxon test was used for the hypothesis H5, testing if participants enjoyed blue rooms more than red hotel rooms. The mean value for the enjoyment measure was higher for blue rooms than for red rooms (0.76 versus 0.62). The Chi-Square statistic for the test was marginally significant at the 10% level (Chi-Square=3.29, p-value=0.06) indicating the statistically important differences in hue preferences among participants. Thus, we can conclude that H5 was supported and participants indeed enjoyed staying in blue hotel rooms more than in the red hotel rooms.

Finally, ANOVA was used to test the last hypothesis H6, stating that color perceptions would vary between the Eastern and Western cultures. Three tests were made for each of the PAD model scales (pleasure, arousal, dominance). No significant differences were found between Eastern and Western cultures in distribution of arousal scores (F=1, p-value=0.36), and also dominance scores (F=0.99, p-value=0.37). The results of Kruskal-Wallis test for pleasure were not statistically significant either (Chi-Square=1.67, p-value=0.43).

Omnibus ANOVA analysis did not show significant results, at the same time ANOVA conducted in the groups split by levels of color attributes (hue, saturation, and brightness) showed significant differences. This result can be explained by the fact that color attributes have distinctive associations with pleasure, arousal, and dominance levels and they cannot be analyzed in bulk as their effects can have opposite directions. Thus, just culture itself is not enough for the analysis of color effects. Both culture and the color attributes' levels should be taken in consideration. Consequently, the cultural differences in the perception of hue, high and low levels of saturation and high and low levels of brightness were analyzed.

First, possible differences in the perception of the hue between cultures were analyzed. The F value for arousal in both blue and red treatments' groups was small and not significant (Blue rooms: F=0.09, p-value= 0.91; Red rooms: F=0.6, p-value=0.55). Dominance scores, analyzed hue wise, did not show statistically significant differences (Blue rooms: F=0.15, p-value=0.86; Red rooms: F=1.5 p-value=0.23). No significant differences in the pleasure levels between blue and red treatments were found (Blue rooms: Chi-Square=2.70, p-value=0.25; Red rooms: Chi-Square=1.62, p-value=0.44). Thus, no significant differences in the hue perception were found among analyzed cultures.

Then the cultural differences in the perception of hotel rooms' colors with high and low saturation levels, as well as, in the rooms with high and low brightness levels were tested. No significant differences in pleasure levels were found among cultures within the low and high brightness treatment groups (Low brightness: Chi-square=2.19, p-value=0.33; High brightness: Chi-Square=0.27, p-value=0.87). At the same time marginally significant differences in pleasure levels were found among culture groups within the color treatments with a low level of saturation. The Chi-square value for conditions with low saturation level was equal to 5.39 and marginally significant at 10% level (p-value=0.06). The Chi-square value among conditions with a high

saturation level was equal to 0.62 and was not significant (p-value= 0.73). The results for the Kruskal-Wallis tests are presented in Table 28 and Table 29.

Table 28

Kruskal-Wallis test results for cultural differences in pleasure scores in treatments with high saturation level

Culture	N	SS	Expected SS	Chi-Square	*P*
Eastern	9	313.00	207.50	0.62	0.73
Western	53	1828.50	1828.50		
Other	6	170.50	207.00		

Table 29

Kruskal-Wallis test results for cultural differences in pleasure scores in treatments with low saturation level

Culture	N	SS	Expected SS	Chi-Square	*P*
Eastern	19	596.00	674.50	5.39	0.06
Western	44	1526.00	248.50		
Other	7	363.00	1562.00		

The distribution of pleasure scores among the Eastern (1), Western (2) and Other (3) cultures for the group of treatments with low saturation is presented in Figure 14. The Other group (3) had a significantly higher mean value for pleasure scores. The further analysis of the differences in pleasure levels among cultures included in the Other group should be made to investigate this finding in detail.

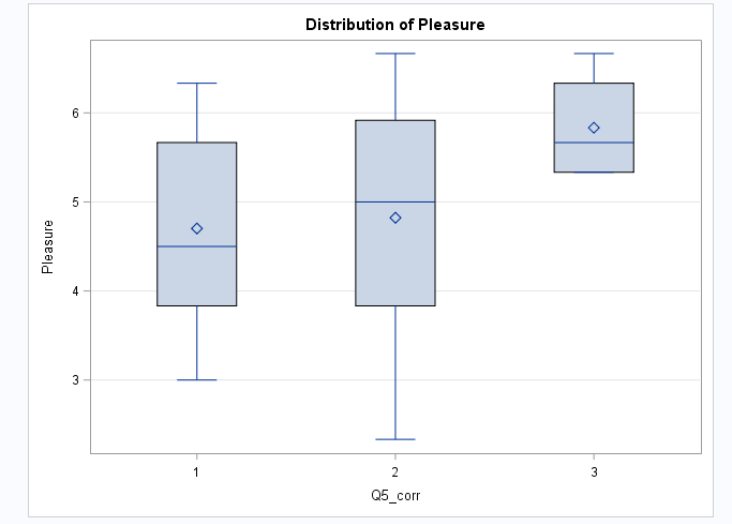


Figure 14. Distribution of pleasure scores among cultures in treatments with low saturation

With regard to arousal, no differences among cultures were found within treatment groups with low and high saturation levels (Low saturation: F=0.21 p-value=0.80; High saturation: F=1.41 p-value=1.25). However, significant differences were found between Eastern and Western cultures in their arousal levels within treatments with low brightness levels (Low brightness: F=3.32, p-value=0.04; High brightness: F=0.25, p-value=0.77). The ANOVA results for the differences in the arousal levels within treatments with different levels of brightness are presented in Table 30 and Table 31.

Table 30

ANOVA results for differences among cultures in treatments with low level of brightness

Source	*Df*	SS	MS	F	*P*
Between groups	2	7.48	3.74	3.32	0.04
Within groups	66	74.44	1.12		
Total	68	81.93			

Table 31

ANOVA results for differences among cultures in treatments with high brightness

Source	*Df*	SS	MS	F	*P*
Between groups	2	0.60	0.30	0.25	0.77
Within groups	66	79.14	1.19		
Total	68	79.75			

The Tukey procedure showed that the Eastern culture group demonstrated a higher level of arousal when exposed to low brightness colors in hotel rooms than representatives of the Western culture, however the result was marginally significant (at the 10% level). This finding can also be visually illustrated with Figure 15, which shows that the Eastern culture (1) had the highest arousal level in high brightness settings, while the Western culture group had the lowest mean arousal score (2).

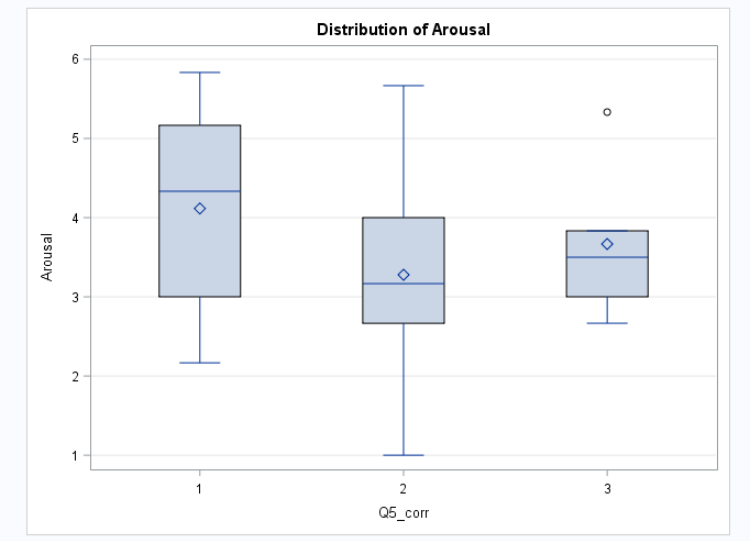


Figure 15. Differences in the response to colors with low brightness levels between Eastern (1), Western (2), and Other (3) cultures

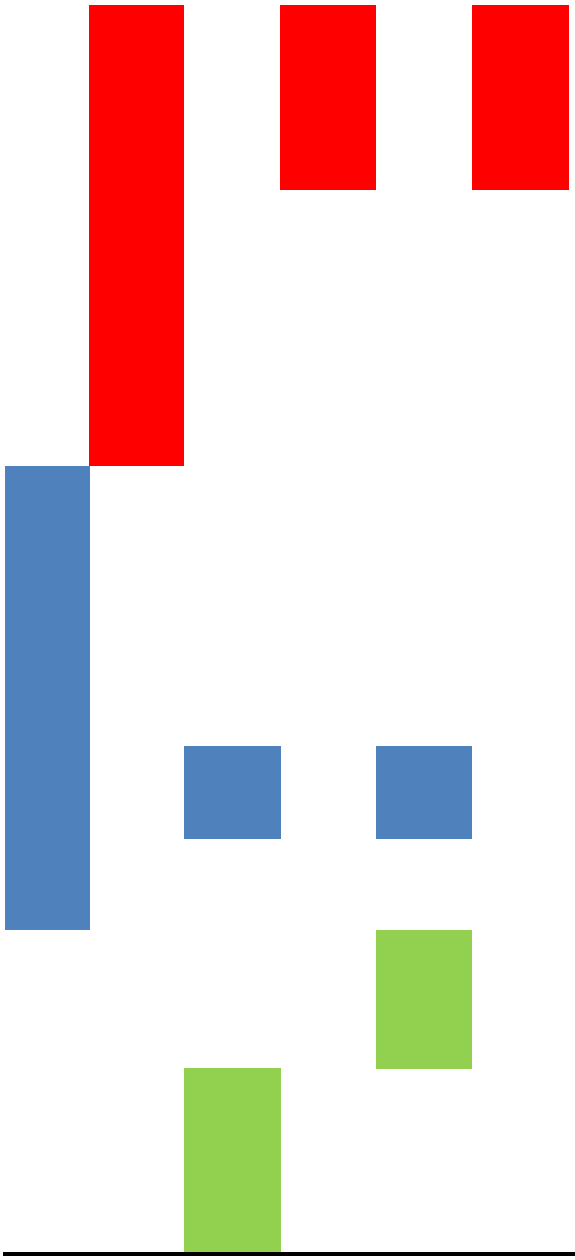
Finally, the dominance scores were not significantly different among cultures both for the treatments with a high and low saturation (Low saturation: F=0.49, p-value=0.61; High

saturation: F=0.93, p-value=0.40) and for treatments with a high and low brightness (Low brightness: F=0.52, p-value=0.59; high brightness: F=0.54, p-value=0.58).

The summary of results of the study is presented in Table 32.

Table 32

Summary of the results of the study

Hue		Saturation		Brightness		Results
Blue	Red	Low	High	Low	High	
						1. RHH was associated with significantly higher arousal levels than other treatments (H1c). 2. Participants felt significantly more dominant in the RHH room than in the RLH room. 3. Red rooms were more arousing than blue ones regardless of the level of saturation or brightness (H2). 4. Subjects with red as their favorite color felt more dominant in the red hotel rooms in comparison to those preferring the blue color (H3). 5. Participants with blue as their favorite color had significantly higher pleasure level and felt more dominant in blue rooms than Other group (H3). 6. Blue rooms were considered more enjoyable (H5). 7. Blue rooms were considered more relaxing but the difference was not significant (H4). 8. BLL was not significantly different from RHH in its arousing property (H1d). 9. Blue color was most frequently chosen as the favorite color by both genders. 10. The Eastern culture group had a higher arousal level than the Western Culture group in the treatments with low brightness levels (H6). 11. Other group (including subjects from Africa and mixed ethnicities) had a significantly higher pleasure level than subjects from Eastern and Western cultures in low saturation treatments (H6).

CHAPTER V

DICUSSION AND CONCLUSIONS

Eight color comparisons with two hues (blue and red) and two levels for saturation and brightness were analyzed in this study. In contrast to the findings of Beach, Wise, and Wise (1988) and Valdez and Mehrabian (1994), color combinations with a high level of saturation and low or high levels of brightness did not result in a significantly higher level of pleasure. Consequently, hypotheses H1a and H1b were not supported. It is possible that pleasure variable was affected by the level of familiarity with VR, creating an additional effect on the subjects' pleasure levels in addition to the effect of colors. In particular, participants that were familiar with VR and VR HMDs expressed a significantly higher pleasure level in the red hue rooms, as well as in the rooms with high level of brightness. They also showed a higher pleasure response to both low and high saturation color treatments, however the results were marginally significant. Thus, it can be assumed that the familiarity with VR and VR HMDs could create bias in the pleasure scores. The hypothesis H1c was supported partially. That is, participants had significantly higher levels of arousal in the red hotel room with high level of both saturation and brightness (RHH) than in blue rooms except for the blue room with low level of saturation and brightness (BLL). Thus, the color with a high level of saturation indeed resulted in a higher level of arousal but only one treatment was significantly different. The reason for this result might be that the arousing effect of the red hue itself added to the arousing effect of saturation and brightness and thus made this one treatment significantly different. The contradicting result

was that RHH color combination was not significantly different from the arousal levels obtained in the BLL room (blue room with low level of saturation and brightness). This finding is especially interesting taking in account previous research indicating a calming and soothing effect of the blue color. This result might add support of the H1d stating that colors with lower level brightness levels are more arousing. However, none of the treatments with low brightness levels was associated with significantly higher arousal levels, thus the hypothesis H1d was not supported.

Previous studies that applied PAD scale to measure emotional response to environments often indicate that the dominance component was the weakest of the three emotional dimensions (Valdez & Mehrabian, 1994). At the same time, it was found that participants felt significantly more dominant in the RHH room than in the RLH room. These results go in line with the hypothesis H1e but are opposite to the hypothesis H1f.

The strong relation between the wall hue and the arousal level of participants was observed in the data. Hotel rooms employing color combinations based on the red hue were associated with a significantly higher arousal level among participants than blue rooms regardless of the level of saturation and brightness. Thus, the hypothesis H2 was supported. Though blue rooms were found to be more relaxing than red hue hotel rooms, the score difference was not significant, thus H4 was not supported. Participants found hotel models with blue hue more enjoyable than red rooms (H5). In addition, the analysis of survey data showed that participants enjoyed staying in blue hotel rooms more than in the red hotel rooms, and this preference was statistically significant. Thus, H5 was supported.

The individual color preference was found to have an important impact on the perception of the hotel room (H3). Blue was found to be the favorite color between both genders. Participants, stating that blue was their favorite color had a significantly higher pleasure level in

blue rooms than subjects with color preferences other than red and blue. As well, they felt significantly more dominant in the blue hotel rooms in comparison to subjects with color preferences other than red and blue. Subjects, who indicated red as their favorite color, felt significantly more dominant in the red hotel rooms in comparison to those preferring the blue color. Interestingly, the results showed that participants had significantly higher feeling of dominance in the hotel rooms that they liked and enjoyed. Thus, it may mean that the feeling dominance in the environment is associated with the positive feeling about the environment.

Finally, with regard to cultural differences, the hypothesis H6 was supported. The results show that there were no differences among cultures with regard to the emotional effect of a hue. At the same time Other group (including representative from Africa and participants of mixed ethnicities) had significantly higher pleasure levels than representatives of Eastern and Western cultures in the low saturation color treatments. These differences in the perception of low saturated colors among participants of the Other group might imply that representatives of the African culture and people of the mixed ethnicities find low saturation environments as more pleasant. This result should be investigated in the next studies. In addition, significant differences between Western and Eastern cultures were found in low brightness environments with regard to arousal levels. The Eastern culture group had significantly higher arousal level in the low brightness settings in comparison to the Western culture group. In other words, representatives of the Eastern culture are more sensitive to the brightness of the color than representatives of the Western culture. This finding might also mean that colors with a low brightness levels are associated with a high arousal in the Eastern culture.

Implications

The following suggestions to the hotels can be made based on the results of the study. Hotels are recommended to avoid using red color schemes in the hotel rooms because they were

found to be related to higher arousal levels in subjects, which in its turn might lead to the decrease in the quality of sleep. In addition, hotels located in the Eastern countries should take into consideration specific to that region arousing quality of colors with low brightness.

Also, the use of the blue color in the hotel rooms will appeal to color preferences of the large group of customers and may lead to more enjoyable experience of the hotel stay for multiple reasons. In particular, participants immersed in the blue rooms were considered more enjoyable than the red hotel rooms. In addition, blue color was most frequently chosen as the favorite color by both genders. Blue rooms were also considered more relaxing than red, which supports findings from the previous research about the soothing effect of the blue color. Though the difference in means for red and blue rooms was not significant, the relaxing effect of the blue color should be investigated in a greater detail by hotels because relaxing environment is one of the crucial functions of the hotel room.

As well, the finding that personal color preferences affect pleasure and dominance feelings of participants can also be effectively used by hotel chains. Hotels are recommended to collect the information about color preferences of their guests. Using this information hotels can either try to assign guests to hotel rooms that match with their color preferences or hotels can add decoration elements of guests' favorite colors to the rooms.

In general, understanding the differences in the effects of blue and red colors can be used by hotel managers to purposefully manipulate guests' emotions and feelings both in the hotel room and other hotel areas. Oliver (1997) found that customer satisfaction has a strong affective component that is attributed to the pleasant and low arousal emotions. Thus, by introducing hues with levels of saturation and brightness that were found less arousing and more pleasant in this study, hotel chains can affect the emotional component of satisfaction contributing to the increase of the overall satisfaction with a hotel stay.

Limitations

Limitations of the study are related to the fact that only two hues from those used in the Best Western hotels were analyzed (red and blue). Also color treatments were assigned without consideration of the culture and color preferences and the distribution of treatments within these groups was unequal. Thus, comparisons of the emotional response between these groups might be biased. In addition the sample size was not big enough to compare pleasure, arousal, and emotional response within cultures among eight treatments. Instead the treatments were grouped in two groups based on hue, levels of saturation and brightness and tested for differences in each of these sets respectively. Finally, two different models of Oculus HMD were used in the study. Though the HMDs were found to provide the similar level of realism, the possibility to act, and the possibility to examine. However, significant differences were found in terms of quality of the interface between the two models. These differences could have affected the perception of colors in the rooms that participants viewed using these HMDs.

Directions for the future research

The directions for the future research include providing a comprehensive analysis of the colors used in the Best Western hotels and their popularity. This information will help to investigate the differences in the perception of a wider range of colors and possibly range them based on their emotional properties with regard to pleasure, arousal, and dominance. As well, further analysis of the role of the feeling of dominance in shaping the impression of the hotel room and its colors will be useful. In addition, it is recommended to extend the sample and conduct the test of cultural differences using equal sample groups for each culture group. This will help to increase the validity of the analysis in the future studies. Finally, it is advised to do a further detailed research on the effect of the familiarity with VR and VR HMDs on participants' perception of colors in the VR environments.

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APPENDICES

A. IRB Approval

Oklahoma State University Institutional Review Board

Date:	Thursday, March 10, 2016	Protocol Expires:	12/17/2016
IRB Application No:	HE1574		
Proposal Title:	Using virtual visualization techniques in understanding user perceptions of hotel environments		
Reviewed and Processed as:	Expedited **Modification**		
Status Recommended by Reviewer(s)	**Approved**		

Principal Investigator(s):

Lisa Slevitch
222 HES
Stillwater, OK 74078

Tilanka Chandrasekera
429D HS
Stillwater, OK 74078

Katia Siamionava
210 HS West
Stillwater, OK 74078

The requested modification to this IRB protocol has been approved. Please note that the original expiration date of the protocol has not changed. The IRB office MUST be notified in writing when a project is complete. All approved projects are subject to monitoring by the IRB.

☐ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

The reviewer(s) had these comments:

Mod to use another model of the VR headsets: Oculus Rift2 and OSVR, randomly assign subjects to one of 8 conditions, make changes to the questionnaire, consent and recruitment script, remove the Emotive Epoc EEG headset

Signature :

Hugh Crethar, Chair, Institutional Review Board

Thursday, March 10, 2016
Date

B. Recruitment Script

Recruitment script

Dear Students,

We are asking you help with a research project investigating a virtual hotel room Virtual Reality Headsets. You will obtain extra bonus points if your decide to help us and participate. Participants will have a chance to win on of the eight $50 gift cards. There are no known risks associated with this project, which are greater than those ordinarily encountered in daily life. If you feel uncomfortable at any time, you can withdraw from the study. We ask you to reserve 20-25 minutes of your time for the entire experiment process. If you are interested please sign your name on the sign-sheet we will be passing around.

Updated: September, 2013

C. Informed Consent Form

Informed Consent Form

PROJECT TITLE: *Using virtual visualization techniques in understanding user perceptions of hotel environments*

PURPOSE: The purpose of the current study is to examine how different room settings affect perceptions of a hotel room.

PROCEDURES: You will be asked answer a survey about their demographic information, previous experience with Virtual Reality, and previous hotel experience. After that you will be assigned to one of the versions of the 3D models of a hotel room. Participants will look at a virtual hotel room using on the of models of the Virtual Reality Headsets. Virtual Reality Headsets such as Oculus glasses and OSVR glasses are virtual reality tools that allow a user to see virtual objects and environments in a 3D mode. All participants will be properly trained to use Virtual Reality glasses according to original official product instructions. Usage of Virtual Reality glasses is not associated with any health risks for participants.
Finally, you will be asked to answer on a short survey about your perceptions of the hotel room you have seen. We ask you to reserve up to 20-25 minutes of your time for the entire process.

RISKS OF PARTICIPATION: There are no known risks associated with this project which are greater than those ordinarily encountered in daily life. If you feel uncomfortable at any time, you can withdraw from the study.

CONFIDENTIALITY: No identifying information will be associated in any way with your responses. Only the researchers will have access to the collected data and only a summary of the overall results will be shared in possible future presentations and/or publications of the survey data. All collected information will be securely stored on a password-protected computer and in a locked cabinet in a secure research office for three years as per ethical process.

COMPENSATION: No monetary compensation will be provided for participation. Student participants will be given bonus course credits if they decide to participate in the study. In addition participants will be included in the lottery with a chance to win one of the eight 50 dollar gift cards.

CONTACTS : You may contact any of the researchers at the following addresses and phone numbers, should you desire to discuss your participation in the study and/or request information about the results of the study: Dr. Lisa Slevitch (lisa.slevitch@okstate.edu), Dr Tilanka Chandreasekera (tilanka@okstate.edu), Katia Siamionava (siamion@okstate.edu). If you have questions about your rights as a research volunteer, you may contact the IRB Office at 223 Scott Hall, Stillwater, OK 74078, 405-744-3377 or irb@okstate.edu

PARTICIPANT RIGHTS: Participation in the study is completely voluntary. If at any time you feel you do not wish to participate for any reason, you are free to withdraw without any penalty.

Okla. State Univ. IRB
Approved 3-10-16
Expires 2-17-16
IRB # HE-15-74

Updated: September, 2013

CONSENT DOCUMENTATION: By agreeing to participate in this study you are agreeing to the following statement: "I have been fully informed about the procedures listed here. I am aware of what I will be asked to do and of the benefits of my participation. I also understand the following statements: I affirm that I am 18 years of age or older".

Signature of Participant_____ Date_____
Signature of Researcher_____ Date_____

Updated: September, 2013

D. Questionnaire

Part 1

1. What is your age?

    a) 18 -19 years old
    b) 20-24 years old
    c) 25-29 years old
    d) 30-34 years old
    e) 35-49 years old
    f) 50-64 years old
    g) 65 years and over

2. What is your gender?

    a) Male
    b) Female

3. What is your country of birth? _____

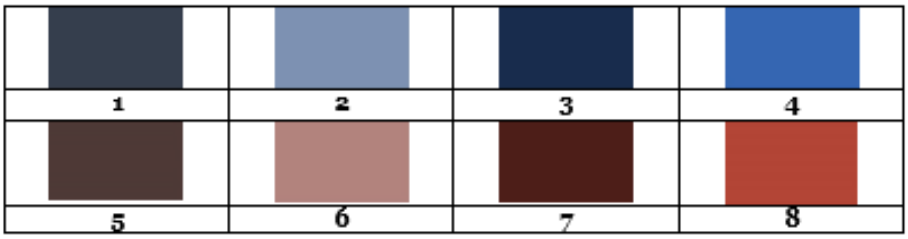
4. Indicate all the countries where you lived for more than 5 years. Include the approximate number of years you lived for each country.
    _____
    _____

5. How would you describe your ethnicity?

    a) Asian or Pacific Islander
    b) Black or African American
    c) Caucasian
    d) Hispanic/ Latino
    e) Native American / Alaska Native
    f) Other (specify) _____

6. What is your favorite color? _____

7. Which of these colors do you prefer most (circle the most preferred option)?



8. Are you familiar with Virtual Reality?

    a) Yes
    b) No

9. Are you familiar with Virtual Reality Headsets (such as Oculus Rift)?

    a) Yes
    b) No

10. Have you ever experienced Virtual Reality?

    a) Yes
    b) No

11. Have you ever tried Virtual Reality Headsets?

    a) Yes
    b) No

12. Do you play console video games?

    a) Yes
    b) No

13. If you selected "yes" for the previous question, indicate how often do you play video games? (otherwise, please, go to the next question)

    a) Once a month
    b) Once a week
    c) Several times a week
    d) Every day

14. Do you play PC games?

    a) Yes
    b) No

15. If you selected "yes" for the previous question, indicate how often do you play PC games? (otherwise, please, go to the next question)

    a) Once a month
    b) Once a week
    c) Several times a week
    d) Every day

16. How often do you stay in a hotel?

    a) Never
    b) Less than once a year
    c) 1 or 2 times a year
    d) 3 or 4 times a year
    e) 5 times or more a year

Part 2

17. Please circle the option that describes how you would finish the following statement: **After looking at the color scheme in the hotel room I feel...**

1 Unhappy	2	3	4	5	6	7 Happy
1 Annoyed	2	3	4	5	6	7 Pleased
1 Unsatisfied	2	3	4	5	6	7 Satisfied
1 Depressed	2	3	4	5	6	7 Contented
1 Despairing	2	3	4	5	6	7 Hopeful
1 Bored	2	3	4	5	6	7 Relaxed
1 Relaxed	2	3	4	5	6	7 Stimulated
1 Calm	2	3	4	5	6	7 Excited
1 Sluggish	2	3	4	5	6	7 Frenzied
1 Dull	2	3	4	5	6	7 Jittery
1 Sleepy	2	3	4	5	6	7 Wide Awake
1 Unaroused	2	3	4	5	6	7 Aroused
1 Controlled	2	3	4	5	6	7 Controlling
1 Influenced	2	3	4	5	6	7 Influential
1 Cared for	2	3	4	5	6	7 In control
1 Insignificant	2	3	4	5	6	7 Important
1 Submissive	2	3	4	5	6	7 Dominant
1 Restricted	2	3	4	5	6	7 Free

18. Do you like the color environment of the room you have just seen?

a) Yes
b) No

19. Would you enjoy to stay in the hotel room with this color environment?

a) Yes
b) No

20. Would you avoid returning to this hotel room?

a) Yes
b) No

21. Characterize your experience in the environment, by circling the appropriate number of t point scale, in accordance with the question content and descriptive labels.

21.1 How responsive was the environment to actions that you initiated (or performed)?

1	2	3	4	5	6	7
Not Responsive			Moderately Responsive			Completely Responsive

21.2 How much did the visual aspects of the environment involve you?

1	2	3	4	5	6	7
Not at All			Somewhat			Completely

21.3 How natural was the mechanism which controlled movement through the environment?

1	2	3	4	5	6	7
Extremely Artificial			Borderline			Extremely Natural

21.4 How compelling was your sense of objects moving through space?

1	2	3	4	5	6	7
Not at All		Moderately Compelling				Very Compelling

21.5 How much did your experiences in the virtual environment seem consistent with your real world experiences?

1	2	3	4	5	6	7
Not Consistent			Moderately Consistent			Very Consistent

21.6 Were you able to anticipate what would happen next in response to the actions that you performed?

1	2	3	4	5	6	7
Not at All			Somewhat			Completely

21.7 How completely were you able to actively survey or search the environment using vision?

1	2	3	4	5	6	7
Not at All			Somewhat			Completely

21.8 How involved were you in the virtual environment experience?

1	2	3	4	5	6	7
Not at All			Somewhat			Completely

21.9 How much delay did you experience between your actions and expected outcomes?

1	2	3	4	5	6	7
No Delays			Moderate Delays			Long Delays

21.10 How quickly did you adjust to the virtual environment experience?

1	2	3	4	5	6	7
Not at All			Slowly			Less Than One Minute

21.11 How proficient in moving within the virtual environment did you feel at the end of the experience?

1	2	3	4	5	6	7
Not Proficient			Reasonably Proficient			Very Proficient

21.12 How much did the visual display quality interfere or distract you from performing assigned tasks or required activities?

1	2	3	4	5	6	7
Not at All			Interfered Somewhat			Prevented Task Performance

21.13 How well could you concentrate on the assigned tasks or required activities rather than on the mechanisms used to perform those tasks or activities?

1	2	3	4	5	6	7
Not at All			Somewhat			Completely

VITA

Katsiaryna Siamionava

Candidate for the Degree of

Master of Science

Thesis: UNDERSTANDING THE EFFECT OF SPATIAL COLORS ON GUESTS' PERCEPTION OF THE HOTEL ROOM USING VIRTUAL VISUALIZATION TECHNIQUES

Major Field: Hospitality Administration

Biographical:

Education:

Completed the requirements for the Master of Science in Hotel and Restaurant Administration at Oklahoma State University, Stillwater, Oklahoma in May, 2016.

Completed the requirements for the Bachelor of Science in Hotel and Restaurant Administration at Belarusian State University, Minsk, Belarus in 2014.

Experience:

September 2014 -now	*Teaching and Research Assistant* School of Hotel& Restaurant Administration, Oklahoma State University: Stillwater, OK, USA
May -August 2015	*Sales and F&B Intern* Four Seasons Hotels & Resorts: Dallas, TX, USA
February-April 2014	*Junior Associate* PricewaterhouseCoopers: Minsk, Belarus
March-April 2013	*Marketing Intern* Holiday.by: Minsk, Belarus
January- December 2010	*Economic manager* DomDecorStroj, Minsk, Belarus

Professional Memberships: HRAD GSA, GPSGA