Exploring the Effects of Lighting on Consumer Responses in a Retail Environment using 3D Walk-Through Animation

Yu-Fong Lin[1], So-Yeon Yoon[2]

[1] Department of Applied Arts, Fu Jen Catholic University, Taipei, Taiwan

[2] Department of Deisgn & Envirnoomental Analysis, Cornell University, Ithaca, USA

Abstract

Background The primary purpose of this study is to empirically explore how lighting affects consumers' visual experiences in a retail environment. Lighting designs can both attract consumers' attention and interest in the merchandise and positively affect consumers' behavioral intentions. Despite its potential, the impact of retail lighting on consumer perception, emotion, satisfaction, and intention has rarely been examined.

Methods The current experimental research followed a 2 x 2 factorial design to identify the effects of contrast and color temperature of display lighting in a retail environment. Four different lighting conditions set in an electronics retail store were developed in a high-fidelity 3D computer simulation and tested using a large screen for a more life-like experience.

Results The findings of this study indicate that both the contrast and color temperature of lighting influence subjects' attention and arousal, whereas only the contrast of lighting influences pleasure and intention.

Conclusion This study demonstrates the effects of contrast and color temperature of lighting on subjects' perceptions and psychological responses.

The contributions made by the study include new knowledge about retail lighting, focusing on consumers' psychological responses, and thereby providing practical guidelines for designers and retailers to effectively plan display lighting in retail environments.

Keywords Lighting, Retail Environment, Environmental Stimuli, Simulation, Animation

*Corresponding author: So-Yeon Yoon (sy492@cornell.edu)

Citation: Lin, Y. F., & Yoon, S. Y. (2015). Exploring the Effects of Lighting on Consumer Responses in a Retail Environment using 3D Walk-Through Animation. *Archives of Design Research, 28*(2), 5-25.

http://dx.doi.org/10.15187/adr.2015.05.28.2.5

Received : Apr. 03. 2015 ; **Reviewed :** Apr. 06. 2015 ; **Accepted :** Apr. 13. 2015
pISSN 1226-8046 **eISSN** 2288-2987

1. Introduction

Lighting is an important environmental stimulus that affects both an individual's perceptual and psychological responses, as well as alters the appearance and atmosphere of a space (Summers & Hebert, 2001). Studies have shown that lighting influences perceptions in meaningful ways and can evoke senses of pleasantness, relaxation, or intimacy in specific environments (Pinto et al., 2010). Environmental psychologists Mehrabian and Russell (1974) use the stimulus-organism-response (S-O-R) paradigm from their conceptual model (M-R model) to explain the relationships among stimuli, environments, responses, and intention. S-O-R is the representation of the interactions between the physical environment (S) and human intentions and behavior (R) as mediated by the individual's characteristics and emotional responses (O). The S-O-R paradigm shows the influence of retail atmospherics on consumers' intentions (Spangenberg et al.,1996). Related studies found that environmental stimuli can affect pleasure and arousal as well as approach and avoidance behaviors (Baker, Grewal, & Levy, 1992).

In a retail environment, lighting should facilitate a customer's efficient and pleasant shopping experience while visually showcasing the merchandise and the space (Russell, 2008; Pae, 2009). Successful lighting design not only attracts consumers' attention to the merchandise, influences their emotions, and increases their satisfaction, but it can also raise their approach intention and shopping desire (Baker et al., 2002; Steffy, 2002). Successful lighting design in a retail environment should consider contrast of lighting. Contrast of lighting refers to the relationship of surfaces that are lit (the focus or foreground) to those that are left in comparative darkness (the surrounding space or background; Boyce, 2003). Contrast is established by developing patterns of light and shade through selecting specific surfaces and objects to receive lighting emphasis while leaving others in comparative darkness (Gordon, 2003). Contrast of lighting in a retail environment consists of two main components: ambient lighting, and accent lighting. Ambient and accent lighting create spatial atmosphere and highlight merchandise in a retail space (Steffy, 2002). The combinations of ambient and accent lighting play key roles in producing different contrasts of light that can draw customers' attention and raise environmental satisfaction and approach intention (Illuminating Engineering Society of North America [IESNA], 2011). Low-contrast lighting means brighter ambient light, and high-contrast lighting consists of less ambient bright light and more accent light. The main applications of a lower lighting contrast are to provide easy task vision, allow random circulation, or permit flexible relocation of work surfaces. The primary application of a higher lighting contrast is to produce attractive images and a special atmosphere, increasing stimulation in a space to evoke feelings of excitement (Gordon, 2003; Liao, 2011). In a retail setting, lighting contrast is closely linked to consumers' visual perception, such as attention to, and interest in merchandise and the surrounding environment (Scuello et al., 2004; Pinto et al., 2010). Low-contrast lighting is known to have obvious influences on pleasure. Studies found that people in bright ambient lighting environments have higher levels of pleasure (Fleisher, Krueger, & Schierz, 2001; Russell, 2008). High-contrast lighting tends to create strong visual images leading to higher levels of arousal and approach intention in a retail space (Gordon, 2003; Summers & Hebert, 2001).

Color temperature is another key factor of lighting known to significantly impact people's feelings. Color temperature or correlated color temperature (CCT) refers to the color of light emitted from a light source. It is typically described in terms of how warm or cool the light is perceived. Color temperature of lighting has a strong relationship to emotional states (Baron et al., 1992). Russell (2008) states that warm lights tend to elicit calmness, relaxation, and pleasure. Flynn (1992) found that a space with warm color lighting and more focused light on objects or walls induce higher impressions of pleasantness. Park and Farr (2007)'s study demonstrates a strong relationship between color temperature of lighting and emotional states. In their experimental study, it was found that higher approach intention in a space with higher CCT (cool color) and higher CCT (5000K) lighting produces a higher level of arousal than lower CCT (3000K). Fleischer et al. (2001) also reported that higher color temperature lighting promotes higher arousal than warm lighting.

Therefore, in order to achieve satisfactory lighting in a retail space, both the contrast and color temperature of light in various combinations must be successfully applied to the foreground merchandise and background environment to influence consumer perception, such as attention and spatial complexity, and elicit emotional and psychological reactions, such as pleasure, arousal, store satisfaction, and approach-avoidance intentions.

1. 1. Effects of Lighting on Perception: Attention and Spatial Complexity

The effects of attention and spatial complexity can cause unique visual experiences or feelings in an environment. Attention refers to the ability to focus or concentrate (Kopec, 2006). In a lighting environment, attention is involuntarily drawn toward areas of brightness that contrast with the visual background (Gordon, 2003). In a retail store, the pattern of light posted in certain locations, such as on the wall at eye level or above, can influence consumers' emotional responses (Boyce, 2003). According to findings of lighting studies, in general, bright light attracts people's attention better than dim light; however, appropriate combinations of bright and dim light can produce a visual contrast that can create stronger images to attract attention and produce attraction to a specific lighting setup (Nuckolls, 1983).

Spatial complexity refers to visual richness, ornamentation, information rate, diversity, and variety in an environment (Custers, Kort, & Ijsselsteijn, 2010; Nasar, 2000). Berlyne (1971) explored the effects of environmental complexity on subjects' emotion and confirmed a linear relationship between environmental complexity and interest, and a curvilinear relationship between environmental complexity and preference. Nasar (1987) and Health, Smith, and Lim (2000) found a positive relationship between spatial complexity and subjects' arousal levels, while Wohlwill (1976) and Nasar (1997) found a negative link between spatial complexity and pleasure. Gilboa and Rafaeli (2003) studied the effects of environmental complexity in a retail environment by testing relationships between complexity, order, and three emotions—pleasure, arousal, and dominance—that mediate approach and avoidance behaviors. They found a positive relationship between complexity and arousal, and a curvilinear relationship to consumers' approach intention.

Flynn et al., (1973) tested combinations of intensity and patterns of light (the images and effect of light on the walls and ceilings) in a conference room and found that various combinations of lighting, including intensity and patterns of light, can affect viewers' impressions of and satisfaction with visual clarity and spatial complexity.

1. 2. Effects of Lighting on Emotion: Pleasure and Arousal

Pleasure refers to the feeling of being pleased and gratified with surrounding environments (Steffy, 2002). Arousal refers to the levels of a person's feelings by stimulation or excitement (Baker et al., 1992). Much research shows that emotion and motivation for shopping are inextricably linked such that many people make purchases for emotional reasons (Runyon & Stewart, 1987). Therefore, emotional responses frequently elicit various consumer behaviors. Some researchers claim that dimmer lighting can induce more pleasure (Custers et al, 2010), while others report more pleasant emotions with higher lighting levels (Fleischer et al., 2001; Hygge & Knez, 2001; Liao, 2011). Fleischer et al. (2001) found that high intensity lighting was more pleasant than a low intensity lighting. Similarly, Sorcar (1987) found that people experience more pleasantness in a brightly lit environment with interesting light patterns created by spot lighting and wall washing.

For arousal, Steffy (2002), Gifford (1988) and Mehrabian (1976) found that bright lighting can elicit active feeling and arousal, whereas dim lighting can induce little to no arousal. With a high contrast lighting environment that renders patterns of light and shade, a hierarchy between foreground and background can increase stimulation in a space (Gordon, 2003). Sorcar (1987) reported that brightly lit spaces with various shadows and lighting patterns can form a dramatic and exciting atmosphere.

1. 3. Effects of Lighting on Store Satisfaction and Intentions

Consumers' satisfaction in a store is an important determinant of approach-avoidance intention (Cheng et al., 2003; Voss et al., 1998). Consumers' performance assessments are based not only on physical attributes of products or retail environments, but also on their emotional responses to physical cues (Burns & Neiser, 2006). According to Spreng and Chiou (2002), there is generally a strong link between satisfaction and repurchase intentions. In addition, many consumer studies also indicate that there is a positive association of satisfaction and intentions (Bigné, Andreu, & Gnoth, 2005; Mittal, Kumar, & Tsiros, 1999). According to Reddy, Reddy, and Azeem (2011), successful image-oriented lighting can create special scenes with varied light and shadow, thus inducing higher consumer satisfaction with merchandise and the retail environment. These findings suggest that lighting design in a retail store should be more oriented toward creating attractive images and atmospheres of the store rather than creating a bright ambient environment for efficient product search tasks.

Regarding effects of lighting on approach-avoidance intention, Summers and Hebert (2001) examined the effects of lighting contrast on display areas, and showed that the stronger contrast of display lighting and background lighting facilitates shoppers with higher approach intention; they stayed longer and examined more products. Some lighting studies suggest that if people have higher levels of pleasure in a bright retail space, they should also have higher approach intentions (Baker et al., 1992; Spies, Hesse, & Loesch, 1997). Other studies show that arousal has a positive effect on approach behavior (Baker et al., 1992; Donovan & Rossiter, 1982). According to Gordon (2003), a higher contrast level was found to attract consumers' attention to merchandise and encourage them to stay longer in a retail environment.

1. 4. Application of Virtual Lighting

Traditional measurement and experiments of lighting are often held in the field or laboratories with different light sources (Boyce et al., 2006). In order to satisfy needs for different lighting experiments, conducting traditional lighting experiments can be very costly with various lights, equipment and spaces to set up (Pinto et al., 2010). Another reliable method, mock-up, is often used to simulate the performance of lighting. However, mock-ups still have the same problems as traditional lighting laboratories: higher costs and longer setting and experimental time.

In recent years, computer simulation has become increasingly popular as a tool to explore various issues of lighting, human perception, and environmental phenomena (Newsham et al., 2005). Although computer lighting simulations probably cannot produce 100% realistic light, they are still greatly useful to help researchers conduct lighting experiments and also helping designers pre-test and determine the setting for lighting (Newsham et al., 2005).

Recently, 3D computer animation simulation has been widely used in the architecture and interior design fields including exploring issues of physical environments, human behavior, and psychology. Bateson and Hui (1992) state that environmental psychologists and marketers have shown simulated environments can lead to similar results that would be found in real environments. The advantages of using 3D computer simulation include the ability to derive more visual and emotional reactions from subjects and produce collected data with higher value for professionals and designers to refer to and use (Mania & Andrew, 2004). In addition, 3D computer simulation is ideal for creating controlled conditions for observing the psychological reactions of people to their environment and in many situations, the reactions of people to virtual environments are similar to those in real environments (Hwang et al., 2012; De Kort et al., 2003). According to the findings from Lin and Yoon's (2011) study with an exhibition space, lighting simulation using computer simulation can successfully replicate physical lighting conditions. Findings indicated that there was no significant difference in perceived visual clarity, pleasure, and satisfaction between the real and virtual exhibition environments. The reliability of 3D computer simulation to test lighting effects and investigate emotional and psychological reactions has gained growing support.

1. 5. Summary

Consumer electronic retail stores are popular places for shopping for computers, laptops, tablets, and smartphones. To successfully create an interesting atmosphere and shopping environment for such products it is necessary to explore the relationship between electronics retail environments, electronic products, and shoppers. In particular, young shoppers, such as college students, are one of the main consumer groups. However, there is a lack of empirical evidence available for designers and retailers to base their decisions when attempting to provide optimal consumer experiences and addressing various needs in an electronics retail setting. In this study, Mehrabian and Russell's model (M-R model) was used to test the effects of retail lighting on consumers' emotions and intentions. Among the many factors to consider, lighting contrast and color temperature in a retail environment were selected for aforementioned reasons to study consumer responses in terms of: 1) perceptions –attention and spatial complexity, 2) emotional responses – pleasure and arousal, 3) store satisfaction and 4) approach and avoidance intentions. In order to conduct different lighting tests with contrast and color temperature of lighting, a 3D walk-through simulation was used to capture subjects' perceptions, emotions, and psychological responses.

2. Method

The primary purpose of this study is to test the effects of lighting on consumers' perception and psychology in a retail environment; hence, the fundamental question for this study is: Does contrast and color temperature of lighting affect consumers in a retail environment, and if so, to what extent?

Visual effects with shadows from lighting contrast can produce a dynamic atmosphere, and thus contrast lighting is likely to promote attention in a retail environment (Assael, 1992; Boyce, 2003). In a high-contrast lighting condition, combinations of images and intensity of light can attract consumers' attention (Boyce, 2003; Nuckolls, 1983). Therefore, we hypothesize that:

H1: Subjects will have higher levels of attention in high-contrast lighting conditions than in low-contrast lighting conditions.

Combinations of light and shadow can produce visual richness, diversity, and variety in an environment (Custers et al., 2010; Nasar, 2000). In a retail store, the pattern of light on the wall can attract consumers' attention (Gordon, 2003). Therefore, a high-contrast lighting condition can increase feelings of spatial complexity. As a result, the following hypothesis was formulated:

H2: Subjects will perceive higher levels of spatial complexity in high-contrast lighting conditions than in low-contrast lighting conditions when overall luminance is kept the same.

Sorcar (1987) stated that people experience more pleasure in a lighting environment with interesting light patterns created by spotlighting and wall washing. Therefore, a high-contrast lighting environment might produce higher levels of pleasure than a low-contrast lighting environment. According to Russell (2008), warm lights tend to elicit the feeling of pleasure, and Flynn (1992) also reported that a space with warm color lighting can induce higher impressions of pleasantness. We posit that:

H3: Subjects will perceive higher levels of pleasure in a high-contrast, warm lighting condition.

Combinations of light and shadows can create stronger visual images that might influence higher arousal in consumers than bright ambient lighting in a retail space (Gordon, 2003). Fleischer et al. (2001) stated that in most buildings and office environments, cool color temperature lighting creates more arousal than warm lighting. Similarly, Park and Farr (2007) found that higher CCT (5000K) lighting produces a higher level of arousal than lower CCT (3000K). Therefore, we posit that:

H4: Subjects will perceive higher levels of arousal in a high-contrast, cool lighting condition.

Reddy et al. (2011) claimed that store lighting can enhance the store's image and contribute to consumers' satisfaction with the store. Their findings indicate that successful image-oriented lighting can create appealing scenes with varied light and shadow that can induce higher consumer satisfaction with merchandise and the retail environment. Therefore, the following hypothesis is formulated:

H5: Subjects will have higher store satisfaction in high-contrast lighting conditions when the overall color temperature of the lighting is kept constant.

According to Summers and Hebert (2001), strong contrast of display lighting can create attractive and interesting images in a retail environment that can raise shoppers' approach intention. Gordon (2003) also reported that a higher contrast of lighting can attract consumers' attention to merchandise and encourage them to stay longer in a retail environment (Gordon, 2003). The following hypothesis is developed:

H6: Subjects will perceive higher levels of approach intention in high-contrast lighting conditions when the overall color temperature of the lighting is kept the same.

2. 1. Sample

Eighty subjects were recruited from the University of Missouri in Columbia, Missouri. The criteria used to select the appropriate subjects include: (1) 19 to 40 years old, (2) no vision impairment that affects recognition of objects, and (3) without experience of working in lighting fields. The age range of participants was kept from 19 to 40 years old for three reasons (Park, 2001; Pae, 2009). The first reason is to avoid possible age effects from different age groups, such as the elderly or children. The second reason is that the young student group is one of the main shopping groups in the electronic products market because most of them need computers and tablets for their academic courses and assignments. The third reason is that student groups have similar behavior and social activities on campus; therefore, using student subjects for this study can achieve a higher consistency of sample behavior and experiences.

2. 2. Experimental Setting and Manipulation

The experiments were conducted in a laboratory at the University of Missouri in Columbia. The size of the laboratory is about 15' by 12', and the height is 8'. During the experiment, the interior lights were turned off. Except for the images presented on the screen, the entire room – including the space behind the screen – was kept dark. There are no windows in the experimental environment.

A between-subjects design was chosen for the study to avoid carry-over effects. The main assumption of the experiment is that the combinations of contrast and color temperature of lighting have direct influence on subjects' perception and psychological responses in an electronics retail store. For the retail environment stimulus, an electronics retail store was selected because electronic goods such as computers and tablets are popular amongst college students and they can relate to various electronic devices and the environment. 3D computer animations were used to simulate a life-like browsing experience in the space for the study. The main reason for choosing a 3D computer animation over a real-time walk-through for this study is that doing so enables us to expose participants to the identical experience with a pre-defined path and duration. The vision of all participants followed the default pathway, and they all saw the same images and spots in the virtual electronics retail environment during the animation. Autodesk 3D Studio Max Design 2012 is a mainstream software package widely used in the fields of architecture and interior design. The program features a varying photorealistic rendering engine that offers an advanced lighting simulation function. The software was used to create virtual retail environments and the 3D scenes were rendered to animation.

The size and style of the experimental virtual retail space were identified through retail space design and interior design guide books (Custers, et al., 2010; Karlen & Benya, 2004). The size of the virtual retail space is approximately 1,300 sq. ft. with a rectangular floor plan, a layout that reflects a typical medium-sized retail store that is freestanding or in a mall (Karlen & Benya, 2004). The ceiling height is about 14'. Layout of furniture, materials of the walls, ceilings, and floors, color scheme, and lighting solutions were chosen to fit current trends of retail store design. Interior design and architecture professionals reviewed the design of the environment during the production stage. The virtual retail environment was projected on a large screen (60" x 60"). The size of the image on the screen was around 57" x 43". A chair and table were placed in front of the big screen, and the participants sat 6' from the screen for optimal viewing. The length of the animation was 40 seconds. After watching the entire animation without interruption, participants were asked to answer a series of questions using a written questionnaire. As participants answered the questions, the animation replayed continuously on the screen. This study did not restrict the time allotted for completing the questionnaires so that participants could simulate a more natural shopping experience.

2. 3. Lighting Conditions

The lighting settings for the study were based on the guidelines from the handbook (IESNA, 2011) and the practical report of retail lighting (IESNA, 2001) published by the Illustrating Engineering Society of North America. According to the IESNA handbook, the suggested lux of lighting in interior circulations and a retail store's whole environment ranges from 100 to 300 lux. For merchandise areas such as the surfaces of display tables, the suggested light levels are from 300 to 1000 lux. Based on these guidelines and the findings from the pilot lighting tests, this study adopted 20 lux as ambient illumination and 1000 lux for merchandise illumination for the high-contrast lighting condition, as well as 300 lux as ambient illumination and 1000 lux for merchandise illumination for the low-contrast lighting condition. The color temperature variable is also tested at two levels: high color temperature conditions, and low color temperature conditions. The high color temperature condition has 5300K cool lighting and the low condition has 3200K warm lighting.

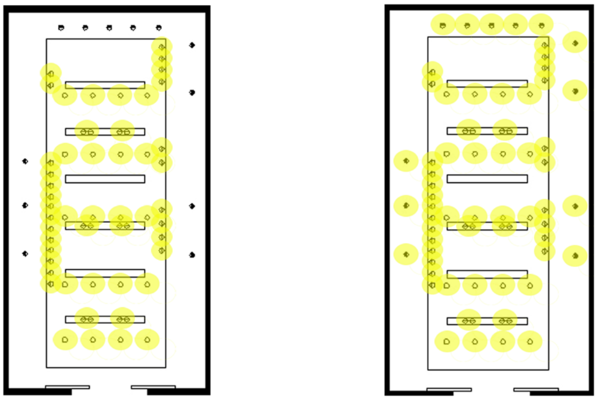
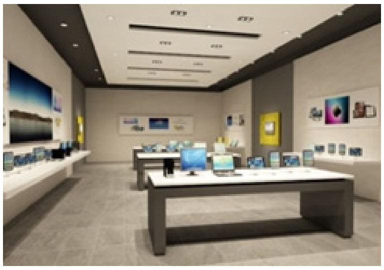
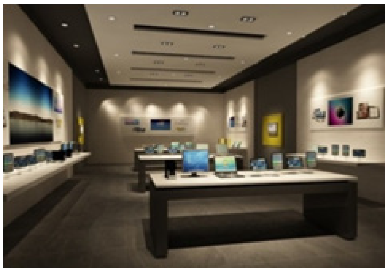
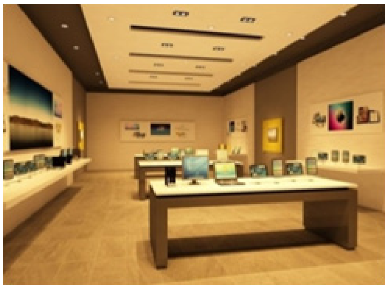
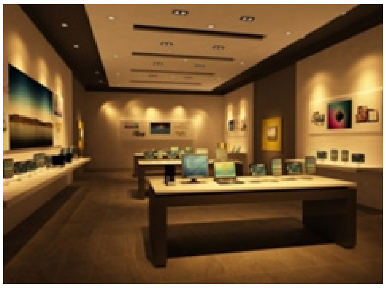


Figure 1 Low– and high–contrast lighting conditions

The present study's retail display space had 68 lights including 20 down lights, 36 spotlights, and 12 wall washers. Spotlights were put in at a 45-degree angle in front of display tables and the surrounding walls including one back wall and two side walls. The back wall had 5 wash lights, the right side wall had 4 wash lights, and the left side wall had 3 wash lights. Two lighting researchers who are university faculty members and two lighting experts from IESNA reviewed the arrangements and conditions of lighting for this study. Figure 1 shows which lights were turned on in low-contrast and high-contrast lighting conditions, and Table 1 presents four 3D virtual lighting environments.

Table 1 Four Different Lighting Conditions

	Contrast of light	
Color Temp.	Low contrast Ambient light: 300lux Merchandise illumination: 1000lux	High contrast Ambient light: 20lux Merchandise illumination: 1000lux
Cool Color 5300K		
Warm Color 3200K		

2. 4. Lighting Contrast (ambient illumination)

High-contrast lighting: luminance ratio of 50 to 1 (between merchandise illumination and ambient illumination)
Low-contrast lighting: luminance ratio of 3 to 1 (between merchandise illumination and ambient illumination)

2. 5. Instruments

A self-report questionnaire was developed based on pilot studies and other related studies. Most question items were directly adopted from instruments with established validity and reliability from previous studies, but some items were modified for the study. The questionnaire consisted of two main sections. The first section included demographic variables such as gender, age, visual impairment, whether or not the participant has worked as a lighting professional, and how often the participant goes shopping in stores. In the second section, the dependent variables for the study were the subjective experience of four lighting treatments. There were questions on six variables: attention, spatial complexity, pleasure, arousal, store satisfaction, and approach-avoidance intentions. All questions for the six dependent variables were directly selected or have been modified from related studies to fit the needs of this study examining retail store environmental settings with four different lighting conditions.

The items for attention were modified from lighting report IESNA (1993) and from cognition studies of Nisbett et al. (2001) and Nisbett and Miyamoto (2005). The questions for spatial complexity variable were selected from lighting studies of Flynn et al. (1973), IESNA (1993), Mullen and Johnson (1988), and cognition studies of Nisbett et al. (2001). The question items for pleasure were selected from studies by Baker et al. (1992) and Pae (2009). Arousal questions were selected from previous studies by Baker et al. (1992) and Bearden et al. (2011). Store satisfaction questions were selected from Pae (2009)'s study. The approach-avoidance intentions questionnaire was developed based on Baker et al (1992)'s study.
Participants were asked to indicate their answers on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree).

2. 6. Experimental Procedure

Appointments for participation in the virtual retail environment were scheduled with one to six subjects at a time. Data was collected through a survey questionnaire given to each subject. A chair and table were placed in front of the big screen, and the participants sat 6' from the screen for optimal viewing. Before the beginning of the experiment, clear explanation regarding the purpose and procedure was given to the participant, and the researcher answered questions or concerns for participants and presented the Informed Consent Form. After the consent form was signed, the participant received a standard oral introduction to explain the process of the experiment. When the participants started to read the questionnaires, they read an introduction and hypothetical scenario in the first section of the questionnaire. Hypothetical scenarios can prime the participants to produce a higher feeling of involvement for the experiment.

2. 7. Data Analysis

This study used the SPSS statistical package to analyze survey data. A series of analyses of variance (ANOVA) were used to analyze the differences between variables. A 2 (contrast of light) x 2 (color temperature of light) factorial experiment design was utilized to test six dependent variables. Reliability analysis using Cronbach's alpha was employed to test the internal consistency of scales that were used to measure the variables. Dependent variables consist of attention (6 items, $\alpha = 0.84$), spatial complexity (3 items, $\alpha = 0.70$), pleasure (5 items, $\alpha = 0.87$), arousal (6 items, $\alpha = 0.77$), store satisfaction (6 items, $\alpha = 0.96$), and approach-avoidance intentions (7 items, $\alpha = 0.86$). Since each of these alpha levels is above the acceptable threshold for reliability (George & Mallery, 2003), these variables were used for further analysis. A p-value of 0.05 was used to determine statistical significance for the study.

3. Result

3. 1. Demographic Characteristics of the Participants

The 80 participants included 26 males (32.5%) and 54 females (67.5%). 11 participants' were younger than 19 years old (13.8%) and 69 participants were 19-24 years old (86.3%). The range of shopping frequency is from "never" to "always". No participant selected "never". Five participants selected "seldom" (6.3%), 40 participants selected "sometimes" (50.0%), 27 participants selected "often" (33.8%), and 8 participants selected "always" (10.0%).

3. 2. States of Perceptions

The contrast and color temperature of the lighting influenced the participants' perception, attention, and spatial complexity states. Table 2 presents the mean and standard deviation scores for participants' attention and spatial complexity states.

Table 2 Mean and Standard Deviation Scores for Attention and Spatial Complexity

	Attention *M(SD)*			Spatial Complexity *M(SD)*		
Color / Contrast	Cool	Warm	Total	Cool	Warm	Total
High	*5.77 (.90) n=20*	*5.22 (1.13) n=20*	*5.49 (1.05) n=40*	*2.58 (1.01) n=20*	*2.58 (1.39) n=20*	*2.58 (1.20) n=40*
Low	*5.04 (1.17) n=20*	*4.51 (1.21) n=20*	*4.78 (1.20) n= 40*	*2.63 (1.07) n=20*	*2.92 (1.44) n=20*	*2.78 (1.26) n= 40*
Total	*5.40 (1.09) n=40*	*4.86 (1.21) n=40*	*5.13 (1.18) N=80*	*2.61 (1.03) n=40*	*2.75 (1.41) n=40*	*2.68 (1.23) N=80*

Table 3 displays the effects of light contrast and color temperature on participants' attention and spatial complexity. The results show two main significant effects on participants' attention. The first main effect is of light contrast, $F(1, 76) = 10.272$, $P < .01$, showing participants perceiving high-contrast lighting ($M = 5.49$, $SD = 1.05$) as more attention-drawing than low contrast lighting ($M = 4.78$, $SD = 1.20$). Hypothesis 1 is accepted in that subjects have higher attention states in high-contrast lighting conditions than in low-contrast lighting conditions.

The second main effect is of lighting color temperature, $F(1, 76) = 5.868$, $p < .05$ which shows that participants (M = 5.40, SD = 1.09) in the cool color temperature condition have a higher level of attention than in the warm color temperature condition (M = 4.86, SD = 1.21). However, no interaction between light contrast and color temperature was observed. The result of the measurement of spatial complexity shows that there are no main effects or interactions on participants' feelings about spatial complexity. Hence, this result rejects hypothesis 2 that a subject will perceive higher levels of spatial complexity in high-contrast lighting conditions than in low-contrast lighting conditions when overall luminance is kept the same.

Table 3 Analysis of Variance for Attention and Spatial Complexity

	Source	df	SS	MS	F	P
Attention	Contrast	1	10.27	10.27	8.37	.005*
	Color	1	5.87	5.87	4.78	*
	Contrast x	1	.001	.001	.001	.032*
	Color	76	93.33	1.23		.973
	Error	80				
	Total	2217.56				
Spatial Complexity	Contrast	1	.74	.74	.48	.492
	Color	1	.40	.40	.26	.611
	Contrast x	1	.40	.40	.26	.611
	Color	76	117.23	1.54		
	Error	80	639.00			
	Total					

*p<.05. **p<.01. ***p<.001

3. 3. States of Emotion

The contrast and color temperature of lighting influenced participants' emotion, pleasure, and arousal states. Table 4 presents the mean and standard deviation scores for participants' pleasure and arousal states.

Table 4 Mean and Standard Deviation Scores for Pleasure and Arousal

	Pleausre *M(SD)*			Arousal *M(SD)*		
Color / Contrast	Cool	Warm	Total	Cool	Warm	Total
High	*5.41 (1.05) n=20*	*4.94 (1.17) n=20*	*5.18 (1.12) n=40*	*4.81 (.79) n=20*	*3.83 (1.17) n=20*	*4.32 (1.11) n=40*
Low	*4.59 (1.15) n=20*	*4.50 (1.14) n=20*	*4.55 (1.33) n= 40*	*4.26 (.81) n=20*	*4.18 (.99) n=20*	*4.22 (.89) n= 40*
Total	*5.00 (1.16) n=40*	*4.72 (1.16) n=40*	*4.86 (1.16) N=80*	*4.53 (.84) n=40*	*4.00 (1.08) n=40*	*4.27 (1.00) N=80*

Table 5 displays the effects of light contrast and light color temperature on participants' pleasure and arousal states. The results show that there is a significant main effect of light contrast $F(1, 76) = 7.938$, $P < .05$ on pleasure in participants. This main effect shows that participants perceiving high light contrast (M = 5.18, SD = 1.12) feel more pleasure than those who perceive low light contrast (M = 4.55, SD = 1.13). However, no interaction between lighting contrast and lighting color temperature was obtained. Hence, this result rejects hypothesis 3 that subjects will perceive higher levels of pleasure in a high-contrast warm lighting condition.

Table 5 Analysis of Variance for Pleasure and Arousal

	Source	df	SS	MS	F	P
Pleasure	Contrast	1	7.94	7.94	6.25	.015*
	Color	1	1.57	1.57	1.23	.270
	Contrast x	1	.72	.72	.57	.453
	Color	76	92.60	1.27		
	Error	80	1996.40			
	Total					
Arousal	Contrast	1	.20	.20	.20	.640
	Color	1	5.69	5.69	6.27	.014*
	Contrast x	1	4.05	4.05	4.46	.038*
	Color	76	68.98	.91		
	Error	80	1535.28			
	Total					

*p<.05. **p<.01. ***p<.001

For states of arousal, the result shows that there is a significant main effect and interaction effect. The main effect is of light color temperature, $F(1, 76) = 5.689$, $p < .05$. A significant two-way interaction of light contrast and light color temperature was obtained with a calculated $F(1, 76) = 4.050$, $P < .05$. Figure 2 shows the interaction effect of light contrast and color temperature on participants' arousal states.

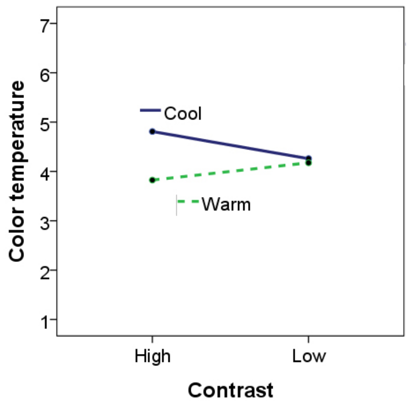


Figure 2 Interaction effect of light contrast and color temperature on arousal

Table 6 shows the results of a simple main effect for light contrast by light color temperature. Analysis of the simple main effect shows that high light contrast, $F(1, 38) = 9.687$, $p < .01$, and cool light color temperature, $F(1, 38) = 3.035$, $p < .05$, have significance. Hence, participants have higher levels of arousal in high-contrast light (M = 4.32, SD = 1.11) than in low-contrast light (M = 4.22, SD = .89). In addition, participants have a higher level of arousal in cool color temperature (M = 4.53, SD = .84) than in warm color temperature (M = 4.00, SD = 1.08). According to the results from the simple main effect, hypothesis 4 was confirmed: subjects will feel higher levels of arousal in a high-contrast, cool color condition.

Table 6 Analysis of Simple Main Effect of Light Contrast by Light Color on Arousal

Source	df	SS	MS	F
Contrast				
High	1	9.67	9.67	9.687**
Low	1	.07	.07	.085
Color				
Cool	1	3.04	3.03	4.705*
Warm	1	1.23	1.23	1.045

*p<.05. **p<.01. ***p<.001

3. 4. States of Store Satisfaction and Intentions

The contrast and color temperature of lighting influenced participants' store satisfaction and approach-avoidance intentions. Table 7 presents the mean and standard deviation scores for participants' store satisfaction and approach-avoidance intentions.

Table 7 Mean and Standard Deviation Scores for Store Satisfaction and Intention

	Store Satisfaction *M(SD)*			Intention *M(SD)*		
Color / Contrast	Cool	Warm	Total	Cool	Warm	Total
High	*5.49 (.89) n=20*	*4.60 (1.43) n=20*	*5.05 (1.26) n=40*	*5.69 (.78) n=20*	*5.12 (1.96) n=20*	*5.40 (.91) n=40*
Low	*4.52 (1.39) n=20*	*4.48 (1.42) n=20*	*4.59 (1.38) n= 40*	*5.02 (.73) n=20*	*4.96 (.88) n=20*	*4.99 (.80) n= 40*
Total	*5.00 (1.25) n=40*	*4.54 (1.41) n=40*	*4.77 (1.35) N=80*	*5.35 (.82) n=40*	*5.04 (.92) n=40*	*5.20 (.88) N=80*

Table 8 displays the effects of light contrast and light color temperature on participants' store satisfaction and approach-avoidance intention states. The results show that there are no main effects or interactions on participants' store satisfaction. Therefore, the results reject hypothesis 5 that subjects feel higher levels of store satisfaction in a high-contrast lighting condition. However, the p-value of lighting contrast reaches .06, so the statistical significance of store satisfaction may be obtained in a larger sample size.

For the states of approach-avoidance intentions, the results show that there is a significant main effect on approach-avoidance intentions in participants. This main effect is light contrast $F(1, 76) = 3.433$, $P < .05$, which shows that participants perceiving high-contrast lighting ($M = 5.40$, $SD = .91$) have higher approach-avoidance intentions than when perceiving low-contrast lighting ($M = 4.99$, $SD = .80$). This result supports hypothesis 6 that subjects have higher approach intention in a high-contrast lighting condition; however, no interaction between light contrast and light color temperature was obtained.

Table 8 Analysis of Variance for Store Satisfaction and Intentions

	Source	df	SS	MS	F	P
Store Satisfaction	Contrast	1	6.05	6.05	3.57	.063
	Color	1	4.36	4.36	2.57	.113
	Contrast x	1	3.61	3.61	2.13	.148
	Color	76	128.84	1.69		
	Error	80	1993.72			
	Total					
Intentions	Contrast	1	3.43	3.43	4.82	.031*
	Color	1	1.98	1.98	2.71	.100
	Contrast x	1	1.25	1.25	1.75	.189
	Color	76	54.17	.71		
	Error	80	2221.06			
	Total					

*$p<.05$. **$p<.01$. ***$p<.001$

4. Discussion and Conclusions

This study was intended to explore the effects of lighting on consumers' perceptions (attention and spatial complexity) and psychological responses (pleasure, arousal, store satisfaction, and approach-avoidance intentions) in an electronics retail environment. Combinations of lighting have obvious influences on subjects' perception. The results show that in an electronics retail environment, participants paid more attention when they perceived high-contrast lighting conditions in comparison to low-contrast lighting conditions. This finding supports the notion that levels of attention are influenced by high-contrast lighting environments as described in previous lighting and environmental studies (Boyce, 2003; IESNA, 2011; Pinto et al., 2010). Therefore, most shoppers will focus their attention on images created by lighting and shadows on the walls in electronics retail environments with high-contrast lighting. In addition, participants have higher levels of attention in cool color conditions than in warm color conditions. This suggests that an electronics retail environment with high-contrast and cool-color lighting may have a greater influence on subjects' attention. In an electronics retail environment, greater attention might arouse shoppers' interest, encouraging them to stay longer and potentially make a purchase. Further exploration is required to the extent to which attention might influence consumer purchasing decisions.

Spatial complexity in this study is composed of complex shadows and bright images in an electronics retail scene. Subjects should perceive higher levels of spatial complexity in high-contrast lighting conditions when the overall color temperature of lighting is kept the same (Custers et al., 2010; Flynn et al., 1973); however, subjects did not perceive higher levels of spatial complexity in high-contrast lighting conditions. There is a possible explanation for this outcome. The retail environment in this study is full of various electronic products on the display tables and shelves along with decor on the walls. These images and decorations in the scene might produce different disturbances so that the viewers' feelings about spatial complexity could also be influenced by the complex arrangement of display tables, products, and wall decor. To avoid these possible disturbances, future research should keep the layout and decorations in the simulated retail space as simple as possible, so that subjects' feelings about spatial complexity will be directly influenced by the images and shadows from lighting rather than by other objects.

Lighting contrast levels have different influences on subjects' pleasure levels, but color temperature seemed to make no obvious difference. This indicates that pleasure seems to be influenced by lighting contrast but not by color temperature. This result can support findings in related studies that people experience more pleasantness in a lighting environment with interesting light patterns created by spotlighting and wall washing (Custers et al, 2010; Donovan & Rossiter, 1982; Sorcar, 1987). Therefore, most shoppers perceive higher levels of pleasure in an electronics retail environment with a high-contrast lighting condition. However, the findings of this study cannot support Quellman and Boyce's finding (2002) that African-Americans prefer warmer light and Pae's finding (2009) that Americans preferred hotel guestrooms with warm color lighting. The explanation might be that, in different spaces, subjects could display different psychological responses to the color temperature of lighting. Cultural differences might also influence the pleasure responses of different groups within an electronics retail environment; hence, the effect of lighting color temperature needs further exploration.

Subjects perceive higher levels of arousal in high-contrast, cool lighting conditions. Previous studies of retail lighting showed that consumers' arousal state in a retail environment was only influenced by bright lighting (Areni & Kim, 1994; Summers & Hebert, 2001). Although Gordon (2003) mentioned that subjects have higher levels of arousal in high-contrast lighting conditions, he did not include actual testing in the field or laboratory. Based on empirical results, the present findings confirm that consumers' arousal is influenced by high-contrast display lighting. In addition, this study also offers empirical evidence that the color temperature of lighting influences subjects' arousal state in an electronics retail environment. This result supports the findings from Park (2001) that American subjects have higher levels of arousal in cool color temperature conditions; hence, high-contrast lighting with cool temperature has more influence on subjects' arousal state in an electronic retail environment.

Reddy et al. (2011) state that store lighting can impact consumers' satisfaction, yet according to the finding from this study, subjects' store satisfaction was not influenced by light contrast or light color temperature. However, this study used an animation to simulate a visual electronics retail environment, meaning the subjects could not walk around and stay in any one spot to examine decoration or to touch products. This condition may have caused different effects on subjects' store satisfaction. Nevertheless, the result of the statistical analysis almost reached significance; therefore, this study's findings can still offer additional knowledge about store lighting that enhances the image of the store, contributing more to the consumers' satisfaction while in the store.

The current results show that in a high-contrast lighting condition, subjects have higher approach intention, which supports a similar finding by Summers and Hebert (2001). In addition, according to Gordon (2003), higher contrast lighting can attract consumers' attention to merchandise and encourage them to stay longer in a retail environment. Although this study did not investigate subjects' shopping attitudes and behaviors, the findings about approach intention can still be used as a reference for consumer behavior and marketing. This study used electronic devices as the main products in the retail environment, so subjects' emotional and psychological responses may be influenced by electronic products, not just by the environment. In addition, the layout of an electronics retail environment might be different from other stores; therefore, the main findings of this study only focus on electronics retail environments, not for all retail environments.

In summary, the results of this study show four main findings:

1. Subjects have higher levels of attention in high-contrast lighting with cool color temperature in an electronics retail store.
2. Subjects have higher levels of pleasure in high-contrast lighting in an electronics retail store.
3. Subjects have higher levels of arousal in high-contrast lighting with cool color temperature in an electronics retail store.
4. Subjects have higher levels of approach intention in high-contrast lighting in an electronics retail store.

This study provides a preliminary understanding of the effects of retail lighting on subjects' perceptions and psychological responses. Several conclusions can be drawn from this analysis. First, the findings show that in high-contrast lighting conditions, subjects have higher levels of attention, pleasure, arousal, and approach intention in an electronics retail environment. However, compared to lighting contrast, the color temperature of lighting did not show a significant effect on most factors. Hence, for retail lighting, controlling contrast is more important than controlling color temperature.

Second, cool color temperature of lighting has a significant effect on attention and arousal states. This suggests that subjects' visual attention and emotional responses are greater when they are exposed to a cool color temperature of lighting. Therefore, high-contrast and a cool color temperature are the two main factors of display lighting that influence subjects' perception and emotion in an electronics retail environment. Third, many studies show that subjects in different environments and spaces have different feelings and emotional responses; hence, the application of these findings about contrast and color temperature of lighting must take into consideration different spatial features and functions. As a result, the findings of this study can only be used to explain the effects of lighting in electronics retail environments. Fourth and finally, some studies have mentioned that different cultural groups have different perceptions and emotional responses under various combinations of lighting. Therefore, cultural differences could be another important factor that impacts subjects' perception and psychological responses in electronics retail environments, a speculation that needs further exploration.

Implications from this study can be applied to the fields of retail environment, consumer behavior, and lighting design. In order to understand the effects of perceptions in retail environments, this study added the theory of perceptions, including attention and spatial complexity, to the M-R model. The findings of this study can offer some information about the effects of perception to reinforce the M-R model. In addition, these results can be interpreted in light of the theory of atmospheric effects on consumers' shopping behavior.

Although this study did not test subjects' actual shopping behavior, the findings can still offer new knowledge about the effects of environmental stimuli on shoppers' emotional and psychological responses in electronics retail environments as well as empirically-based guidelines for designing different contrast and color temperature of light in a retail environment. For example, an electronics retail environment could be designed to have high-contrast lighting conditions that will induce higher levels of pleasure among shoppers, and thereby increase their likelihood of making a purchase. Consequently, designers and retailers can refer to these guidelines to design different electronics retail environments with optimal lighting conditions in order to attract customers.

References

1 Areni, C. S., & Kim, D. (1994). The influence of in-store lighting on consumers' examination of merchandise in a wine store. *International Journal of Research in Marketing, 11*(2), 117-125.

2 Assael, H. (1992). *Consumer behavior & marketing action* (4nd ed.). Boston, MA: PWS-KENT.

3 Baker, J., Grewal, D., & Levy, M. (1992). An experimental approach to making retail store environmental decisions. *Journal of Retailing, 68,* 445-460.

4 Bateson, J. E., & Hui, M. K. (1992). The ecological validity of photographic slides and videotapes in simulating the service setting. *Journal of Consumer Research,19*(2), 271-281.

5 Baron, R. A., Rea, M. S., & Daniels, S. G. (1992). Effects of indoor lighting (illuminance and spectral distribution) on the performance of cognitive tasks and interpersonal behaviors: The potential mediating role of positive affect. *Motivation and Emotion, 1,* 1-33.

6 Berlyne, D. E. (1971). *Aesthetics and psychobiology.* New York, NY: Appleton-Century-Crofts.

7 Bearden, W. O., Netemeyer, R. G., & Haws, K. L. (2011). *Handbook of Marketing Scales: Multi-Item Measures for Marketing and Consumer Behavior research* (3nd ed.). Thousand Oaks, CA: Sage.

8 Berlyne, D. E. (1971). *Aesthetics and psychobiology.* New York, NY: Appleton-Century-Crofts.

9 Bign, J. E., Andreu, L., & Gnoth, J. (2005). The theme park experience: An analysis of pleasure, arousal, and satisfaction. *Tourism Management, 26*(6), 833-844.

10 Boyce, P. R. (2003). *Human factors in lighting.* New York, NY: Taylor & Francis.

11 Boyce, P. R, Veitch, J., Newsham, G., Jones, C., Heerwagen, J., Myer, M., & Hunter, C. (2006). Lighting quality and office work: two field simulation experiments. *Lighting Research and Technology, 38*(3), 191-223.

12 Burns, D., & Neisner, L. (2006). Customer satisfaction in a retail setting: The contribution of emotion. *International Journal of Retail & Distribution Management, 34*(1), 49-66.

13 Cheng, C. M. K., Zhu, L., Kwong, T., Chan., G. W. W., & Limayem, M. (2003). Online consumer behavior: A review and agenda for future research. *Proceedings of the 16th Bled eCommerce Conference eTransformation,* 201.

14 Custers, P., Kort, Y. A. W., & Ijsselsteijn, W. (2010). Lighting in retail environments: Atmosphere perception in the real world. *Lighting Research & Technology, 42,* 331-343.

15 De Kort, Y. A., Ijsselsteijn, W. A., Kooijman, J., & Schuurmans, Y. (2003). Virtual laboratories: Comparability of real and virtual environments for environmental psychology. *Presence: Teleoperators and virtual environments, 12*(4), 360-373.

16 Donovan, R. J., & Rossiter, J. R. (1982). Store atmosphere: An environmental psychology approach. *Journal of Retailing, 58*(1), 34-57.

17 Fleischer, S., Krueger, H., & Schierz, C. (2001). Effect of brightness distribution and light colours on office staff. *The 9th European Lighting Conference Proceeding Book of Lux Europa,* 77-80.

18 Flynn, J. E., Spencer, T. J., Martyniuk, O., & Hendrick, C. (1973). Interim study of procedures for investigating the effect of light on impression and behavior. *Journal of the Illuminating Engineering Society, 3*(1), 87-94.

19 Flynn, J. E. (1992). Lighting-design decisions as interventions in human visual space. In J.

L. Naasas (Ed.), *Environmental aesthetics: Theory, research and applications.* New York, NY: Cambridge University Press.

20 George, D., & Mallery, P. (2003). *SPSS for Windows step by step: A simple guide and reference* (4nd ed.). Boston, MA: Allyn & Bacon.

21 Gilboa, S., & Rafaeli, A. (2003). Store environment, emotions and approach behavior: Applying environmental aesthetics to retailing. *The International Review of Retail, Distribution and Consumer Research, 13*(2), 195-211.

22 Gifford, R. (1988). Light, decor, arousal, comfort and communication. *Journal of Environmental Psychology, 8*(3), 177-189.

23 Gordon, G. (2003). *Interior lighting for designers.* John Wiley & Sons.

24 Heath, T., Smith, S. G., & Lim, B. (2000). Tall buildings and the urban skyline: The effect of visual complexity on preferences. *Environment and Behavior, 32*(4), 541-556.

25 Hwang, J., Yoon, S. Y., & Bendle, L. J. (2012). Desired privacy and the impact of crowding on customer emotions and approach-avoidance responses: Waiting in a virtual reality restaurant. *International Journal of Contemporary Hospitality Management, 24*(2), 224-250.

26 Hygge, S., & Knez, I. (2001). Effects of noise, heat and indoor lighting on cognitive performance and self-reported affect. *Journal of Environmental Psychology, 21*(3), 291-299.

27 Illuminating Engineering Society of North America. (1993). *Lighting Education ED-100.* New York.

28 Illuminating Engineering Society of North America. (2001). *Recommended practice for lighting merchandise areas: A store lighting guide.* New York, NY.

29 Illuminating Engineering Society of North America. (2011). *The lighting handbook* (10nd ed.). New York, NY.

30 Karlen, M., & Benya, J. R. (2004). *Lighting design basics.* Hoboken, NJ: John Wiley & Sons.

31 Kopec, D. (2006). *Environmental psychology for design.* New York, NY: Fairchild Publications.

32 Liao, L. H. (2011). *Retail lighting design preferences between recreational and task oriented shoppers.* Unpublished master's thesis, University of Florida, Gainesville, FL.

33 Lin, Y.-F., & Yoon, S.-Y. (2011). Exploring display lighting effects: A comparison of real and virtual experience. *The Journal of Korean Living Science Research, 31*(1), 59-69.

34 Mania, K., & Andrew, R. (2004). The effect of quality of rendering on user lighting impressions and presence in virtual environments. *Proceedings of the 2004 ACM SIGGRAPH international conference on Virtual Reality continuum and its applications in industry,* ACM Press, New York, NY, USA, 200-205.

35 Mittal, V., Kumar, P., & Tsiros, M. (1999). Attribute-level performance, satisfaction, and behavioral intentions over time: a consumption-system approach. *The Journal of Marketing,* 88-101.

36 Mullen, B., & Johnson, C. (1988). *The psychology of consumer behavior.* Hillsdale, NJ: Lawrence Erlbaum.

37 Mehrabian, A. (1976). *Public places and private spaces: The psychology of work, play, and living environments.* New York, NY: Basic Books.

38 Mehrabian, A., & Russell, J. A. (1974). *An approach to environmental psychology.* Cambridge, MA: MIT Press.

39 Nasar, J. L. (1987). The effect of sign complexity and coherence on the perceived quality of retail scenes. *Journal of the American Planning Association, 53*(4), 499-509.

40 Nasar, J. L. (1997). New developments in aesthetics for urban design. In *Toward the Integration of Theory, Methods, Research, and Utilization* (pp. 149-193). Springer US.

41 Nasar, J. L. (2000). The evaluative image of places. In W. B. Walsh, K. H. Craik, & R. H. Price (Eds.), *Person-environment psychology* (2nd ed., pp. 117-168), Mahwah, NJ: Lawrence Erlbaum.

42 Newsham, G. R., Richardson, C., Blanchet, C., & Veitch, J. A. (2005). Lighting quality research using rendered images of offices. *Lighting Research and Technology, 37*(2), 96-112.

43 Nisbett, R. E., & Miyamoto, Y. (2005). The influence of culture: holistic versus analytic perception. *TRENDS in Cognitive Sciences, 9*(10), 467-473.

44 Nisbett, R. E., Peng, K., Choi, I., & Norenzayan, A. (2001). Culture and systems of thought: Holistic

vs. analytic cognition. *Psychological Review, 108*(2), 291–310.

45 Nuckolls, J. L. (1983). *Interior lighting for environmental designers* (2nd ed.). New York, NY: John Wiley & Sons.

46 Pae, J. Y. (2009). *The effects of hotel guestroom lighting on consumer's emotional states, preferences and behavioral intentions.* (Unpublished master's thesis). University of Florida, Gainesville, FL.

47 Park, N. K. (2001). *Indoor lighting perceptions and preferences: a cross-cultural comparison.* (Unpublished doctoral dissertation). Oklahoma State University, Stillwater, OK.

48 Park, N. K., & Farr, C. A. (2007). The effects of lighting on consumers' emotions and behavioral intentions in a retail environment: A cross cultural comparison. *Journal of Interior Design, 33*(1), 17–32.

49 Pinto, P. D., Felgueiras, P. E. R., Linhares, J. M. M., & Nascimento, S. M. C. (2010). Chromatic effects of metamers of D65 on art paintings. *Ophthalmic and Physiological Optics, 30*(5), 632–637.

50 Qullman, E. M., & Boyce, P. R. (2002). The light source color preferences of people of different skin tones. *Journal of Illuminating Engineering Society, 31*(1), 109–118.

51 Reddy, N. R. V., Reddy, N. T., & Azeem, A. (2011). Role of in-store lighting in store satisfaction. *International Journal of Business & Management Tomorrow, 1*(3), 1–8.

52 Russell, S. (2008). *The architecture of light.* La Jolla, CA: Conceptnine.

53 Runyon, K. E., & Stewart, D. W. (1987). *Consumer behavior* (3nd ed.). Columbus, OH: Merrill.

54 Scuello, M., Abramov, I., Gordon, J., & Weintraub, S. (2004). Museum lighting: Why are some illuminants preferred?. *Journal of the Optical Society of America A, 21*(2), 306–311.

55 Sorcar, P. C. (1987). *Architectural lighting for commercial interiors.* New York, NY: John Wiley & Sons.

56 Spies, K., Hesse, F., & Loesch, K. (1997). Store atmosphere, mood and purchasing behavior. *International Journal of Research in Marketing, 14*(1), 1–17.

57 Spangenberg, E. R., Crowley, A. E., & Henderson, P. W. (1996). Improving the store environment: Do olfactory cues affect evaluations and behaviors?. *The Journal of Marketing, 60*(2), 67–80.

58 Spreng, R. A., & Chiou, J. S. (2002). A cross-cultural assessment of the satisfaction formation process. *European Journal of Marketing, 36*(7), 829–839.

59 Steffy, G. (2002). *Architectural lighting design.* New York, NY: John Wiley & Sons.

60 Summers, T. A., & Hebert, P. R. (2001). Shedding some light on store atmospherics influence of illumination on consumer behavior. *Journal of Business Research, 54*(2), 145–150.

61 Voss, G. B., Parasuraman, A., & Grewal, D. (1998). The roles of price, performance and expectations in determining satisfaction in service exchanges. *Journal of Marketing, 62*(4), 46–61.

62 Wohlwill, J. F. (1976). Environmental aesthetics: The environment as a source of affect. In *Human behavior and environment* (pp. 37–86). Springer US.