INDOOR LIGHTING PERCEPTIONS AND PREFERENCES: A CROSS-CULTURAL COMPARISON

By

NAM-KYU PARK

Bachelor of Science
Kon-Kuk University
Seoul, Korea
1989

Master of Science
Oklahoma State University
Stillwater, Oklahoma
1999

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A CROSS-CULTURAL COMPARISON

Thesis Approved:

Cheryl A. Farr
____
Thesis Adviser

Shiretta Ownbey
____

____

Theodore Drab
____

Timothy J. Pettibone
____
Dean of the Graduate College

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CHAPTER I

INTRODUCTION

Steiner and Haas (1995) describe the world today as follows:

"Business is global
People are different
Communication means survival"

The world has become a global village, describing the condition of interdependence among nations. This interdependent world has matured through advances in technology, increased globalization of economics, the development of international corporations, cultural exchanges, and overlapping political spheres. Reardon (1984) stated the world may be shrinking into a global city, but whatever their nationality, people still maintain many of their cultural rules. Steiner and Haas (1995) also pointed out that "despite the superficial homogenization of a Big Mac and a Coke, people continue to assert, even at the cost of war, their own cultural identities." As a function of this globalization, personal relationships that develop between business partners from different nations require a special kind of knowledge and sensitivity towards each other's culture. And also, design industries need to place an increased emphasis upon internationalization by understanding cultural sensitivity, cultural awareness, and concrete knowledge about foreign establishments.

According to researchers, consumer behavior is influenced by the atmospherics of the shopping environment (Bitner, 1990; Donovan & Rossiter, 1982; Grossbart, Hampton, Rammohan & Lapidus, 1990; Kotler, 1973-1974). Store atmospherics describe the special sensory qualities of retail spaces which can evoke a consumer's emotional and/or cognitive states that influence consumer shopping behavior. Other researchers found that consumer perception of the atmospheric stimuli in a store environment is highly related to consumer behavior (Grossbart, et. al, 1990; Spanenberg, Crowley, & Henderson, 1996; Yalch & Spangenberg, 1990). Kotler (1973-

1974) as a pioneer of marketing research in relation to store atmospherics maintains that atmosphere factors include visual, aural, olfactory or tactile dimensions and mentioned that these store atmospherics encourage consumers to enter a store, linger, and purchase. Donovan and Rossiter's (1982) study, by applying Mehrabian and Russell's environmental psychology theory (1974), showed that store atmospherics influence consumers' emotional states and behavioral intentions. Mehrabian and Russell's model (M-R model) presented the paradigm of the stimulus-organism response (S-O-R), explaining that the stimulus (S) that causes a consumer's emotional states (O) is closely related to a consumer's behavior responses (R). Many studies of retail environments related to atmospheric stimuli, emotional state, and responses have employed the M-R model as their theoretical frame work (Baker, Levy, & Grewal, 1992; Bitner, 1990; Crowley, 1993; Donovan & Rossiter, 1982; Donovan, Rossiter, Marcoolyn, & Nesdale, 1994; Grossbart, et. al., 1990; Sherman, Mathur, & Smith, 1997).

Upon atmospheric stimuli in store environments, studies have broadly included color, lighting, music, scent, temperature, layout, and crowding, and their influence on the consumer's emotional states such as arousal, pleasure, and dominance, and have had an effect on a wide range of behavioral responses such as approach-avoidance, satisfaction, time in store, and purchases. In order to classify the limitations of store atmospheric studies examined broadly, Berman and Evans (1995) divided atmospheric stimuli into four variable categories as follows: external variables, general interior variables, layout and design variables, and point-of purchase and decoration variables. Turley and Milliman (2000) extended the research using the same four categories but added a fifth, human variables. Display windows, building architecture, storefront, and entrances are included in the category of the external variables. Lighting factors are included in the general interior variables.

Previous research shows that lighting is one of the major contributing factors in retail store atmospherics. (Cuttle & Brandston, 1995; Gardner & Siomkos, 1986; Kotler, 1973-1974; Lopez, 1995; Rea, 1999). Lighting as a mood inducer affects the person's emotional states (Veitch, 1997). The impacts of store lighting in evaluation and shopping behavior were examined by Areni and Kim (1994), Baker, Grewal, and Prasuraman (1994), Baker, Levy, and Grewal

(1992), and Hebert (1997). These studies indicate that lighting factors influence both the consumer's emotional states and shopping behavior including approach-avoidance behavior, examination of merchandise, and product purchase. However, all these studies examined the quantity of lighting as a lighting factor for consumer responses. Even though the importance and benefits of light quality are generally acclaimed for retail environments, few empirical retail lighting studies have been conducted.

Cuttle & Brandston (1995) pointed out that store lighting affects both color perception of products and the appearance of skin tone which could have a direct impact on customers' purchase behavior. The story of Ray Grenald's lighting design by illuminating an S-curve in the entryway to a beauty salon explained that the color properties of light sources significantly influence the customers' complexion and skin appearances (Schiler, 1992). Park and Farr (2000) found that the color temperature of the light source influences the appearance of skin tone in a store environment. Even though light affects the store image, the color perceptions of products and the appearance of skin tone in a retail environment, no study focusing specifically on light quality for diverse cultural consumers has been found.

Based on the research cited above, cultural differences were observed with regard to the effects of light quality as an atmospheric stimulus on consumer perception, evaluation, and behavior intentions before coming to a store and while in the store. For this reason, the focus of this lighting study concentrated on the possible effects of light quality with color temperature and color rendering index on lighting perceptions and preferences, color perception and designation of store products, and the appearance of complexion and skin color among individuals with different cultural backgrounds.

Purposes and Objectives of the Study

The primary purpose of the study was to identify the similarities or differences in lighting perception and preference between representatives of two different cultures, Caucasian Americans and Koreans. The second purpose of the study was to identify the effects of light source color on complexion and skin color appearances. The third purpose of the study was to identify the effects of light source color on color perception and designation of store products as identified by different consumers.

The fourth purpose of this study was to identify the similarities or differences in lighting perception and preference, and the effects of light source color on color perception and designation of the store products according to different consumers as observed from outside the lighted environment. The fifth purpose of the study was to identify differences that may exist between lighting preference and perception, and color perception of store products under different color properties of the light source according to different consumers by comparing responses made inside and outside of a lighted environment. The final purpose of the study was to identify the effects of light source color on lighting preference and perception, and color perception and designation of store products according to different consumers when two lighting conditions are evaluated simultaneously from outside the lighted environment.

The specific objectives of the study were:

1. To identify and compare lighting perception including arousal, pleasure, visual clarity, and glare and lighting preference between Caucasian Americans and Koreans under different color rendering indices (CRI) and color temperatures (CT) of fluorescent light in a lighted environment.
2. To identify and compare impression and preference of the light color between Americans and Koreans under color rendering index (CRI) and color temperatures (CT) of fluorescent light in a lighted environment.
3. To identify and compare the effects of light source color on complexion and skin color appearance between Americans and Koreans under different color rendering indices (CRI) and color temperatures (CT) of fluorescent light in a lighted environment.
4. To identify and compare the subjects' color perception of store products under color rendering indices (CRI) and color temperatures (CT) of fluorescent light in a lighted environment.
5. To identify and compare lighting perception including visual clarity, room attractiveness, and approach-avoidance intention and lighting preference according to culture difference with

regard to color rendering indices (CRI) and color temperatures (CT) of fluorescent light as observed from outside the lighted environment.

6. To identify and compare impression and preference of the light color according to culture difference with regard to color rendering indices (CRI) and color temperatures (CT) of fluorescent light as observed from outside the lighted environment.
7. To identify and compare the subjects' color perception and designation of store products according to culture difference with regard to color rendering indices (CRI) and color temperatures (CT) of fluorescent light as observed from outside the lighted environment.
8. To identify and assess lighting perception in visual clarity and lighting preference according to culture difference with regard to color rendering indices (CRI) and color temperatures (CT) of fluorescent light by comparing responses made between inside and outside the lighted environment.
9. To identify and assess impression and preference of the light color according to culture difference with regard to color rendering indices (CRI) and color temperatures (CT) of fluorescent light by comparing responses made between inside and outside the lighted environment.
10. To identify and assess the subjects' color perception of store products according to culture difference with regard to color rendering indices (CRI) and color temperatures (CT) of fluorescent light by comparing responses made between inside and outside the lighted environment.
11. To identify and compare lighting perception in visual clarity, room attractiveness, and approach and avoidance and lighting preference according to culture difference with regard to color rendering indices (CRI) and color temperatures (CT) of fluorescent light when two lighting conditions are observed simultaneously from outside the lighted environment.
12. To identify and compare impression and preference of the light color according to culture difference with regard to color rendering indices (CRI) and color temperatures (CT) of fluorescent light when two lighting conditions are observed simultaneously from outside the lighted environment.

13. To identify and compare the subjects' color perception and designation of store products according to culture difference with regard to color rendering indices (CRI) and color temperatures (CT) of fluorescent light when two lighting conditions are observed simultaneously from outside the lighted environment.

Research Hypotheses

To accomplish the objectives of this study, the research was designed to test null hypotheses. For clarity, the hypotheses were grouped by the subjects' placement during the experiment. The hypotheses in Section 1 address the subjects' responses to each lighting condition in the cubicle. Therefore, the subjects' perceptions of lighting are made when viewed in the lighted environment. There are twelve hypotheses in Section 1. The hypotheses in Section 2 address the subjects' responses to each of four lighting conditions from outside the cubicle. Thus, the subjects' perceptions of lighting are made when observed from outside the lighted environment as a spectator's position. There are ten hypotheses in Section 2. The Hypotheses in Section 3 address the comparison of the subjects' responses to each of four lighting conditions from inside and outside the cubicle. Thus, the subjects' perceptions of lighting are made when viewed inside and outside the lighted environment. There are seven hypotheses in Section 3. The hypotheses in Section 4 address the subjects' responses to two lighting conditions from outside the cubicle. Thus, the subjects' perceptions of lighting are made when two lighting conditions were observed and compared simultaneously from outside the lighted environment at a spectator's position. There are forty hypotheses in Section 4.

Hypotheses in Section 1: Subject Inside the Cubicle

Hypothesis 1. There is no difference in the subjects' perception of lighting as being visually warm or visually cool when observed in the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Hypothesis 2. There is no difference in subjects' perception of glare when observed in the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Hypothesis 3. There is no difference in the subjects' perception of lighting as a factor in arousal when observed in the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Hypothesis 4. There is no difference in the subjects' perception of lighting as a factor in pleasure when observed in the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Hypothesis 5. There is no difference in the subjects' perception of lighting as a factor in visual clarity when observed in the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Hypothesis 6. There is no difference in the subjects' impression of the light color when observed in the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)

Hypothesis 7. There is no difference in the subjects' preference of the light color when observed in the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)

c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Hypothesis 8. There is no difference in the subjects' perception of skin color appearance when observed in the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Hypothesis 9. There is no difference in the subjects' perception of complexion appearance when observed in the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Hypothesis 10. There is no difference in the subjects' perception of fruit color as being natural or unnatural when observed in the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Hypothesis 11. There is no difference in the subjects' color perception for five different kinds of fruit when observed in the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)

Hypothesis 12. There is no difference in the subjects' overall lighting preference when observed in the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Hypotheses in Section Two

Hypothesis 13. There is no difference in the subjects' perception of the lighting as being visually warm or visually cool by observing from outside the cubicle with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Hypothesis 14. There is no difference in the subjects' perception of lighting as a factor in visual clarity by observing from outside the cubicle with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Hypothesis 15. There is no difference in the subjects' perception of the light for room attractiveness by observing from outside the cubicle with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Hypothesis 16. There is no difference in the subjects' perception of the lighting for approach-avoidance intention by observing from outside the cubicle with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Hypothesis 17. There is no difference in the subjects' overall lighting preference by observing from outside the cubicle with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Hypothesis 18. There is no difference in the subjects' impression of the light color by observing from outside the cubicle with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)

Hypothesis 19. There is no difference in the subjects' preference of the light color by observing from outside the cubicle with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Hypothesis 20. There is no difference in the subjects' perception of fruit color as being natural or unnatural by observing from outside the cubicle with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Hypothesis 21. There is no difference in the subjects' color perception for five different kinds of fruit with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)

Hypothesis 22. There is no difference in the subjects' ability to match and designate colors with regard to culture, color rendering index, and color temperature for T-shirts dyed

a) red
b) yellow
c) blue
d) purple blue

<u>Hypotheses in Section Three</u>

Hypothesis 23. There is no difference in the subjects' perception of the lighting as being visually warm or visually cool with regard to

a) culture (American and Korean)
b) location (inside and outside)
c) color rendering index of fluorescent light (75 CRI and 95 CRI)
d) color temperature of fluorescent light (3000 K and 5000 K)
e) two-way interaction of culture by location

f) two-way interaction of culture by CRI
g) two-way interaction of culture by CT
h) two-way interaction of location by CRI
i) two-way interaction of location by CT
j) two-way interaction of CRI by CT
k) three-way interaction of culture by location by CRI
l) three-way interaction of culture by location by CT
m) three-way interaction of culture by CRI by CT
n) three-way interaction of location by CRI by CT
o) four-way interaction of culture by location by CRI by CT

Hypothesis 24. There is no difference in the subjects' perception of the lighting as a factor in visual clarity with regard to

a) culture (American and Korean)
b) location (inside and outside)
c) color rendering index of fluorescent light (75 CRI and 95 CRI)
d) color temperature of fluorescent light (3000 K and 5000 K)
e) two-way interaction of culture by location
f) two-way interaction of culture by CRI
g) two-way interaction of culture by CT
h) two-way interaction of location by CRI
i) two-way interaction of location by CT
j) two-way interaction of CRI by CT
k) three-way interaction of culture by location by CRI
l) three-way interaction of culture by location by CT
m) three-way interaction of culture by CRI by CT
n) three-way interaction of location by CRI by CT
o) four-way interaction of culture by location by CRI by CT

Hypothesis 25. There is no difference in the subjects' overall lighting preference with regard to

a) culture (American and Korean)
b) location (inside and outside)
c) color rendering index of fluorescent light (75 CRI and 95 CRI)
d) color temperature of fluorescent light (3000 K and 5000 K)
e) two-way interaction of culture by location
f) two-way interaction of culture by CRI
g) two-way interaction of culture by CT
h) two-way interaction of location by CRI
i) two-way interaction of location by CT
j) two-way interaction of CRI by CT
k) three-way interaction of culture by location by CRI
l) three-way interaction of culture by location by CT
m) three-way interaction of culture by CRI by CT
n) three-way interaction of location by CRI by CT
o) four-way interaction of culture by location by CRI by CT

Hypothesis 26. There is no difference in the subjects' impression of the light color with regard to

a) culture (American and Korean)
b) location (inside and outside)
c) color rendering index of fluorescent light (75 CRI and 95 CRI)
d) color temperature of fluorescent light (3000 K and 5000 K)

Hypothesis 27. There is no difference in the subjects' preference for the light color with regard to

a) culture (American and Korean)
b) location (inside and outside)
c) color rendering index of fluorescent light (75 CRI and 95 CRI)
d) color temperature of fluorescent light (3000 K and 5000 K)
e) two-way interaction of culture by location
f) two-way interaction of culture by CRI
g) two-way interaction of culture by CT
h) two-way interaction of location by CRI
i) two-way interaction of location by CT
j) two-way interaction of CRI by CT
k) three-way interaction of culture by location by CRI
l) three-way interaction of culture by location by CT
m) three-way interaction of culture by CRI by CT
n) three-way interaction of location by CRI by CT
o) four-way interaction of culture by location by CRI by CT

Hypothesis 28. There is no difference in the subjects' perception of fruit color as being natural or unnatural with regard to

a) culture (American and Korean)
b) location (inside and outside)
c) color rendering index of fluorescent light (75 CRI and 95 CRI)
d) color temperature of fluorescent light (3000 K and 5000 K)
e) two-way interaction of culture by location
f) two-way interaction of culture by CRI
g) two-way interaction of culture by CT
h) two-way interaction of location by CRI
i) two-way interaction of location by CT
j) two-way interaction of CRI by CT
k) three-way interaction of culture by location by CRI
l) three-way interaction of culture by location by CT
m) three-way interaction of culture by CRI by CT
n) three-way interaction of location by CRI by CT
o) four-way interaction of culture by location by CRI by CT

Hypothesis 29. There is no difference in the subjects' color perception for five different kinds of fruit with regard to

a) culture (American and Korean)
b) location (inside and outside)
c) color rendering index of fluorescent light (75 CRI and 95 CRI)
d) color temperature of fluorescent light (3000 K and 5000 K)

Hypotheses Section Four

Set one: The simultaneous comparison of 730 and 930 lighting conditions: two color rendering indices of 75 CRI and 95 CRI are compared when the color temperature of 3000 K is being held constant.

Hypothesis 30. When two lighting conditions (730 and 930) are evaluated simultaneously, there is no difference in the subjects' perception of lighting as being visually warm or visually cool with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Hypothesis 31. When two lighting conditions (730 and 930) are evaluated simultaneously, there is no difference in the subjects' perception of lighting as a factor in visual clarity with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Hypothesis 32. When two lighting conditions (730 and 930) are evaluated simultaneously, there is no difference in the subjects' perception of lighting for room attractiveness with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Hypothesis 33. When two lighting conditions (730 and 930) are evaluated simultaneously, there is no difference in the subjects' perception of lighting for approach-avoidance intention with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Hypothesis 34. When two lighting conditions (730 and 930) are evaluated simultaneously, there is no difference in the subjects' overall lighting preference with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Hypothesis 35. When two lighting conditions (730 and 930) are evaluated simultaneously, there is no difference in the subjects' impression of the light color with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)

Hypothesis 36. When two lighting conditions (730 and 930) are evaluated simultaneously, there is no difference in the subjects' preference of the light color with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Hypothesis 37. When two lighting conditions (730 and 930) are evaluated simultaneously, there is no difference in the subjects' perception of fruit color as being natural or unnatural with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Hypothesis 38. When two lighting conditions (730 and 930) are evaluated simultaneously, there is no difference in the subjects' perception for five different kinds of fruit with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)

Hypothesis 39. When two lighting conditions (730 and 930) are evaluated simultaneously, there is no difference in the subjects' ability to match and designate colors with regard to culture and color rendering index for T-shirts dyed

a) red
b) yellow
c) blue
d) purple blue

Set two: The simultaneous comparison of 750 and 950 lighting conditions: two color rendering indices of 75 CRI and 95 CRI are compared when the color temperature of 5000 K is being held constant.

Hypothesis 40. When two lighting conditions (750 and 950) are evaluated simultaneously, there is no difference in the subjects' perception of lighting as being visually warm or visually cool with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Hypothesis 41. When two lighting conditions (750 and 950) are evaluated simultaneously, there is no difference in the subjects' perception of lighting as a factor in visual clarity with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Hypothesis 42. When two lighting conditions (750 and 950) are evaluated simultaneously, there is no difference in the subjects' perception of lighting for room attractiveness with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Hypothesis 43. When two lighting conditions (750 and 950) are evaluated simultaneously, there is no difference in the subjects' perception of lighting for approach-avoidance intention with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Hypothesis 44. When two lighting conditions (750 and 950) are evaluated simultaneously, there is no difference in the subjects' overall lighting preference with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Hypothesis 45. When two lighting conditions (750 and 950) are evaluated simultaneously, there is no difference in the subjects' impression of the light color with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)

Hypothesis 46. When two lighting conditions (750 and 950) are evaluated simultaneously, there is no difference in the subjects' preference of the light color with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Hypothesis 47. When two lighting conditions (750 and 950) are evaluated simultaneously, there is no difference in the subjects' perception of fruit color as being natural or unnatural with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Hypothesis 48. When two lighting conditions (750 and 950) are evaluated simultaneously, there is no difference in the subjects' perception for five different kinds of fruit with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)

Hypothesis 49. When two lighting conditions (750 and 950) are evaluated simultaneously, there is no difference in the subjects' ability to match and designate colors with regard to culture and color rendering index for T-shirts dyed .

a) red
b) yellow
c) blue
d) purple blue

<u>Set three</u>: The simultaneous comparison of 730 and 750 lighting conditions: two color temperatures of 3000 K and 5000 K are compared when the color rendering index of 75 CRI is being held constant.

Hypothesis 50. When two lighting conditions (730 and 750) are evaluated simultaneously, there is no difference in the subjects' perception of lighting as being visually warm or visually cool with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Hypothesis 51. When two lighting conditions (730 and 750) are evaluated simultaneously, there is no difference in the subjects' perception of lighting as a factor in visual clarity with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Hypothesis 52. When two lighting conditions (730 and 750) are evaluated simultaneously, there is no difference in the subjects' perception of lighting for room attractiveness with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Hypothesis 53. When two lighting conditions (730 and 750) are evaluated simultaneously, there is no difference in the subjects' perception of lighting for approach-avoidance intention with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Hypothesis 54. When two lighting conditions (730 and 750) are evaluated simultaneously, there is no difference in the subjects' overall lighting preference with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Hypothesis 55. When two lighting conditions (730 and 750) are evaluated simultaneously, there is no difference in the subjects' impression of the light color with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)

Hypothesis 56. When two lighting conditions (730 and 750) are evaluated simultaneously, there is no difference in the subjects' preference of the light color with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Hypothesis 57. When two lighting conditions (730 and 750) are evaluated simultaneously, there is no difference in the subjects' perception of fruit color as being natural or unnatural with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Hypothesis 58. When two lighting conditions (730 and 750) are evaluated simultaneously, there is no difference in the subjects' perception for five different kinds of fruit with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)

Hypothesis 59. When two lighting conditions (730 and 750) are evaluated simultaneously, there is no difference in the subjects' ability to match and designate colors with regard to culture and color temperature for T-shirts dyed

a) red
b) yellow
c) blue
d) purple blue

Set four: The simultaneous comparison of 930 and 950 lighting conditions: two color temperatures of 3000 K and 5000 K are compared when the color rendering index of 95 CRI is being held constant.

Hypothesis 60. When two lighting conditions (930 and 950) are evaluated simultaneously, there is no difference in the subjects' perception of lighting as being visually warm or visually cool with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Hypothesis 61. When two lighting conditions (930 and 950) are evaluated simultaneously, there is no difference in the subjects' perception of lighting as a factor in visual clarity with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Hypothesis 62. When two lighting conditions (930 and 950) are evaluated simultaneously, there is no difference in the subjects' perception of lighting for room attractiveness with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Hypothesis 63. When two lighting conditions (930 and 950) are evaluated simultaneously, there is no difference in the subjects' perception of lighting for approach-avoidance intention with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Hypothesis 64. When two lighting conditions (930 and 950) are evaluated simultaneously, there is no difference in the subjects' overall lighting preference with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Hypothesis 65. When two lighting conditions (930 and 950) are evaluated simultaneously, there is no difference in the subjects' impression of the light color with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)

Hypothesis 66. When two lighting conditions (930 and 950) are evaluated simultaneously, there is no difference in the subjects' preference of the light color with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Hypothesis 67. When two lighting conditions (930 and 950) are evaluated simultaneously, there is no difference in the subjects' perception of fruit color as being natural or unnatural with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Hypothesis 68. When two lighting conditions (930 and 950) are evaluated simultaneously, there is no difference in the subjects' perception for five different kinds of fruit with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)

Hypothesis 69. When two lighting conditions (930 and 950) are evaluated simultaneously, there is no difference in the subjects' ability to match and designate colors with regard to culture and color temperature for T-shirts dyed.

a) red
b) yellow
c) blue
d) purple blue

Assumptions

The following assumptions are included in this study:

1. Respondents understood and answered the self-administered questionnaire truthfully and accurately.
2. The instruments used for collecting data, a self-administered questionnaire, accurately measured the perceptions of the respondents regarding lighting, color of item, skin and complexion, and light in store setting.
3. The experimental setting for the general merchandising area and fitting room was assumed to be relevant to a typical retail situation.

Limitations

The limitations in this study are as follows:

1. Samples of Korean and American as two different cultures were limited to those students enrolled at Oklahoma State University during the study period and those people living in Stillwater, Oklahoma..
2. For the sample of Koreans, acculturation may be a variable that could impact the lighting perception and preference, but acculturation is not a focus of this study.

3. For color matching and designating of the colored T-shirt, the selection of the color chip was limited to fourteen color chips for each of four color cards. The study was limited because the respondents' possible choice of color chips was based on 14 color chips.
4. The study was limited to a synthetic retail environment. The study conducted in a laboratory experiment was limited due to the respondents' opportunity to express their perception of lighting within a synthetic retail setting.

Definition of Terms

The following terms are used in this study and are defined as follows:

Ambient lighting - Lighting throughout an area that produces general illumination (Rea, 1999).

American - People from the United States of America

Approach behavior - A willingness or desire to move towards and explore the environment (Baker, et. al., 1992).

Arousal - The extent to which a person feels excited or stimulated (Baker et al, 1992).

Candela (cd) - The international basic physical quantity in all measurements of light (North American Philips Lighting Corporation, 1984).

Color rendering - A general expression for the effect of a light source on the color appearance of objects in conscious or subconscious comparison with their color appearance under a reference light source (Rea, 1999).

Color rendering index (CRI) - A measure of the degree of color shift objects undergo when illuminated by the light source as compared with those same objects when illuminated by a reference source of comparable color temperature (Rea, 1999).

Color temperature (CT) of a light source - The absolute temperature of a blackbody radiator having a chromaticity equal to that of the light source (Rea, 1999).

Correlated color temperature (of a light source) - The absolute temperature of a blackbody whose chromaticity most nearly resembles that of the light source (Rea, 1999).

Culture - The complex of values, ideas, attitudes, and other meaningful symbols created by people to shape human behavior and the artifact of that behavior transmitted from one generation to another. (Engel, Blackwell & Miniard, 1986)

Fluorescent lamp - A low-pressure mercury electric-discharge lamp in which a fluorescing coating (phosphor) transforms some of the UV energy generated by the discharge into light (Rea, 1999).

Footcandle (fc) - The illumination at a point on a surface which is one foot from and perpendicular to a uniform point source of one candela (North American Philips Lighting Corporation, 1984).

General lighting - Lighting designed to provide a substantially uniform level of illumination throughout an area, exclusive of any provision for special local requirements (Rea, 1999).

Glare - The sensation produced by luminance within the visual field that is sufficiently greater than the luminance to which the eyes are adapted to cause annoyance, discomfort or loss in visual performance and visibility (Rea, 1999).

Illuminance - The areal density of the luminous flux incident at a point on a surface (Rea, 1999).

Illumination - Quantity of light per unit of surface area; the intensity or density of light falling on a surface (English unit: footcandle) (Lam, 1977).

Korean - People from Korea

Lamp - A generic term for an artificial source of light (Rea, 1999).

Light - Radiant energy that is capable of exciting the retina and producing visual sensation. The visible portion of the electromagnetic spectrum extends from about 380 to 775 nm (Rea, 1999).

Luminance - The physical measure of brightness; luminous intensity per unit projected area of any surface, as measured from a specific direction (Lam, 1977).

Luminaire (light fixture) - A complete lighting unit consisting of a lamp or lamps and ballasting (when applicable) together with the parts designed to distribute the light, to position and protect the lamps and to connect the lamps to the power supply (Rea, 1999).

Lux - The International System unit of illumination. One lux = .0929 footcandle (North American Philips Lighting Corporation, 1984).

Nanometer (nm) - A unit of wavelength equal to 10^{-9} meter (Rea, 1999).

Perception - A meaningful impression obtained through the senses and interpreted in the mind (Lam, 1977).

Pleasure - The extent to which a person feels good in the environment (Baker et. al., 1992).

Quality of lighting - Favorable distribution of luminance in a visual environment, with regard to visual performance, visual comfort, ease of seeing, safety and esthetics or the specific visual tasks involved (Rea, 1999).

Quantity of light (luminous energy) - The product of the luminous flux by the time it is maintained. It is the time integral of luminous flux (Rea, 1999).

CHAPTER II

REVIEW OF LITERATURE

Interior design promotes and sustains quality of life through creating environments that support users' physiological, psychological, and cultural needs. One aspect of interior design which assists in creating such an environment is light. Lighting is one of the major contributing factors in retail store atmospherics. (Cuttle & Brandston, 1995; Gardner & Siomkos, 1986; Kotler, 1973-1974; Lopez, 1995; Rea, 1999). Even though the importance and benefits of lighting are generally acclaimed for retail environments, few empirical retail lighting studies have been conducted. Furthermore, no study focusing specifically on retail store lighting for consumers from different cultural backgrounds has been found. For this reason, the focus of this study concentrated on examining lighting perceptions and preferences for consumers from different cultural backgrounds.

In this chapter, the literature review includes sections that address color and light, lighting studies of the store environment, and cultural differences between Americans and Koreans. An integrated theoretical framework for lighting perceptions and preferences of consumers from different cultures based on store atmospheric theories has been developed to guide the study.

Light and Color

Light is radiant energy that travels in waves composed of vibrating electric and magnetic fields. Out of the full electromagnetic spectrum from very short cosmic rays to very long rays of electric power, the human eye responds to the energy within the limits of the visible spectrum, an exceedingly small portion of the electromagnetic spectrum between the ultraviolet and infrared. These wavelengths measured in nanometers are called visible energy or light. Visible light, however, is not really visible. It must strike an object first, then be reflected into the human eye.

The visible wavelengths extend from approximately 380 nm to 780 nm on the electromagnetic spectrum (Egan, 1983). Each visible spectrum varies in length, and the different wavelengths comprising the light spectrum determine a color. All colors depend on light. "Color is the presence or absence of light as it is reflected or not reflected from a surface" (Mills, Paul, & Moormann, 1995, p.76). Within the light spectrum, there are all the colors of the rainbow. Light energy at the shortest visible wavelength, from approximately 380 to 450 nm, produces the sensation of violet; the longest wavelengths, between about 630 and 780 nm, appear as red. All other colors (indigo, blue, green, yellow, and orange) are of intermediate wavelengths (Egan, 1983).

Light that contains balanced radiant energy of all visible wavelengths appears as white to the eye. White light is invisible to the eye until it strikes an object. When light waves fall on an object and are reflected, the image is focused onto the retina, absorbed by photoreceptors in the cones and converted into neural signals to the brain as the perceived color of the object (Baucom, 1996).

White light, which is formed of the visible wavelengths in equal quantities, produces the true color of an object, as opposed to a light that has unbalanced chromaticity. The different wavelengths within a given light source can vary greatly. The most common variations are described as warm or cool. Fluorescent light is said to be a cool white source due to its being dominated by the short end of the spectrum, with "cool" color tones of green through blue. In contrast, incandescent light is said to be warm white light because it emphasizes the long end of the spectrum, with "warm" color tones orange through red (Gordon & Nuckolls, 1995). Differences in the color of a light source can have a pronounced effect on the color appearance of objects and surfaces. "No matter how good the finish of an object may be, its true color will never be visible if the light source does not contain a matching wavelength" (Sorcar, 1987, p.7).

According to the Lighting Handbook (Rea,1999), the color characteristics of light sources can be described by two standard measurements: color temperature and color rendering index. Color temperature is a numerical measurement that describes the color appearance of the light produced by the lamp and the color appearance of the lamp itself by comparing it with the color of a blackbody radiator. The color temperature of the light source is measured by degrees in Kelvin (K). When a blackbody is heated, with increased temperature, the color of its glow changes in a predictable manner from red at a temperature of 800 K, to yellow-white at 2,800 K, to white at about 5,000 K, to bluish white at 8,000 K, and to a brilliant blue at 60,000 K. Because the light source color may not exactly match that of a blackbody, the term correlated color temperature (CCT) is used and expressed in Kelvins (K). Incandescent sources have color temperatures between 2,600 K and 3,100 K, whereas selected fluorescent lamps are available with correlated color temperatures from 2,700 K to 7,500 K. Color temperature refers to the absolute temperature of the laboratory blackbody when its visible radiation closely matches the color of the light source. That is, it is an approximate way of identifying the source as appearing warm or cool (North American Philips Lighting Corporation, 1984).

Color Rendering Index (CRI) is the rating system of other color characteristic of light sources. To measure a lamp's color rendering ability, the CRI compares the color rendition of a given light source with a standard light source allowing easy consideration of the perceived color of objects and surfaces. The comparison is expressed as a number from 0 to 100. As the number increases, the color of the given light source is closer to the standard light source. A CRI of 100 indicates that the tested source exactly matches the standard source. Any CRI rating of 80 or above is considered high and indicates that the source has good color properties. Comparisons are valid within the similar color temperature of two light sources (Gordon & Nuckolls, 1995).

In application, lamps with a CRI rating of 80 or higher are considered to have "good" color rendering properties, causing objects to look "natural." Because of improvements in lamp phosphor technology, CRI ratings for fluorescent lamps have steadily increased. The color rendering indices of fluorescent lamps have a range from 48 up to 95 CRI. In design, high-CRI lamps are ideal for color critical applications where color rendering and matching is important, such as clothing stores, groceries, graphic design studios and similar applications.

Kruithof (1941) measured the range of color temperature under which objects appear natural and pleasant at different levels of luminance. Applying the "Kruithof effect", experiments examining the psychological effects of varying correlated color temperature and illuminance have suggested that using lamps with high correlated color temperature value at low illuminances will make a space appear cold and dim. Conversely, using lamps with low correlated color temperature values at high illuminances will make a space appear artificial and overly colorful. Baron, Rea, and Daniels (1992) confirm the Kruithof findings by examining the impact of illuminance and spectral distribution on the performance of tasks. However, other investigators have failed to find a similar tradeoff of correlated color temperature and illuminance (Boyce & Cuttle, 1990; Davis & Ginthner, 1990). In Taylor's and Sucov's (1974) phototropic behavior study, it was found that the light clearly attracted people and changed the path by increasing illumination level. They suggested that increasing illumination level could lead people to the desired traffic displays such as in museums and retail stores.

Blackwell and Blackwell (1971) found visual performance largely differs both among individual observers of the same age and between the averages of different age groups. Hughes and Neer (1981) indicated special attention needs to be given to lighting applications for the elderly such as excessive brightness, differences, discomfort glare, veiling reflections, and the importance of color and the spectral power distribution of the light source. Their finding also indicated a full spectrum fluorescent light source is recommended rather than the cool white fluorescent lamp because it simulates natural sunlight for indoor illumination.

Lighting Studies of Store Environments

Many studies draw attention to the need to gain further understanding of the influence of retail store environments on customer behavior. In previous studies, researchers found that store image attributes including music, scent, layout, fixtures, size, shape, color, and light, are environmental stimuli that interact with consumers' responses in store environments (Baker, et al., 1992; Bellizzi, Crowley & Hasty, 1983; Kotler, 1973-1974; Lindquist, 1974-1975). Atmospherics as the intentional control and structuring of environmental cues was first introduced in the Kotler study (1973-1974).

According to Kotler (1973-1974), the atmosphere of the store is one of the most influential factors in the purchasing decision. He suggests that atmosphere as a marketing tool can be produced by manipulating the visual, aural, olfactory, and tactile dimensions of the surrounding space. He specifies that the main visual dimensions of an atmosphere-- color, brightness, size, shapes-- can help draw attention, convey messages, and create feelings that may increase purchase probability. Donovan and Rossiter (1982) state that the emotional states of pleasure and arousal created by store atmosphere can affect approach or avoidance shopping behaviors within the store environment. Furthermore, Markin, Lillis, and Narayana (1976) report that store image manipulated by lighting and noise levels influences consumer's behavior.

Mehrabian (1976) has interpreted the influence of lighting in terms of its ability to arouse individuals. An individual who is highly aroused "will become stimulated, jittery, alert," whereas a person in a non-arousing environment "will feel relaxed, calm, sluggish, or sleepy" (p. 18). Moreover, a highly aroused individual will exhibit increased heart rate, muscle tension, a lowered skin temperature. Meharbian suggests that lighting is an extremely important determinant of the environment because "brightly lit rooms are more arousing than dimly lit ones" (p.89). In support of this conceptualization of the effects of illumination, Gifford (1988) found that college students expended more effort on an experimental task when illumination levels were higher.

Grant (1991) states that "the goal of the store lighting is to create enough light to sell goods and stimulate interest while still keeping electric bill within reason" (p. 52). He adds that the key to controlling consumer behavior by store lighting choices is the effective use of the correct lamps by providing correct combination of primary (general) and secondary (accent) lighting. For general retail lighting, fluorescent lighting systems are the most popular because of the cost of energy and length of lamp life (Ward, 1991).

Birren (1988) observes that the eye always concentrates on brightness rather than dimness. Even though the general illumination provides brightness, spot or flood lights are necessary to be able to see clearly and to provide character, depth, plasticity, and texture within a store. In general, researchers conclude that good store lighting design requires well-combined quantity and quality of lighting to provide visual focus, safety and security; to attract customers' attention; to direct customer traffic in a specific pattern; to create a mood; and to leave a lasting impression (Roush, 1994; Sorcar, 1987).

Milliman (1986) indicated that consumers stayed longer in a store with soft lighting and additional time provided an opportunity to buy more. Meer (1985) believed that soft lighting tends to create a more relaxing, comfortable atmosphere than bright light. Gorn (1982) stated that soft lighting in a store may indicate a high quality of merchandise. Therefore, soft lighting tends to result in an increased willingness to purchase by relaxing and slowing consumers' shopping movement. Butler and Biner (1987) stated that individuals' preference for lighting levels differs for various behaviors and settings. Biner, Bulter, Fischer, and Westergren (1989) found preferred lighting levels vary with visual activities, and non-visual activities and the social situation.

There are not many empirical studies of store lighting. Many researchers studied the relationship between lighting and general human behavior, and used laboratory to conduct their study rather than real setting of lighted environment (Biner et al., 1989; Butler & Biner, 1987; Forester & Eastlick, 1992). Some studies mentioned lighting as a store image attribute without experimental examination (Bellizzi et al., 1983; Kotler, 1973-1974; O'Neill & Jasper, 1992; Zimmer & Golden, 1988). Smith (1988) suggested that different lighting levels should be considered depends on the types of store. For instance, clothing stores need soft general lighting while food and drug stores need bright general light.

Baker, Levy and Grewal (1992) studied an experimental approach to making retail store environmental decisions using two factors: 1) Ambient cues (lighting and music), and 2) social cues (number/friendliness of employees). They considered the effects of these factors on respondents' pleasure, arousal, and willingness to buy in retail card and gift stores. They found arousal and pleasure to have a positive relationship with respondents' willingness to buy.

Based on arousal theory and visual acuity theory frameworks, Areni and Kim (1994) examined the effect of lighting on consumer behavior in a wine store. Their field study in a wine store was tested to investigate the impact of in-store lighting on consumer behavior by manipulating two lighting settings, soft and bright. The soft lighting setting by using a 75 watt lamp was the dining area of the wine cellar, while the bright lighting setting lighted with twenty-two

50 watt lamps was the merchandise area. However, this study was not reported the empirical measurements of the illumination levels for both lighting settings. The results indicate that the customer preferred testing wine in a bright environment rather than in a softly lit environment. In addition, in the cellar area of the store, couples spent more than other groups of patrons. There were no significant differences in the effects of lighting on couples' spending in the cellar, the number of items sold and the total sales in a wine store. The researchers also found that experienced customers preferred a highly illuminated cellar that enhanced visual acuity and facilitated the examination of merchandise. In contrast, non-experienced consumers preferred softer illumination to enhance their shopping experience. Their findings did not support Markin, Lillis, and Narayan (1976) results that soft store lighting did not have a significant relationship with the amount of time spent in a store.

In the retail lighting field study, Cuttle and Brandston (1995) experimented to compare the new lighting with the existing lighting at the two furniture galleries. Empirical measurements were made relating to six aspects of lighting performance: illumination, power density, lighting costs, sales, customer perceptions, and sales staff perceptions. The old lighting provided low illuminances with low efficiency in both galleries. The new lighting raised the light level and increased system efficacy by more than 200 percent, but power densities were affected only slightly. Both customers and sales staff responded positively to the new lighting in both galleries compared to the old lighting. The sales staff believed that the new lighting helped them to perform their jobs better.

Cuttle and Brandston (1995) also suggested that good (high quality) lighting is realized when the mood created is consistent with the function of each space, when the lighting provides spatial clarity, and when it promotes productivity. Lighting quality has been described as a multidimensional concept which has biological, psychological, and aesthetic needs in contrast to quantity. Researchers agree that different light patterns and colors help to elicit various feelings or subjective responses, and appear to influence task performance, human comfort, and one's sense of well being (Benya, 1995; Flynn & Spencer, 1977; Heerwagen & Heerwagen, 1986; Steffy, 1990).

Additional illumination field study utilizing a grocery store setting, Boyce, Lloyd, Eklund, and Brandston (1996) described on the impact of the new lighting on consumer attitudes, sales, and electrical power consumption. Consumer attitudes were measured before and after the lighting renovations were made. Customers responded more pleasing and comfortable to the new lighting than old conditions. However, the researchers noted that several intervening variables could impact the consumers' lighting perceptions because not only the lighting was changed, also interior modifications were made in the grocery store. After the lighting modifications, the researchers reported that there was a significant increase in sales for the grocery store.

Hebert (1997) applied the M-R model to the study of the effect of lighting in a retail display area on the approach-avoidance behavior of consumers. The study was examined the influence of lighting on three aspects of approach-avoidance consumer behavior: 1) A desire to approach the test display or to avoid the test display, 2) a desire or willingness to explore the test display or to avoid the test display, 3) the degree of approach or avoidance of the task of picking up the merchandise at the test display. For the study, two retail stores including a hardware store and a western apparel/feed store in non-urban areas, were selected as settings to test the effects of supplemental lighting treatments on consumer behavior. The Illuminance used in the study was 47 footcandles and 72.35 footcandles in the hardware store and western apparel/feed store respectively. In the hardware store, the color temperature was 4150 K and color rendering index was 62 CRI. The color temperature was 3000 K and the color rendering index was 70 CRI in the western apparel/feed store. Video tapes were recorded and collected for consumer behavior under the display lighting conditions. The results of this study indicated that light levels contribute to consumer approach behavior by supporting approach-avoidance theory.

The Illuminating Engineering Society of North America (IES) Handbook states that the three primary goals of lighting in the retail environment are: "1) Lighting should attract the customer, 2) Lighting should allow the customer to evaluate the merchandise, and 3) Lighting should facilitate the completion of the sale" (Rea, 1999, p.17-2). In order to achieve these goals of retail lighting, the IES Handbook recommends that the lighting design consideration should address "task visibility, appearance of the space and its luminaries, appearance of people and objects, visual comfort, and health and well-being" (p.17-2). Good lighting in a store can attract a potential customer to the appearance of the store's interior and draw the customer to approach the merchandise area. Since every customer seeks personal improvement, pleasant facial appearance and true color perception in the fitting room area demands lighting with good color rendering to enhance the customer's final evaluation of the merchandise, inviting the decision to buy (Rea, 1999).

IES recommends that the general lighting in a store serves three basic types of retailers, "low-end (mass merchandising), middle, and high-end (exclusive) " (Rea, 1999, p. 17-5). The suggested illumination levels of general lighting in mass-merchandising stores are high, from 75 to 150 footcandles. Stores for the middle category need average illumination levels of 30 to 60 footcandles. For high-end stores, general lighting levels are suggested to be low from 3 to 24 footcandles. IES suggests that light sources should have neutral to cool color temperature ranging from 3500 to 5000 K for low-end stores, neutral color temperature of 3500 K for middle level stores, and warm color temperatures of 2700 to 3000 K in exclusive establishments. Since color is a critical factor in the merchandising and the fitting areas of retail stores, IES recommends that light sources have a minimum color rendering index of 80 to 90 (Rea, 1999).

Taking the IES recommendations of illuminance levels (75 FC for general merchandising areas, and 100 FC for fitting rooms) and the color temperature and color rendering index of light sources in a retail environment, Hegde (1996) compared the existing lighting in the merchandising areas and fitting rooms of three stores with the IES recommendations. She found that the lighting in the three stores was inadequate for both the illuminance levels and the color rendering index as compared to the IES recommendations. The fitting rooms were more problematic than the general merchandising areas for illumination levels and the color rendering ability of light sources in all three stores. The color temperature of the light in the three stores was adequate for both the merchandising and the fitting room areas. The study indicated that the retailers did not understand the importance of lighting in the fitting rooms where the final decision to buy is made.

Cultural Differences between America and Korea

De Mooij (1998) states culture is a complex word and can be defined different way depends on the subject area. She defines that "culture is learned, not inherited. It derives from one's social environment, not from one's genes." It is added that "culture is the glue that binds groups together. Without cultural patterns, organized systems of significant symbols, people would have difficulties in living together (p. 43)." The cultural influences including values, norms, attitudes, and traditions etc. are important to determine the identity of culture

To understand and classify cultural differences and similarities in global marketing, several researchers have studied dimensions of culture (Gannon, 1994; Hall, 1984; Hofstede, 1991). Hofstede (1991) identifies five dimensions of national culture. They are power distance, individualism versus collectivism, masculinity versus femininity, uncertainty avoidance and long-term orientation. His model of five dimensions of culture was originally used to describe differences in work-related values. However, it has been applied by cultural oriented researchers to compare cultural differences that are not only work-related values, also consumption-related values and motives. Hofstede' model explains differences in actual consumption behavior and product use and thus can assist in predicting consumer behavior or effectiveness of marketing strategies for cultures other than one's own.

Among five dimensions of culture, two dimensions, individualism/collectivism and masculinity/femininity, have been used to distinguish cultural difference in behavior research studies, especially cross-culture research between Western and Asian culture. Individualism versus collectivism are defined as "people looking after themselves and their immediate family only, versus people belonging to in-groups that look after them in exchange for loyalty" (De Mooij, 1998, p. 75). While people in individualistic culture express private opinions as "I"-conscious, people in collectivistic cultures are "we"-conscious. Individualistic cultures are low-context cultures whereas collectivistic cultures are high-context cultures (Hofstede, 1991). In his study, it shows that most Western countries are individualistic and Asian and Latin American countries are collectivistic.

De Mooij (1998) defines the masculinity dimension as follows: "the dominant values in a masculine society are achievement and success, the dominant values in a feminine society are caring for others and quality of life" (p.80). Miracle, Chang, and Taylor's study (1992) about the advertising styles of Korea shows that Koreans are the characteristics of collectivistic and feminine culture. De Mooij (1998) outlines characteristics of advertising styles of the United States, Korea and several other countries in his book of global marketing and advertising. The American advertising style reflects the assertiveness of its culture. It is characterized by the direct approach and competitiveness, which can be explained by the configuration masculinity-individualism. However, the Korean advertising style is a reflection of a collectivistic and feminine culture with focus on the indirect approach and symbolism. Therefore, the United States is an individualistic culture while Korea is specified as a collectivistic culture.

De Mooij (1998) defines that "perception is the process by which each individual selects, organizes, and evaluates stimuli from the external environment to provide meaningful experiences for him-or herself." What people see is a function of what they have been trained or have learned to see in the course of growing up. Perceptual patterns are learned and culturally determined. Because they are culturally determined, they also are consistent. People's interests, values, and culture act as filters and lead us to distort, block, and even create what we choose to see and hear. People perceive what they expect to perceive. People perceive things according to their cultural map (Adler, 1991). Researchers encounter the perception, preference and behavior can be vary depends on all these manifestations of different culture (Adler, 1991; De Mooij, 1998).

The culture influences peoples' perception. The way people perceive other cultures is from their own cultural mind-set, and it is very difficult not to take the ethnocentric point of view when classifying other cultures. Classification of cultures is necessary to develop marketing strategies in the global marketplace. Classifying cultures based on dimensions has proved to be the most constructive method. A plethora of research has been conducted about cultural differences and similarities.

Cutler, Javalgi, and Erramilli (1992) conducted a multi-country content analysis, comparing the visual components of print advertising from five countries: the United States, the United Kingdom, France, Korea, and India. They concluded that there are more differences than similarities. The United States is the greatest user of comparative advertising and a low user of all types of symbolic approaches. Both Korea and the U.S. are heavy users of people in ads. The prices are relatively often included in Korean ads, while the United States includes the frequent use of comparative advertising.

The United States is a heterogeneous society in terms of its population. The majority population in the United State is no longer European due to the immigration from various areas worldwide. It is widely known that the country is moving away from the "melting-pot" concept and toward a "multi-cultural society" in which no single ethnicity dominates the culture (Doka, 1996). Conversely, Korea is a highly homogeneous society in terms of race in the population, which consists of more that 90% Korean. The common tradition cultivated a society that shares the same values, norms, language, and aesthetics with minimal variation. In summary, cultural profiles between the United States and Korea can sort out based on points of contrast including heterogeneity versus homogeneity, individualism versus collectivism, and masculinity versus femininity.

It has been reported that ethnic consumers differ in their consumer behavior in store environments. Fisher's study (1994) showed that many African Americans buy high fashions and name brands as signals of their success. Asian-Americans are loyal to brands or stores they like, value high-quality goods and services (Braun, 1991; Klein, 1990; Miller, 1993), and value name brands and well-known companies (Henricks, 1992; Romano, 1995). Although ethnic consumers have been studied in terms of their consumer behavior, no research study has been conducted in their lighting perception of retail stores.

Yang and Brown (1992) conducted a landscape preference study to investigate the characteristics of preference patterns as related to landscape styles and landscape elements by comparing two cultural groups, Korean residents and western tourists in Seoul. The results showed there were both similarities and differences for landscape preference. Both Korean and the Western tourists most preferred the Japanese landscape style and water, while they least preferred the Rock as a landscape element. Koreans preferred the Western landscape style more than the Korean landscape style, while the Western tourists preferred the Korean landscape style more than the Western landscape style.

As the literature illustrated, there are differences for environmental preference and consumer behavior between cultural and ethnic groups. Even though no retail research has been conducted on lighting perception and preference based upon cultures, it is assumed there might be some differences of lighting perception and preference between Americans and Koreans in store environments.

Discussion of Theoretical Framework for the Study

Mehrabian and Russell (1974), the environmental psychologists developed a theoretical framework for analyzing the interaction between the physical environment and human behavior. "The M-R model is based on a Stimulus-Organism-Response (S-O-R) paradigm, relating features of the environment (S) to approach-avoidance behavior (R) within the environment, mediated by the individual's emotional states (O) aroused by the environment. The M-R model proposes a general measure of S, the environment, in terms of information rate, a measure of novelty and complexity, but focuses mainly on the O-R aspects of the model" (Donovan, et al., 1994, p.284). In the Mehrabian and Russell's (M-R) environmental psychology model (1974), an emotional state consists of three basic dimensions of pleasure, arousal, and dominance (PAD).

Donovan and Rossiter (1982) introduced the Mehrabian-Russell (M-R) model to the study of store atmosphere in relation to consumer behavior. In their study, consumer's shopping intention as approach or avoidance behavior in retail settings was measured in relation to consumers' emotional states as influenced by retail environments. The study was exploratory, using 30 student subjects and measuring attitudes and intentions. The environmental attribute pertained to store atmospherics. The emotional states included pleasure, arousal and dominance dimensions. The shopping intention measured approach and avoidance as consumer's anticipated behavior. Donovan and Rossiter (1982) determined that consumers want to stay in stores which are regarded as pleasant and arousing. They found that the dominance factor was insignificant, while two emotional states of pleasure and arousal significantly influenced consumer's shopping behavior. Therefore, the dominance dimension was eliminated due to its lack of empirical support in studies using the M-R model.

Donovan, Rossiter, Marcoolyn and Nesdale (1994) extended the Donovan and Rossiter (1982) study using a modified Mehrabian-Russell (M-R) environmental psychology model. In the modified model, they deleted the dominance dimension because of a lack of empirical evidence and theoretical reasons. The study followed the methodological analyses of the Donovan and Rossiter study but extended that study by measuring the Mehrabian-Russell emotions during the shopping experience and relating these mood states to pre-measures of estimated spending and time to be spent in the store compared to post-measures of actual spending and actual time spent in the store by restricting the sample to shoppers. The researchers found that the pleasantness of in-store atmospherics was a significant predictor of desire to approach or remain in the store and to spend money. Arousal was found to vary in its influence in this study.

Since Donovan and Rossiter introduced the Mehrabian-Russell (M-R) model, many studies of retail environments related to atmospheric stimuli, emotional state, and consumer behaviors have subsequently employed the M-R model as their theoretical frame work (Areni and Kim 1994; Baker et al., 1992; Bitner, 1990; Crowley, 1993; Dawson, Bloch, & Ridgway, 1990; Donovan, Rossiter, Marcoolyn, & Nesdale, 1994; Grossbart, et al., 1990; Hebert, 1997; Sherman, et al., 1997). Color as a store factor was studied by Bellizzi and Hite (1992). Areni and Kim (1994) cited Meharabian's (1976) interpretation of the influence of lighting on arousal.

In the studies of environmental stimuli, atmospheric factors have been examined including crowding (Eroglu & Machleit, 1990; Harrell, Hutt, & Anderson, 1980), music (Dube, Chebat, & Morin, 1995; Milliman, 1982, 1986; Yalch & Spangenberg, 1990, 2000), colors (Bellizzi, et al, 1983; Bellizzi & Hite, 1992; Crowley, 1993), and aroma (Gulas & Bloch, 1995; Mitchell, Kahn, and Knasko, 1995; Spangenberg, Crowley, & Henderson, 1996). The impact of lighting as one of atmospheric factors was investigated by Areni and Kim (1994), Baker, et al., (1994), Baker, et al., (1992), Hebert (1997), and Schlosser (1998). These investigations suggest that lighting factors can influence both the store image and the examination and handling of merchandise. However, Areni and Kim (1994) also found that lighting levels did not influence sales. Later Hebert (1997) applied the M-R model by emphasizing the need for researchers to investigate the impact of lighting on consumer behavior and found that different lighting conditions result in different approach-avoidance behaviors. Due to the dominance dimension is not significantly related to approach-avoidance measures in shopping environments, this variable has been deleted in studies and the M-R model has been modified (Donovan, et al., 1994; Hebert, 1997; Sherman, et al., 1997).

Each research study has implications for the influence of lighting on consumers, yet each model does not provide an overall framework, especially if cultural background is a consideration. Therefore, the following model is proposed for the study of the effect of store environment on humans (see Figure 1). The focus of this study was on testing only the lighting and the human perceptions and preferences. The model identifies physical features of the store environment that may act as stimuli the human organism's response to the environmental stimuli is influenced or filtered by each person's cultural background (Branson & Sweeney, 1991).

This study refines and extends Donovan and Rossiter's work by testing the M-R model thought the manipulation of specific store lighting factors in an experimental setting. In the classical stimulus-organismic-response model, the stimulus is that which affects humans' internal states. In this study model, the stimulus is the quality of the lighting factor as it affects the affective and/or cognitive states of the individuals. More specifically, the lighting as an atmospheric factor included the color rendering index and color temperature of the light sources.

Bagozzi (1986) states organism as "internal states intervening between stimuli external to the person and the final actions, reactions, or responses emitted. Notice that the intervening processes and structures consist of perceptual, physiological, feeling, and thinking activities" (p. 46). Therefore, in this study, the intervening processes affected by lighting stimuli are included not only in terms of their effects on emotions but also in terms of their effects on perception and evaluation.

To measure emotion, a number of items from the Mehrabian and Russell (1974) pleasure and arousal scales were combined with additional emotional descriptors. Additional descriptors in lighting perceptions and lighting preference of this study were adapted from Flynn's and Spencer's (1977) user impression test and Kasmar's (1970) environmental descriptors. Thus, the internal states to the stimuli would be arousal, pleasure, visual clarity, room attractiveness, lighting preference, appearance of complexion and skin color, impression and preference of the light color, and perception and designation of store products. These responses would lead to the organism responding with specific behaviors. In a M-R model, response is approach or avoidance behavior. Therefore, this proposed lighting study model in an experimental setting includes only intention of approach-avoidance because of the characteristics of the research design.

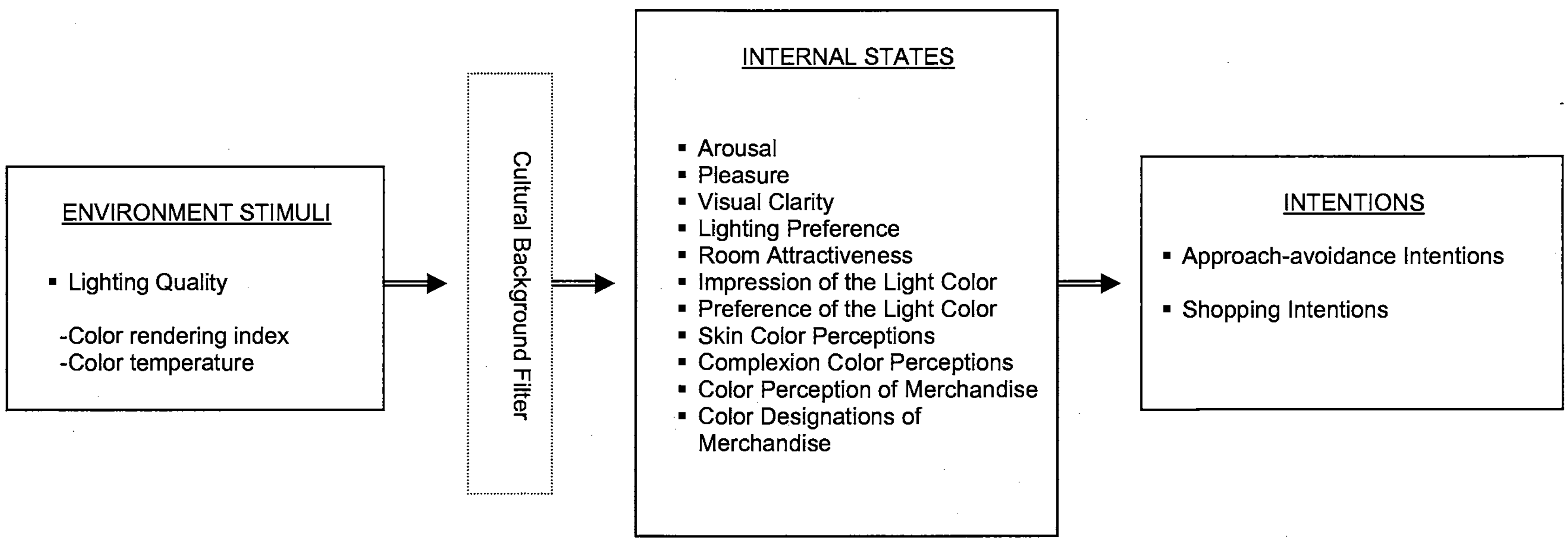


Figure 1. Proposed Study Model for In Store Environmental Stimuli and Human Response

CHAPTER III

METHODS

Introduction

According to the literature review, the question of cross cultural consumers' special needs for lighting in retail stores has not been explored in previous research studies. Therefore, the purpose of this study was to examine effects of light quality and differences in lighting perceptions and preferences, appearance of complexion and skin color, impression and preference of the light color, color perception and designation of merchandise, and approach-avoidance intentions in store lighting environments among individuals from different cultures. This chapter explains and describes the criteria used in this study, specifically addressing the selection of the sample, the research design (basic design and independent variables, experimental setting and lighting conditions), dependent measures, experimental procedure, and data analysis.

Sample

The subjects in this study, conducted on the Oklahma State University (OSU) campus, consisted of ninety-eight adults. The total group was divided into two subgroups: 1) forty-nine Caucasian American subjects and 2) forty-nine Korean subjects. The purposive sample of volunteers was solicited primarily via campus advertisements, flyers, and personal contact. The criteria used to select the purposive sample for the Korean subjects included: (1) born and raised in Korea; (2) have been in the U.S. for less than 3 years; (3) have not lived outside Korea for an extended period of time (more than 6 months) before coming to the U.S.; (4) are adults 19 to 35 years old; (5) have not studied any lighting courses or worked as a professional exercising lighting knowledge; and, (6) are not color blind. The criteria for the Americans were (1) born and raised in the U.S.; (2) are Caucasian; (3) have not lived outside the U.S. for an extended period of time (more than 6 months) before participating in this study; (4) are adults 19 to 35 years old; (5) have not taken any lighting courses or worked as a professional who exercising lighting knowledge; and, (6) are not color blind. The American subjects were limited by skin color for this study because one would anticipate that individuals with different skin colors could respond very differently to different lighting conditions. The use of individuals with other skin colors would be the focus of future research.

Snowball sampling was used to identify additional Caucasian American and Korean subjects (Touliatos & Compton, 1992). The Caucasian American subjects were recruited primarily from the OSU student body. The Korean subjects were recruited through the Korean Student Association (KSA) at Oklahoma State University. Members of KSA were asked to recruit their families and friends who are not KSA members to participate. Because some subjects, especially Korean subjects, were acquainted with one another, following each subject's participation in the study the subject was instructed to refrain from discussing the study with other who had not yet participated. After completing all three parts of the experiment, all subjects were given a $5 store gift card to express gratitude of their participation in the study.

To avoid introducing the additional variable of age effects, subjects' ages for both Americans and Koreans were limited to the range from 19 to 35 years. To control for prior knowledge, individuals who have taken lighting courses or worked as a professional by exercising lighting knowledge were excluded from the study. All subjects were screened for color vision deficiencies using the Ishihara (1993) Color Vision test, and screened for the presence of tinted or colored contact lenses. Prior to contacting the subjects to gain their interest and participation in the study, the researcher applied for and was granted permission to use human subjects by the University's Institutional Review Board (see Appendix A).

Research Design

Basic Design and Independent Variables

To accomplish the objectives of this study, the experimental research was designed to test four sections of hypotheses. For Sections 1 and 2, a 2 x 2 x 2 factorial, repeated measures design was used to identify the impact of three independent variables. The Independent variables were the color temperature and color rendering index of the T8 fluorescent lamps, and the cultural difference of the subject. The cross-cultural group was compared at two levels, Caucasian American and Korean participants. The variable of color temperature was compared at two levels, 3000 K and 5000 K. The variable of the color rendering index was compared at two levels, 75 CRI and 95 CRI. Therefore, there were four lighting conditions for the experiment of this research.

For Section 3, a 2 x 2 x 2 x 2 factorial, repeated measures design to identify the impact of four independent variables was used as follows: (1) culture group (Caucasian Americans and Koreans); (2) color rendering index (75 CRI and 95 CRI); (3) color temperature (3000 K and 5000 K); and (4) location of subjects (in the lighted environment and outside the lighted environment). For Section 4, a 2 x 2 factorial, repeated measures design to identify the impact of two independent variables was used as follows: (1) culture group (Caucasian Americans and Koreans) and (2) color rendering index (75 CRI and 95 CRI) by holding color temperature constant, or color temperature (3000 K and 5000 K) by holding color rendering index constant.

Experimental Setting

The experiment was conducted in three parts within the Lighting and Technology Laboratory in the College of Human Environmental Sciences at Oklahoma State University. The laboratory is 21 feet by 45 feet, with a height of nine feet and nine inches. The laboratory has light gray walls, floors and ceilings. The front of the room, the east end of the Lighting Laboratory, contains four cubicles measuring 5' 9" by 6' 6" (cubicles number 2 and 3 from the north side), 5' 6" by 6' 6" (cubicle number 1), and 3' 9" by 6' 6" (cubicle number 4) with a height of 10' 6" ceilings. The four cubicles are divided by vertical blinds having a matte finish in Pantone Color Cool Gray 1. The four cubicles are enclosed on three sides and are open to the Lighting Laboratory on one side. The two center cubicles (cubicle numbers 2 and 3) were used for the study because they are exactly the same size and have the same number of lamps. A projector screen that is 95" wide and 65" in length from the ceiling is positioned in front of the two center cubicles. To minimize the light coming from the Laboratory into the cubicles, the projector screen was used for Part 1 of the experiment. The two side cubicles on each ends of the room (cubicle numbers 1 and 4) were closed using light colored wood screens in order that no distractions would be introduced from the side cubicles during the second and third parts of the experiment.

To investigate the objectives of this study by creating a store setting, each cubicle contained a fruit bowl, two manikins with clothes, and a mirror and two shirts on the wall (see Figure 2). The study of natural color perceptions under different store lighting conditions used a fruit bowl containing two apples, two oranges, three bananas, two lemons, and a bundle of grapes displayed on a table. The tabletop was fully covered with a neutral light ivory colored cloth. In order to provide consistency in fruit color and shape throughout the data collection, artificial fruits were used. Both cubicles had identical fruit and containers. To determine complexion perception and acceptability under different lighting conditions, an approximately 12" by 15" square mirror was mounted on the center of the front wall. The center of the mirror was located five feet on-center above the floor surface.

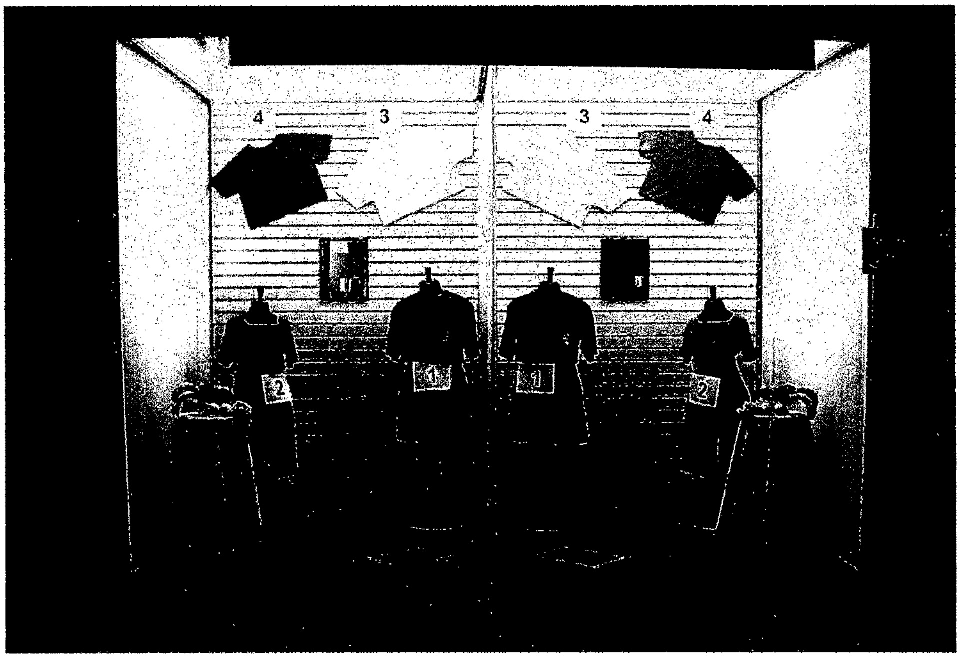
Previous studies in relation to store environment and consumer purchase behavior suggested that fashion stores are considered to carry the type of merchandise most amenable to shoppers by carrying high involvement goods (Flicker & Speer, 1990; Sherman, Mathur, & Smith, 1997). And also, Schlosser's study (1998) for the influence of store atmosphere on store inferences indicated that store atmosphere (e.g. lighting and music) selectively affected quality perceptions of social identity merchandise (e.g. a socially communicate products). Therefore, in order to examine color perceptions and designations of merchandise under different lighting conditions, two color shirts on the wall and two dressed manikins were used by creating the impression of a store environment. Yellow and purple-blue shirts were displayed on the front wall of each cubicle. Each of the two manikins was dressed with a red or blue shirt and black short pants on bottoms.

The colors of T-shirts used in this study were selected among the primary colors of red, yellow, and blue. Because of their contrasting on the color spectrum, consumer's most common color, and the extreme differences between the two colors found in previous research (Bellizzi & Hite, 1992; Fehrman & Fehrman, 2000), the red and blue colored T-shirts were selected and two manikins were dressed with red and blue color T-shirts. Park (1999) found that Munsell red was perceived as having the greatest color distortion under the different color temperatures of the light source. According to previous research (Fehrman & Fehrman 2000), blue is consumers' most preferred color. However, Park (1999) observed that people's concept of true blue was not the same for all people. Also based on a pretest of this study, it was questionable to distinguish people's concept of true blue between Munsell's 5B and 5PB. Thus, the purple-blue color was added for use in the study.

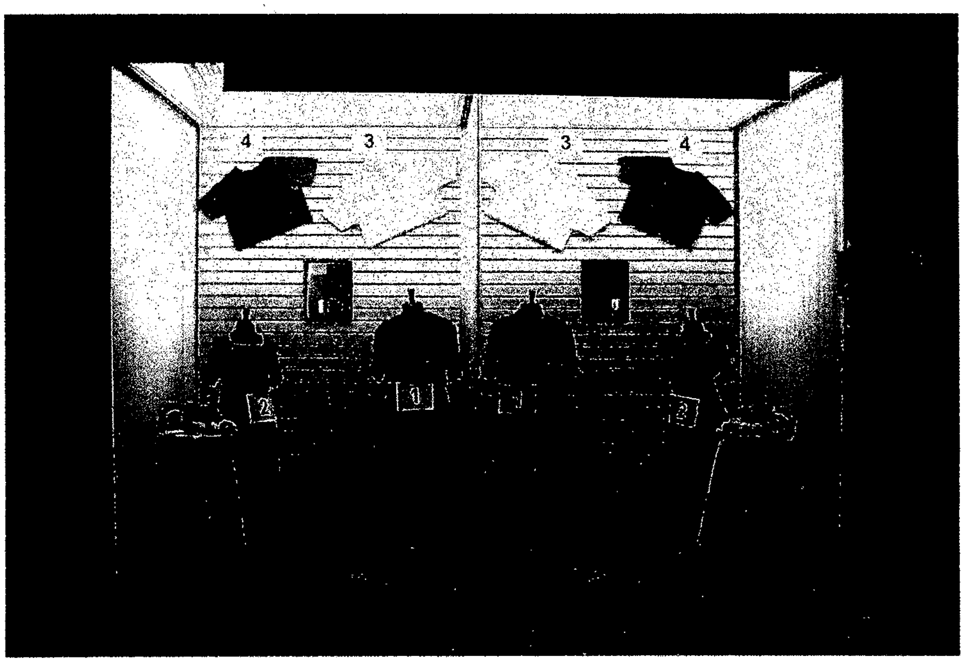
For the experimental setting, displays in each cubicle were balanced in terms of color, presenting both warm and cool colors without any strong emphasis on either. The colors of the shirts for the display were selected from the Munsell standardized color notation system using "The New Munsell Student Color Set" and "The Munsell Book of Color." The Munsell references that matched each shirt under natural light were Munsell Hue 5R 4/14 for the red shirt, Munsell 5Y 8.5/14 for the yellow shirt, Musell Hue 5B 5/10 for the blue shirt, and Munsell Hue 5PB 5/10 for the purple blue shirt. The two manikins in each cubicle were the same size and both were black in color. The location of manikins was identical in both cubicles. The displays in the two cubicles were mirror images. The positions of the wall displays, the fruit basket, manikins and the mirror are indicated in Figure 2.

Lighting Conditions

Ward (1991) indicates that three basic lamp families are used in retail lighting; fluorescent, incandescent and high intensity discharge (HID). Among them, fluorescent



Lighting 730 Lighting 750



Lighting 950 Lighting 930

Figure 2. The displays in cubicles and four different lighting conditions

lamps are the most popular for general retail lighting establishments. Grant (1991) reports that "fluorescent lamps are still best for general lighting in most stores. Unfortunately, the color rendition of standard fluorescent lamps is pretty dismal" (p. 52). Color rendering, cost, and lamp life are important factors when selecting a store lighting system (Ward, 1991).

Modern fluorescent technology can produce lamps with both high color rendering and high luminous efficacy as rare earth phosphor lamps. T8 fluorescent lamps use rear-earth phosphors, which provide a substantial increase in lighting efficiency and good color rendering (Gordon & Nuckolls, 1995). Hence, in this study, T8 fluorescent lamps were used for testing of color temperature and color rendering index. Each cubicle holds 2 circuits of four unshielded 4-foot ceiling-mounted fluorescent lamps. According to IES recommends, light sources in retail environments have a minimum CRI of 80-90 and an average of 3000-3500K. For the investigation of this study, two types of lamps with two different color temperatures, 3000K and 5000K, and color rendering indices, 75 CRI and 95 CRI were used. Therefore, there were four lighting conditions including 730, 750, 930, and 950 lamps. A typical T8 fluorescent lamp designation is outlined in Figure 3.

The four fluorescent lamps used were nearly equal in lumen output. The illuminance was approximately 65 footcandles on the surface of the questionnaire 42" above the floor. General illuminance of the laboratory was approximately 20 footcandles. All data were collected during daylight hours. To minimize the effect of the general lighting in the lab, daylight was used to achieve about 20 footcandles. Light blocking and light filtering shades for window treatments were used to adjust the natural light to 20 footcandles. In the event of a very cloudy day, indirect artificial light in the back of the Laboratory was needed to adjust the illumination level to 20 footcandles. An illumination level being utilized is based on the store lighting recommendation of the Illumination Engineering Society's Lighting Handbook. IES suggests an illuminance level of 30-100 footcandles for the general merchandise display area (Rea, 1999). All the lamps used were relatively new having operated about 100 hours before the start of the study.

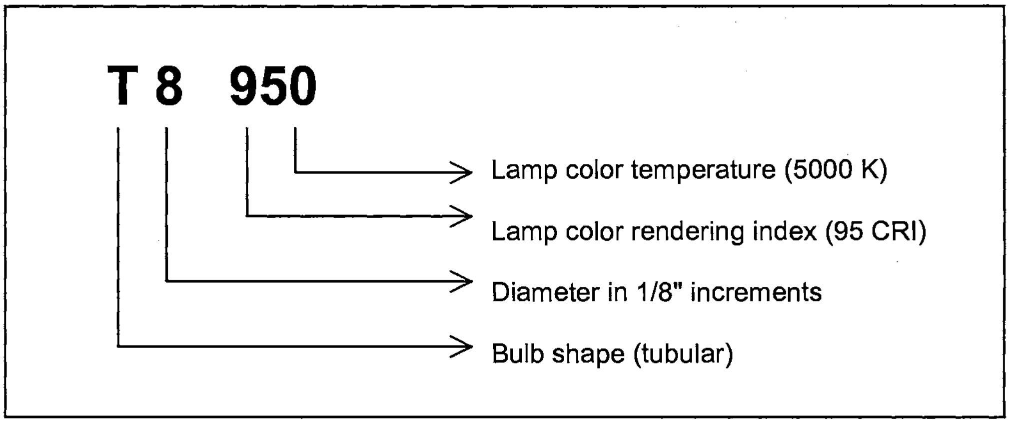


Figure 3. Fluorescent lamp designation

Instrumentation and Dependent Measures

The instrument for the purpose of this study was a self-completed questionnaire, presented in three sections. Section one was designed to obtain demographic and background information on both American and Korean subjects (see Appendix B and C).

Due to the criteria of the sample selection, there were a few differences between the American and Korean demographic items on the questionnaire. Fourteen items for the American demographic section and fifteen items for the Korean demographic section were related to personal information including age, sex, nationality, length of time lived in the U.S.A and Stillwater for Korean respondents, completed degree, current status, length of time lived outside of their own countries, wearing glasses or contacts or not, wearing makeup or not, eye color, and hair color. The questionnaire presented in section two was designed to evaluate the dependent variables of the study by containing three parts of questionnaire. Within section three, one page of the questionnaire was designed to identify general lighting preferences in residential, work, and shopping environments; shopping avoidance intentions due to lighting in the retail store; and three favorite colors.

In section two, the dependent variables for the study were the subjective evaluation of four lighting treatments as measured by a self-administered questionnaire package. This questionnaire package contained three parts: Part I) questionnaire for the inside cubicle, Part II) questionnaire for the outside cubicles, and Part III) questionnaire for side-by-side (simultaneous) comparisons from the outside cubicles (see appendix B).

The questionnaire used for the inside cubicles included the test for lighting perception in arousal, pleasure, impression of glare, and visual clarity, the test for lighting preference, the test for impression and preference of the color of the light, and the test for store product color perception. The measures for lighting perceptions of arousal and pleasure were selected from Mehrabian and Russell's pleasure-arousal scales (Mehrabian & Russell, 1974). Items for the lighting perception of visual clarity were selected from the Flynn and Spencer User Impression Test (Flynn & Spencer, 1977). Additional items in lighting perceptions of this study, lighting preference, complexion and skin color perceptions were adapted from the Flynn and Spencer (1977) User Impression Test and Kasmar's (1970) environmental descriptors. The measures of light color impression and preference test were selected from the Davis and Ginthner (1990) paper. The selection of the adjective pairs for the test was based on all three references, yet the questionnaire has been modified to fit the needs of this study to examine store environmental settings with four different lighting conditions.

Seven-point Likert-type scales were used to differentiate between the bipolar adjectives for the perception and preference of the lighting and skin and complexion color perception test. The bipolar adjectives used to test lighting perception and preference are visually warm/visually cool, bright/dim, glare/non glare, visually comfortable/uncomfortable, stimulating/boring, wide awake/sleepy, distinct/vague, clear/unclear, relaxing/tense, pleasant/unpleasant, and like/dislike. The scales used to test complexion and skin color perception were attractive/unattractive, healthy/unhealthy, and acceptable/unacceptable. Associating with six names of colors such as reddish, orangish, yellowish, greenish, bluish, and whitish, the color impression of the lighting was assessed. In addition, subjects' preference of the color of the light was asked using a like/dislike scale. A bowl of fruit was used to test color perceptions of natural objects by using the scale that colors appear very natural/colors appear not natural at all. Also, the scale used to test the color perception for each of five different kinds of fruit was color distorted/not distorted.

The second part of the questionnaire was used to measure the dependent variables of lighting perceptions including visual clarity, room attractiveness, and approach-avoidance intentions, lighting preferences, impression and preference of the light color, and color perceptions and designation of the merchandise by observing one lighting condition at a time from outside the cubicle. In order to examine the differences of lighting perceptions and preferences, the impression and preference of the light color, and the color perceptions of store products that may exist between inside and outside the lighted environment, the items in Part II were exactly the same in Part I. For lighting perceptions from outside the cubicles, four sets of bipolar adjectives were the same as those used inside cubicle. These bipolar adjectives are visually warm/visually cool, bright/dim, clear/unclear, and like/dislike. For the dependent variable of room attractiveness and approach-avoidance intentions in retail lighting environments, three bipolar adjectives are adapted from Kasmar's (1970) environmental descriptors including attractive/not attractive, inviting/not inviting, and approach/avoid on seven-points bipolar scales. The scales used to assess impression and preference of the light color, and color perceptions of natural objects were same as the inside cubicle measures. The items on this questionnaire were highly similar to those used in many previous studies (Bellizzi and Hite, 1992; Boyce & Cuttle, 1990; Chao & Bennett, 1981; Cockram, Collins, & Langdon, 1970; Hegde & Woodson, 1999; Knez, 1995).

To investigate the difference in the ability to match and designate colors under the different lighting conditions by observing from outside the cubicles, the four hues from the Munsell color system were tested using four different colored T-shirts. The four hues of the T-shirts were red, yellow, blue, and purple blue. Munsell designations of the four T-shirts matched under natural light are Munsell Hue 5R 4/14 for the red shirt, Munsell 5Y 8.5/14 for the yellow shirt, Musell Hue 5B 5/10 for the blue shirt, and Munsell Hue 5PB 5/10 for the purple blue shirt. For this merchandise color matching test, the subjects were asked to match and designate the best color of the shirts using four color cards. Color cards were designed based on the New Munsell Student Color Set by adding more Munsell color chips from the Munsell Book of Color in order to provide various color choices.

Three experts who work in the apparel and interior design professions performed matching colors between the shirts and two color charts (the New Munsell Student Color Set and the Munsell Book of Color) in order to recommend the color selections for color card. Each of the three experts independently rated the colors to be used for color card. After rating independently, three experts met together to recommend final color selections. Therefore, fourteen color chips for each of four color cards were selected from the New Munsell Student Color Set and the Munsell Book of Color (see appendix C). For practical reasons, the number of color chip was limited. Reasons for limiting the number of color chips were to minimize time need for subjects to make selections and to minimize confusion with "too many" choices.

Since the color cards were designed using the New Munsell Student Color Set, color chips used to collect data from the New Munsell Student Color Set are placed in the same position and designated the name of the color chips as in the New Munsell Student Color Set. To provide a variety color choices in the reasonable range of options as identified with three independent experts, the New Munsell Student Color Set were supplemented with additional colors from the Munsell Book of Color. The color chips selected from the Munsell Book of Color were arranged in relation to hue, value and chroma as close as possible for each of four color cards. However, it must be noted that the color chips in cards cannot be arranged sequentially by hue, value, and chroma due to the different name of the hue in number designation and the limitation of the space on the New Munsell Student Color Set.

For all fourteen possible red choices, five more color chips from the Munsell Book of Color were added to the New Munsell Student Color Set (see card A in appendix C). They are indicated with Italic letters in Table 1. The original nine color chips placed in the New Munsell Student Color Set for the test of this study are listed in Table 1.

For all fourteen possible blue choices, seven more color chips from the Munsell Book of Color were added to the New Munsell Student Color Set (see card B in appendix C). They are indicated with Italic letters in Table 2. The original seven color chips placed in the New Munsell Student Color Set for the test of this study are listed in Table 2.

Table 1

The Designation of Color Chips for the Red T-Shirt

	Original research color chip designation in card A	Munsell hue designation: all possible choices for red
1	3/12	2.5R 5/10
2	*3/14*	*2.5R 4/14*
3	4/10	5R 4/10
4	4/12	5R 4/12
5	<u>4/14</u>	<u>5R 4/14</u>
6	5/10	5R 5/10
7	5/12	5R 5/12
8	5/14	5R 5/14
9	6/10	5R 6/10
10	6/12	5R 6/12
11	*6/14*	*7.5R 5/16*
12	7/10	5R 7/10
13	*7/12*	*2.5R 6/12*
14	*7/14*	*7.5R 5/14*

Note. Underlined Designation, "___", indicates the "true" color match for the red T-shirt under natural light. Designations with Italic letters indicate the color chips added to the New Munsell Student Color Set from the Munsell Book of Color

Table 2

The Designation of Color Chips for the Blue T-Shirt

	Original research color chip designation in card B	Munsell hue designation: all possible choices for blue
1	4/6	5B 4/6
2	*4/8*	*10BG 5/10*
3	*4/10*	*2.5B 5/10*
4	5/6	5B 5/6
5	5/8	5B 5/8
6	<u>5/10</u>	<u>5B 5/10</u>
7	6/6	5B 6/6
8	6/8	5B 6/8
9	*6/10*	*5B 6/10*
10	7/6	5B 7/6
11	7/8	5B 7/8
12	*7/10*	*7.5B 7/8*
13	*8/6*	*10BG 7/6*
14	*8/8*	*10BG 7/8*

Note. Underlined Designation, "___", indicates the "true" color match for the red T-shirt under natural light. Designations with Italic letters indicate the color chips added to the New Munsell Student Color Set from the Munsell Book of Color

For all fourteen possible yellow choices, nine more color chips from the Munsell Book of Color were added to the New Munsell Student Color Set (see card C in appendix C). They are indicated with Italic letters in Table 3. The original five color chips placed in the New Munsell Student Color Set for the test of this study are listed in Table 3.

For all fourteen possible purple blue choices, five more color chips from the Munsell Book of Color were added to the New Munsell Student Color Set (see card D in appendix C). They are indicated with Italic letters in Table 4. The original nine color chips placed in the New Munsell Student Color Set for the test of this study are listed in Table 4

The third part of the questionnaire was designed to assess the subjects' perception of lighting including visual clarity, room attractiveness, and approach-avoidance intentions, lighting preferences, color impression and preference of the light, and color perceptions and designation of products. The questionnaire used in this part was exactly same as the questionnaire in Part II. For visual clarity assessment, two bipolar adjectives including bright/dim and clear/unclear were used. For lighting preference assessment, a bipolar adjective of like/dislike was used.

For the dependent variable of room attractiveness and approach-avoidance intentions in store lighting environments, the bipolar adjective scales of attractive/not attractive, inviting/not inviting, and approach/avoid were used. The measure of the dependent variables for color impression of the light, color preference of the light, and color perceptions of natural objects were the same as first and second parts of the questionnaire. The questionnaire used for the test of color matching and designation of merchandise in this part was exactly the same as the items in Part II.

For the Korean subjects, all questionnaires were written in both English and Korean in order to avoid any possible bias resulting from language issues and understanding the questionnaire. One of the criteria of the Korean sample selection was that participants have lived in the U.S less than 3 years in order to minimize acculturation. For the functional equivalence of the cross-cultural research in the measurement of the same meaning across societies, the translation and back-translation methods of Brislin, Lonner, and Thorndike (1973) were used in this study.

Table 3

<u>The Designation of Color Chips for the Yellow T-Shirt</u>

	Original research color chip designation in card C	Munsell hue designation: all possible choices for yellow
1	*5/10*	*2.5Y 8.5/8*
2	*5/12*	*2.5Y 8.5/12*
3	*5/14*	*5Y 8/14*
4	*6/10*	*2.5Y 8.5/12*
5	*6/12*	*2.5Y 8/12*
6	<u>*6/14*</u>	<u>*5Y 8.5/14*</u>
7	7/8	5Y 7/8
8	7/10	5Y 7/10
9	*7/12*	*7.5Y 8.5/12*
10	*7/14*	*5Y 8.5/12*
11	8/8	5Y 8/8
12	8/10	5Y 8/10
13	8/12	5Y 8/12
14	*8/14*	*7.5Y 8.5/8*

<u>Note.</u> Underlined Designation, "___", indicates the "true" color match for the red T-shirt under natural light. Designations with Italic letters indicate the color chips added to the New Munsell Student Color Set from the Munsell Book of Color

Table 4

<u>The Designation of Color Chips for the Purple Blue T-Shirt</u>

	Original research color chip designation in card D	Munsell hue designation: all possible choices for purple blue
1	4/8	5PB 4/8
2	4/10	5PB 4/10
3	*4/12*	*2.5PB 5/12*
4	5/8	5PB 5/8
5	<u>5/10</u>	<u>5PB 5/10</u>
6	*5/12*	*10B 6/10*
7	6/6	5PB 6/6
8	6/8	5PB 6/8
9	6/10	5PB 6/10
10	*6/12*	*2.5PB 6/10*
11	7/6	5PB 7/6
12	7/8	5PB 7/8
13	*7/10*	*7.5PB 7/6*
14	*7/12*	*7.5PB 7/8*

<u>Note.</u> Underlined Designation, "___", indicates the "true" color match for the red T-shirt under natural light. Designations with Italic letters indicate the color chips added to the New Munsell Student Color Set from the Munsell Book of Color

First, the researcher translated English into Korean for all three parts of the questionnaire. Then the researcher used the back-translation method in order to verify the construction and meaning of questionnaires between English and Korean. A post doctor with a TESL (Teaching English as a Second Language) degree who has teaching and research experience in college both in Korea and the U.S. back-translated the Korean into English. Modifications were made for same meaning between English and Korean questionnaires. A pretest of all three parts of the questionnaire both in English and Korean was preformed. Minor corrections such as formatting and arrangement of the items on questionnaire were made before being administered to the two groups of the research subjects.

Experimental Procedure

The experiment is designed to have all three parts administered in one session. The first part of the experiment was administered inside the cubicle. The second and third parts were administered outside the cubicles. To control for the influence of ambient light on the experiment, data were collected during day light hours in April and May 2001. Room darkening and light filtering window treatments were used to adjust the ambient light to approximately 20 footcandles before the experimental lighting conditions were turned on during all three parts of experimental session.

In order to collect data, all subjects were scheduled by appointment. Subjects were instructed to go to the Lighting Laboratory in room 433 of the Human Environmental Sciences building. Participants were greeted by the researcher. Only one subject was in the Lighting Laboratory at any time. When the subject entered the Lighting Laboratory, all experimental lighting conditions were turned off. After the participants were seated toward the south wall, the subjects were informed that the general aim of the experiment was to obtain their honest reactions to each lighting condition. The researcher answered questions or concerns and presented the Informed Consent Form. The subjects were allowed sufficient time to read and sign the Informed Consent Form. After the consent form was signed, the subjects took the standard Ishihara Color Vision test. If no color deficiency problem was detected, subjects' assistances were not required to proceed for the experiment. The demographic questionnaire and background information were distributed and subjects were asked to complete them. After completing the demographic questionnaire, each subject was asked to return the demographic questionnaire.

Each subject was asked to put on a white drape to cover the subject's clothing for the first part of the experiment in order to minimize the influence of the subjects' clothing color on the perception of the subjects' complexion color. The instruction and process for the three parts of the experiment were explained. All subjects received the same test instruments and same instructions for three parts of the experiment. The order for the lighting conditions was randomized for each subject for each of the three parts of the experiment. Since there were four different lighting conditions, two subjects in each group had the same order of treatments.

The first part of the experiment was conducted inside the cubicle (see Figure 4). There are two cubicles: one cubicle holds 730 and 950 lamps at 65 footcandles while the other cubicle holds 750 and 930 lamps at 65 footcandles. Each subject experienced all four different lighting conditions (730, 750, 930, and 950 lamps). The subject was asked to enter the cubicle; lights were turned on after the subject was in the cubicle. After a 60-second adaptation period, the subject was instructed to complete the questionnaire for the first lighting condition.

As each subject completed the questionnaire for the first condition, the subject was asked to exit the cubicle and the experimenter turned off the first lighting condition. The subject was seated in a waiting area in the Lighting Laboratory for at least 60 seconds to rest their eyes before viewing the next lighting condition. During the "resting" period, the waiting area had the illumination level of approximately 10 footcandles with the natural lighting condition encountered when entering the Lighting Laboratory.

This procedure for entering the cubicle, turning on the cubicle light, allowing a 60-second adaptation period, completing the questionnaire, exiting the cubicle, turning off the cubicle light, and resting the eyes for 60 seconds was repeated between each experimental treatment. The average length of time approximated for each subject to complete the questionnaire was four minutes in each lighting condition.

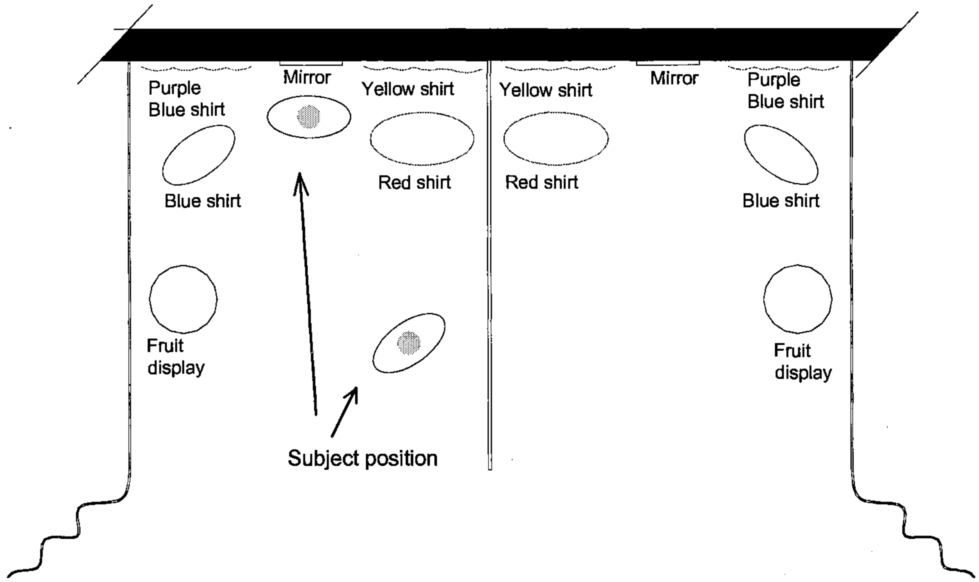


Figure 4. Data Collection in Part I with the Subject in the Lighted Environment

The second part of the experiment was administered from outside the cubicle (see Figure 5). Each subject was seated at a table that measured thirteen feet from the front edge of the cubicle (see Figure 6). The area where the subject answered the questionnaire had general illuminance of 20 footcandles plus any illuminance for the experimental condition. Each subject experienced the four lighting conditions in a random order. There was a 60 second resting period between each experimental treatment. The sequence for the experimental lighting conditions was randomized for data collection from outside the cubicles.

The subject observed each lighting condition separately from outside the cubicles. The experimenter turned on the first lighting condition. After a 30-second lighting adaptation period, the subject was instructed to complete the questionnaire for the first lighting condition. After the subject completed the questionnaire for the first condition, the experimenter turned off the first lighting condition.

The subjects were asked to rest their eyes at least one minute before viewing the next lighting condition. The subject was exposed to each condition for a 30-second adjustment period plus the time needed to complete the portion of the questionnaire for that treatment, approximately three minutes. All procedures for the remaining three lighting conditions were repeated in the same manner including turning on the cubicle light, allowing a 30-second adaptation period, completing the questionnaire for three minutes, turning off the cubicle light, and resting the eyes for one minute.

The third part of the experiment was conducted in the same position of Part 2 from outside the cubicles (see Figures 5 and 6). For part three, each subject assessed and compared two lighting conditions simultaneously from outside the cubicles. Two lighting conditions from cubicle one (left) and cubicle two (right) were turned on at the same time, and each subject observed and compared two lighting conditions simultaneously from outside the cubicle. In this part, there are four sets of lighting comparisons according to two different color temperatures and color rendering indices.

For the first set in this part, the 730 and 930 lighting conditions were evaluated simultaneously. Thus, two color rendering indices of 75 CRI and 95 CRI were compared when the color temperature of 3000 K is being held constantly. For the second set in this part, the 750 and 950 lighting conditions were evaluated simultaneously. Thus, two color rendering indices of 75 CRI and 95 CRI were compared when the color temperature of 5000 K was being held constant. For the third set in this part, the 730 and 750 lighting conditions were evaluated simultaneously. Thus, two color temperatures of 3000 K and 5000 K were compared when the color rendering index of 75 CRI was being held constant. For the fourth set in this part, the 930 and 950 lighting conditions were evaluated simultaneously. Thus, two color temperatures of 3000 K and 5000 K were compared when of the color rendering index of 95 CRI was being held constant.

In summary, this simultaneous and "side by side" evaluation allowed the comparison of two different color rendering indices by holding one of two color temperatures constant and the comparison of two different color temperatures by holding one of two color rendering indices constant. Thus:

- Set 1: 730 and 930 lamps were compared simultaneously (different CRI, 75 v. 95 at same CT, 3000K).
- Set 2: 750 and 950 lamps were compared simultaneously (different CRI, 75 v. 95 at same CT, 5000K).
- Set 3: 730 and 750 lamps were compared simultaneously (different CT, 3000K v. 5000K with same CRI, 75).
- Set 4: 930 and 950 lamps were compared simultaneously (different CT, 3000K v. 5000K with same CRI, 95).

Each subject seated at a table 13' from the front edge of the cubicle was asked to give his or her perceptions for two lighted environments by comparing them simultaneously. The experiment condition in each cubicle was turned on simultaneously. Both conditions were assessed separately using the side-by-side comparison pages of the questionnaire.

After subjects finished their first set of comparative lighting conditions, the experimenter turned off the light and subjects were given at least 60 seconds to rest their eyes before viewing the next set of comparative lighting conditions. The same procedure was conducted for the remaining comparative lighting combinations. The sequence for comparing the lighting conditions was randomized. Following the completion of the last experimental condition, subjects were asked to fill out the general questionnaire about the lighted environments, and not to discuss the experiment. This procedure was used to avoid any preconceptions by other potential subjects.

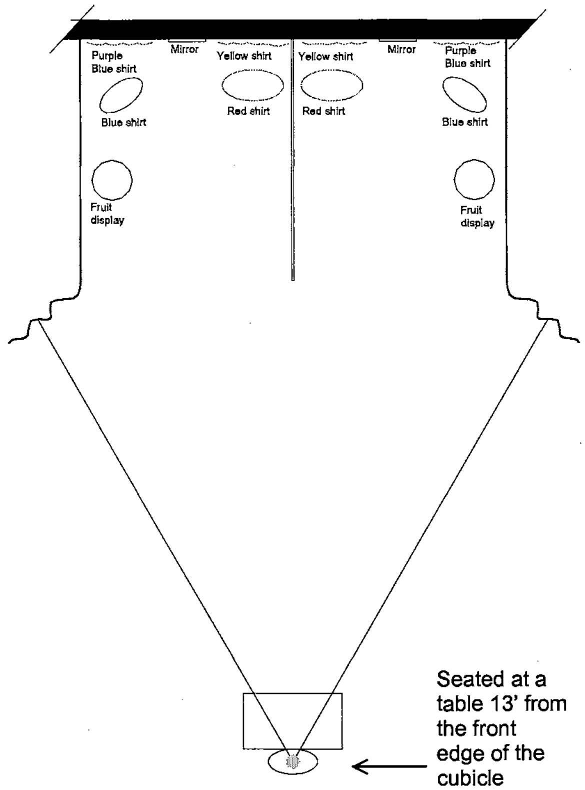


Figure 5. Data collection in Part 2 when observed from outside the lighted environment and in Part 3 when two lighting conditions were observed simultaneously from outside the lighted environment

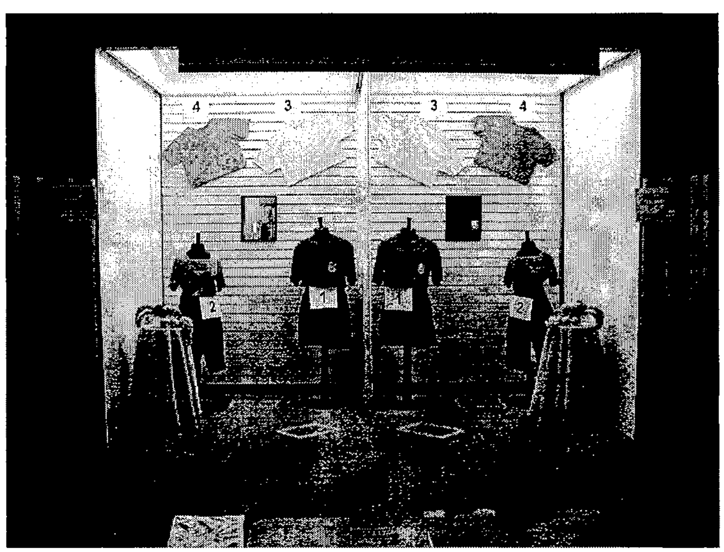


Figure 6. Cubicles seen from the 13' seated position

Data Analysis

All data collected from the questionnaire were tabulated, coded, and analyzed to test the proposed hypotheses. Descriptive statistics, such as frequencies and percentages were calculated for the subjects' demographic characteristics. Descriptive statistics, such as means and standard deviations, were reported for the dependent variables.

Three-factor analysis of variance with repeated measures was used to analyze the variables of lighting perception and preference, appearance of complexion and skin color, preference of the light color, and color perception of store product for hypotheses in Section 1. After the significant findings of three-way and two-way interactions, simple main effects tests were used to analyze in order to establish which variables for dependent measures were significant. Chi-square statistic was used to analyze the effect of the independent variables (culture group, color rendering index, and color temperature) on impression of the light color and color distortion of five fruits for hypotheses in Section 1. Due to the small size of the sample, no analysis for the interactions was performed.

For hypotheses in Section 2, three-factor analysis of variance with repeated measures was used to analyze the variables of lighting perception and preference, preference of the light color, and color perception of store products. After the significant findings of three-way and two-way interaction, simple main effects tests were used to analyze in order to establish which variables were significant for dependent measures. Chi-square statistic was used to analyze the effect of the independent variables (culture group, color rendering index, and color temperature) on impression of the light color, color distortion of five fruits, and color designation of merchandise. Due to the small size of sample, no analysis for the interactions was performed.

For hypotheses in Section 3, four-factor analysis of variance with repeated measures was used to analyze the variables of lighting perception and preference, preference of the light color, and color perception of store products. After the significant findings of four-way, three-way, and two-way interaction, simple main effects tests were used to analyze in order to establish which variables for dependent measures were significant. Chi-square statistic was used to analyze the effect of the independent variables (culture group, color rendering index, color temperature, and location) on impression of the light color and color distortion of five fruits. Due to the small size of the sample, no analysis for the interactions was performed.

Two-factor analysis of variance with repeated measures was used to analyze the variables of lighting perception and preference, preference of the light color, and color perception of store products for the hypotheses of each set in Section 4. After the significant findings of two-way interaction, simple main effects tests were used to analyze in order to establish which variables for dependent measures were significant. Chi-square statistic was used to analyze the effect of the independent variables (culture groups, color rendering index, and color temperature) on impression of the light color, color distortion of five fruits, and color designation of merchandise. Due to the small size of the sample, no analysis for the interactions was performed.

CHAPTER IV

FINDINGS

In this chapter, characteristics of the sample, the results of the reliability test, and results of the research hypotheses from the study are presented. The characteristics and background information of the respondents are reported under the heading of characteristics of the sample. The tests of hypotheses and findings are presented under the heading of each hypothesis.

Characteristics of the Sample

In this section, the characteristics and background information of the respondents in each cultural group and the sample comparison are reported.

Korean Sample

The Korean participants were recruited through the Korean Student Association (KSA) at Oklahoma State University (OSU), their families, relatives, and friends, and the Stillwater Korean community. Due to the potential bias of acculturation in the present study involving a cross-cultural comparison, the researcher planned to use newcomers to the U.S. as much as possible. After checking the residency time of all the KSA members in Stillwater from the KSA directory, the criterion for the study was limited to less than three years in order to reach a planned sample size of forty-eight.

As mentioned in the previous chapter, the criteria for the Korean sample selection were: (1) Born and raised in Korea; (2) had been in the U.S. for less than three years; (3) had not lived outside Korea for an extended period of time (more than six months) before coming to the U.S.; (4) were adults 19-35 years old; (5) had not studied any lighting courses or worked as a professional exercising lighting knowledge; and, (6) were not color blind.

A total of 50 subjects participated in the experiment. However one subject was removed from the study because she had lived in the U.S. more than 36 months. Even though the subject has lived in Stillwater, Oklahoma, less than 36 months, she was excluded from the study in order to maintain uniformity within the criteria of the study. The number of years Korean participants had lived in the U.S. and Stillwater are presented in Table 5. As seen in Table 5, more than half of the subjects had lived in the U.S. and Stillwater less than one year.

Therefore, 49 Korean subjects who met the requirement of participation were selected for this study. They were born and raised in Korea, had been in the U.S. for less than three years, had not lived outside Korea for more than six months before coming to the U.S., were adults aged 19 to 35 years, had a limited knowledge of lighting, and were not color blind.

Table 5

Length of Time Living in the U.S. and Stillwater for Korean Subjects

Length of time in the U.S.	n	%	Length of time in Stillwater	n	%
Less than 6 months	5	10.2	Less than 6 months	12	24.5
7 - 12 months	26	53.1	7 - 12 months	26	56.1
13 - 18 months	4	8.2	13 - 18 months	3	6.1
19 - 24 months	5	10.2	19 - 24 months	4	8.2
25 - 30 months	3	6.1	25 - 30 months	1	2.0
31 - 36 months	6	12.2	31 - 36 months	3	6.1

American Sample

The American participants were limited to being Caucasian American for the purpose of this study (subject's skin color perception) since one would anticipate that individuals with different skin colors may respond very differently to different lighting conditions. They were recruited primarily from the OSU student body. The criteria for the American participants were:

(1) Born and raised in the U.S.; (2) were Caucasian; (3) had not lived outside the U.S. for an extended period of time before participating in this study; (4) were adults 19 to 35 years old; (5) had not studied any lighting courses or worked as a professional exercising lighting knowledge; and, (6) were not color blind.

A total of 51 subjects participated in the study. Two of the 51 subjects were eliminated from the study. One male subject was observed to be partially color blind after being tested with the Ishihara Color Vision Test. The other had lived outside the U.S. for more than six months before participating in the study. Therefore, 49 Caucasian American subjects who met the requirements for participation were selected for this study.

Sample Comparison

The subjects in this study consisted of 98 adults. All subjects were divided into two subgroups: 1) 49 Caucasian American subjects and 2) 49 Korean subjects. Table 6 shows the frequency distribution of the general characteristics of the respondents in each of the groups tested. The 49 subjects in the American group included 22 males (44.9%) and 27 females (51.1%). The 49 subjects in the Korean group included 25 males (51%) and 24 females (49%). To avoid introducing an additional variable of age effects, subjects' ages for both Americans and Koreans were limited to the range of 19 to 35 years. The mean age of the American subjects was 23.6, the median was 23, and the mode was 22 years old. The mean age of the Korean subjects was 26.8, the median was 27, and the mode was 27 years old.

Their educational level ranged from high school to doctoral degrees. Since the samples in the study were recruited in various ways, the subjects were asked to reveal their current status in order to distinguish the distribution of subjects as being students or non-students. Most of the American subjects were students including 29 undergraduates (59.2%) and 17 graduate students (34.7%). Three subjects were university staff members. The Korean subjects included 19 undergraduates (38.8%) and 12 graduate students (24.5%). The remainder of the18 subjects (36.7%) included in this study included eight students attending the English Language Institute, two research associates, one businessman, and seven spouses of students.

Table 6

Characteristics of the Subjects

Characteristics	American (N=49) n	American (N=49) %	Korean (N=49) n	Korean (N=49) %	Total n
Gender					
Male	22	44.9	25	51.0	47
Female	27	55.1	24	49.0	51
Age					
19-24 years	32	5.0	13	26.5	45
25-30 years	14	28.6	27	55.1	41
31-35 years	3	6.1	9	18.4	12
Educational level					
High school	27	5.1	18	32.7	45
Bachelor's degree	18	36.7	25	51.0	43
Master's degree	4	8.2	5	10.2	9
Doctor's degree			1	2.0	1
Current status					
Undergraduate student	29	59.2	19	38.8	48
Graduate student	17	34.7	12	24.5	29
Other	3	6.1	18	36.7	21
Use glasses/contacts[1]					
Needed	21	42.9	30	61.2	51
Not needed	28	57.1	19	38.8	47

[1] One American and two Korean subjects who needed glasses or contacts were not wearing them at the time of the study.

Twenty-one of the American subjects (42.9%) and 30 of the Korean subjects (61.2%) usually wear glasses or contacts for visual correction. Twenty-eight of the American subjects (57.1%) and 19 of the Korean subjects (38.8%) did not require glasses or contacts for visual correction. All subjects were screened for color vision deficiencies using the Ishihara Color Vision Test, and screened for the presence of tinted or colored contacts. To control for prior knowledge, individuals who have studied lighting courses or worked as a professional by exercising lighting knowledge were excluded from the study. Thus, all 98 subjects met the requirements for participation in the study.

Reliability of Measures

Prior to inferential analyses, Cronbach's alpha test was performed on the variables of arousal, pleasure, visual clarity, and skin and complexion appearances in Part 1, and room attractiveness in Parts 2 and 3 questionnaires. The total value of Cronbach's coefficient alpha was calculated under each lighting condition. Table 7 shows the results of the reliability test for Parts 1 and 2 under each lighting condition. Based on the Mehrabian and Russell (1974) arousal scale, two bipolar adjective pairs (stimulating/boring, wide awake/sleepy) were combined as an arousal measure. The reliability of this scale was 0.80. Three bipolar adjective pairs (comfortable/uncomfortable, relaxing/tense, pleasant/unpleasant) were combined as a pleasure scale. The reliability of this scale was 0.77. The bright/dim, distinct/vague and clear/unclear scale were combined as a visual clarity measure in Part 1. The internal consistency of this scale was 0.85. The bright/dim and clear/unclear scale were combined as a visual clarity measure in Part 2. The internal consistency of this measure was 0.84. As the skin and complexion color appearance measure, three bipolar adjective pairs including attractive/not attractive, healthy/unhealthy, and acceptable/unacceptable were combined. Alpha values were 0.93 for the skin color appearance measure and 0.94 for the complexion appearance measure. Two bipolar adjective pairs including attractive/not attractive and inviting/not inviting in Part 2 were combined as a room attractiveness measure with an internal consistency of 0.93. In addition to the room attractiveness measure in Part 3, two bipolar adjective pairs, attractive/not attractive and inviting/not inviting, were calculated. The result of the coefficient alpha was 0.92 for all lighting conditions and both cultural groups. The bright/dim and clear/unclear scale were combined as a visual clarity measure in Part 3 at an internal consistency of 0.80. Table 8 shows the results of the reliability test for Part 3.

Table 7

Cronbach's Alpha Coefficients for the Reliabilities of Scales

Measure	Lighting Condition				
	730	750	930	950	Total
Arousal	.81	.85	.80	.72	.80
Pleasure	.77	.78	.78	.73	.77
Visual Clarity[1]	.88	.87	.86	.83	.85
Visual Clarity[2]	.88	.85	.82	.81	.84
Skin Color Appearance	.94	.90	.92	.93	.93
Complexion Color Appearance	.95	.90	.95	.94	.94
Room Attractiveness	.94	.90	.92	.93	.93

1. Visual clarity scale when observed inside the lighted environment
2. Visual clarity scale when observed outside the lighted environment

Table 8

Cronbach's Alpha Coefficients for the Reliabilities of Room Attractiveness Scales When Two Lighting Conditions Are Observed Simultaneously from Outside the Lighted Environment

Measure	Comparative Lighting Conditions								
	730 vs. 930		950 vs. 750		730 vs. 750		950 vs. 930		Total
Room Attractiveness	.94	.91	.89	.87	.92	.91	.94	.94	.92
Visual Clarity	.90	.81	.87	.75	.78	.74	.79	.77	.80

Tests of Hypotheses and Findings

The remainder of this chapter discusses the tests of the hypotheses and findings based on the research hypotheses outlined in Chapter One. Descriptive statistics of the means and standard deviations are presented for each hypothesis. The numerical data for Part 1 and 2 were analyzed using a 2 x 2 x 2 analysis of variance (ANOVA). The analysis was performed as a repeated measure design with participants as a culture group in the main unit and their evaluations of the four combinations analyzed as a split unit. The numerical data for Part 3 were analyzed using a 2 x 2 analysis of variance with repeated measure design, considering participants as a culture group in the main unit and their evaluations of the two lighting comparisons in a split unit. The numerical data for the comparison of Part 1 and 2 were analyzed using a 2 x 2 x 2 x 2 analysis of variance with repeated measure design, participants as a culture group in the main unit and their evaluations of the four lighting conditions and two different locations in a split unit. After the significant findings of four-way, three-way, and two-way interactions, simple main effects tests were used to analyze in order to establish which variables for dependent measures were significant.

Chi-square analysis was performed on the categorical data based on the main effects of culture, color temperature, color rendering index, and location for the hypotheses of Sections 1, 2, 3, and 4. An alpha level of 0.05 was used to determine statistical significance. The selection of an alpha level of 0.05 is appropriate because this value indicates 0.95 (95%) of the variation is explained by the variables tested and only 0.05 (5%) of the variation in individuals' responses is not explained by the manipulation of the variables tested.

As stated in Chapter One, the hypotheses were grouped by the subjects' placement during the experiment. For the hypotheses in Section 1, the subject responded to lighting conditions inside the cubicle. For the hypotheses in Section 2, the subject observed each lighting condition from outside the cubicle. The hypotheses in Section 3 address the comparison of the subjects' responses to each of four lighting conditions from inside and outside the cubicle. In the Section 3 hypotheses, responses made from inside and outside the cubicle were compared. For the hypotheses in Section 4, the subject observed or compared two lighting conditions simultaneously from outside the cubicles. Therefore, in Section 4, there are four sets of hypotheses. In each set, two lighting conditions were compared simultaneously according to two different color temperatures and color rendering indices. Therefore, the test results of the hypotheses are organized based on each section.

Hypotheses in Section 1: Inside the Cubicle

Hypothesis 1. There is no difference in the subjects' perception of lighting as being visually warm or visually cool when observed in the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Responses using the bipolar adjectives "visually warm and visually cool," on a seven-point Likert-type scale were used to assess the subjects' perceptions of lighting under the four different lighting conditions (730, 750, 930, and 950). Table 9 shows the mean and standard deviation scores for main effects, two-way interactions, and a three-way interaction of subjects' perception of lighting conditions.

The results of the analysis of variance (ANOVA) are summarized in Table 10. Color temperature as a main effect was statistically significant at p = .000 with calculated F (1,288) = 226.66. This result showed that regardless of the culture group or color rendering indices, the lower color temperature (3000 K) of the light source was estimated as being warm (M = 2.75), while the higher color temperature (5000 K) of the light source was estimated as being cool (M = 4.75). Therefore, Hypothesis 1c was rejected. The culture group and the color rendering indices (CRI) of fluorescent light as a main effect were not significant in subjects' perception of lighting as being visually warm or cool. Thus, Hypotheses 1a and 1b were not rejected. Culture by CRI, culture by CT, and CRI by CT, as a two-way interaction and culture by CRI by CT as a three-way interaction were not significant for the subjects' perception of lighting as being visually warm or cool. Thus, Hypotheses 1a, 1b, 1d, 1e, 1f, and 1g were not rejected.

Table 9

Mean and Standard Deviation Scores for Subjects' Perception of Lighting as Being Visually Warm or Visually Cool[1] When Observed in the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	196	3.79	1.80	
Korean	196	3.71	1.62	
Color Rendering Index				N.S.
75 CRI	196	3.86	1.70	
95 CRI	196	3.64	1.72	
Color Temperatures				0.000
3000 K	196	2.75	1.29	
5000 K	196	4.75	1.49	
Culture by CRI				N.S.
American x 75 CRI	98	3.95	1.78	
American x 95 CRI	98	3.63	1.82	
Korean x 75 CRI	98	3.77	1.63	
Korean x 95 CRI	98	3.65	1.61	
Culture by CT				N.S.
American x 3000 K	98	2.70	1.31	
American x 5000 K	98	4.88	1.56	
Korean x 3000 K	98	2.80	1.27	
Korean x 5000 K	98	4.62	1.40	
CRI by CT				N.S.
75 CRI x 3000 K	98	2.97	1.42	
75 CRI x 5000 K	98	4.74	1.49	
95 CRI x 3000 K	98	2.53	1.10	
95 CRI x 5000 K	98	4.76	1.49	
Culture by CRI x CT				N.S.
American x 75 CRI x 3000 K	49	2.98	1.49	
American x 75 CRI x 5000 K	49	4.92	1.50	
American x 95 CRI x 3000 K	49	2.43	1.04	
American x 95 CRI x 5000 K	49	4.84	1.64	
Korean x 75 CRI x 3000 K	49	2.96	1.35	
Korean x 75 CRI x 5000 K	49	4.57	1.49	
Korean x 95 CRI x 3000 K	49	2.63	1.17	
Korean x 95 CRI x 5000 K	49	4.67	1.33	

[1.] 7 point Likert-type scale: 1 = visually warm and 7 = visually cool
Note. N.S. = not significant at $p < .05$ (see ANOVA results in the next table).

Table 10

Analysis of Variance for Subjects' Perception of Lighting as Being Visually Warm or Visually Cool When Observed in the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	0.65	0.65	0.26	0.612
Between Error	96	241.35	2.51		
CRI	1	4.50	4.50	2.60	0.108
CT	1	392.00	392.00	226.66	0.000***
Culture x CRI	1	1.02	1.02	0.59	0.443
Culture x CT	1	2.95	2.95	1.71	0.193
CRI x CT	1	4.94	4.94	2.86	0.092
Culture x CRI x CT	1	0.01	0.01	0.01	0.934
Within Error	288	498.08	1.73		

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

Hypothesis 2. There is no difference in subjects' perception of glare when observed in the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Responses using the bipolar adjectives, “glare or no glare,” on a seven- point Likert-type scale were used to assess subjects' perceptions of glare under the four different lighting conditions (730, 750, 930, and 950). Table 11 shows the mean and standard deviation scores for the main effects, two-way interactions, and a three-way interaction of subject’s perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 12. One main effect, color temperature, was statistically very significant at $p = .014$ with calculated $F(1,288) = 6.17$. All respondents estimated the lower color temperature of 3000 K (M = 4.70) of the light source as less glaring than the higher color temperature of 5000 K (M = 4.36) of the light source, regardless of culture group and color rendering index differences. Therefore, Hypothesis 2c was rejected.

There was no significant difference in subjects' perception of glare with regard to the main effects of culture group and color rendering index (CRI). Thus, Hypotheses 2a and 2b were not rejected. Culture by CRI, culture by CT, and CRI by CT as a two-way interaction and culture by CRI by CT as a three-way interaction were not significant for the subjects' perception of glare. Thus, Hypotheses 2a, 2b, 2d, 2e, 2f, and 2g were not rejected. Two-way interaction between culture and color temperature, however, approached significance at $p = .06$ with an F ratio of 3.58.

Table 11

Mean and Standard Deviation Scores for Subjects' Perception of Glare[1] When Observed in the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	196	4.40	1.58	
Korean	196	4.67	1.41	
Color Rendering Index				N.S.
75 CRI	196	4.48	1.54	
95 CRI	196	4.58	1.46	
Color Temperatures				0.014
3000 K	196	4.70	1.41	
5000 K	196	4.36	1.58	
Culture by CRI				N.S.
American x 75 CRI	98	4.42	1.60	
American x 95 CRI	98	4.38	1.57	
Korean x 75 CRI	98	4.55	1.49	
Korean x 95 CRI	98	4.79	1.33	
Culture by CT				N.S.
American x 3000 K	98	4.44	1.55	
American x 5000 K	98	4.36	1.62	
Korean x 3000 K	98	4.97	1.20	
Korean x 5000 K	98	4.37	1.54	
CRI by CT				N.S.
75 CRI x 3000 K	98	4.67	1.44	
75 CRI x 5000 K	98	4.30	1.63	
95 CRI x 3000 K	98	4.73	1.38	
95 CRI x 5000 K	98	4.43	1.53	
Culture by CRI x CT				N.S.
American x 75 CRI x 3000 K	49	4.53	1.57	
American x 75 CRI x 5000 K	49	4.31	1.65	
American x 95 CRI x 3000 K	49	4.35	1.55	
American x 95 CRI x 5000 K	49	4.41	1.61	
Korean x 75 CRI x 3000 K	49	4.82	1.30	
Korean x 75 CRI x 5000 K	49	4.29	1.62	
Korean x 95 CRI x 3000 K	49	5.12	1.07	
Korean x 95 CRI x 5000 K	49	4.45	1.47	

[1] 7 point Likert-type scale: 1 = glare and 7 = no glare

Note. N.S. = not significant at $p < .05$ (see ANOVA results in the next table).

Table 12

Analysis of Variance for Subjects' Perception of Glare When Observed in the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	7.17	7.16	2.15	0.146
Between Error	96	320.15	3.33		
CRI	1	0.92	0.92	0.50	0.482
CT	1	11.45	11.45	6.17	0.014*
Culture x CRI	1	1.86	1.86	1.00	0.318
Culture x CT	1	6.64	6.64	3.58	0.060
CRI x CT	1	0.13	0.13	0.07	0.795
Culture x CRI x CT	1	1.13	1.13	0.61	0.437
Within Error	288	534.13	1.85		

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

Hypothesis 3. There is no difference in the subjects' perception of lighting as a factor in arousal when observed in the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Responses using two bipolar adjectives, “stimulating/boring and wide awake/sleepy,” on a seven-point Likert-type scale were used to assess the subjects’ perception of lighting as a factor in arousal under the four different lighting conditions (730, 750, 930, and 950). Table 13 shows the mean and standard deviation scores for main effects, two-way interactions, and a three-way interaction of subjects’ perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 14. There were significant differences for the main effects of culture group and color temperature. Culture group reached statistical significance at $p = .013$ with calculated $F(1,96) = 6.36$. American respondents

(M = 7.68) estimated the room light as significantly more arousing than Korean respondents (M = 8.30) regardless of color rendering indices and color temperatures. Color temperature reached statistical significance at $\underline{p}$ = .000 with calculated $\underline{F}$ (1,288) = 11.98. All respondents estimated the higher color temperature of 5000 K (M = 7.49) as more arousing than the lower color temperature of 3000 K (M = 8.13) regardless of culture group and color rendering index differences. Therefore, Hypotheses 3a and 3c were rejected.

There was no significant difference in subjects' perception of lighting as a factor in arousal with regard to the main effects of color rendering index (CRI). Thus, Hypothesis 3b was not rejected. Culture by CRI, culture by CT, and CRI by CT as a two-way interaction and culture by CRI by CT as a three-way interaction were not significant for subjects' perception of lighting as a factor in arousal. Thus, Hypotheses 3d, 3e, 3f, and 3g were not rejected.

Table 13

Mean and Standard Deviation Scores for Subjects' Perception of Lighting as a Factor in Arousal[1] When Observed in the Lighted Environment

Source	n	Mean	SD	p
Culture group				0.013
American	196	7.65	2.91	
Korean	196	8.30	2.53	
Color Rendering Index				N.S.
75 CRI	196	7.81	2.80	
95 CRI	196	8.13	2.68	
Color Temperatures				0.000
3000 K	196	8.45	2.82	
5000 K	196	7.49	2.58	
Culture by CRI				N.S.
American x 75 CRI	98	7.49	3.02	
American x 95 CRI	98	7.81	2.81	
Korean x 75 CRI	98	8.13	2.54	
Korean x 95 CRI	98	8.46	2.52	
Culture by CT				N.S.
American x 3000 K	98	8.36	2.92	
American x 5000 K	98	6.94	2.74	
Korean x 3000 K	98	8.54	2.73	
Korean x 5000 K	98	8.05	2.30	
CRI by CT				N.S.
75 CRI x 3000 K	98	8.23	2.84	
75 CRI x 5000 K	98	7.39	2.71	
95 CRI x 3000 K	98	8.66	2.80	
95 CRI x 5000 K	98	7.60	2.46	
Culture by CRI x CT				N.S.
American x 75 CRI x 3000 K	49	8.33	3.02	
American x 75 CRI x 5000 K	49	6.65	2.80	
American x 95 CRI x 3000 K	49	8.39	2.85	
American x 95 CRI x 5000 K	49	7.22	2.67	
Korean x 75 CRI x 3000 K	49	8.14	2.67	
Korean x 75 CRI x 5000 K	49	8.12	2.44	
Korean x 95 CRI x 3000 K	49	8.94	2.75	
Korean x 95 CRI x 5000 K	49	7.98	2.18	

1. Index score created for arousal perception: 2 = the score that indicates the highest or best arousal perception and 14 = the score that indicates the highest or best arousal perception

Note. N.S. = not significant at $p < .05$ (see ANOVA results in the next table).

Table 14

Analysis of Variance for Subjects' Perception of Lighting as a Factor in Arousal When Observed in the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	41.15	41.15	6.36	0.013*
Between Error	96	621.29	6.47		
CRI	1	10.13	10.13	1.36	0.245
CT	1	89.21	89.21	11.98	0.000***
Culture x CRI	1	0.00	0.00	0.00	0.985
Culture x CT	1	21.13	21.13	2.84	0.093
CRI x CT	1	1.13	1.13	0.15	0.698
Culture x CRI x CT	1	12.86	12.86	1.73	0.190
Within Error	288	2143.80	7.44		

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

Hypothesis 4. There is no difference in the subjects' perception of lighting as a factor in pleasure when observed in the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Responses using three bipolar adjectives, "comfortable/uncomfortable, relaxing/tense, and pleasant/unpleasant," on a seven-point Likert-type scale were used to assess the subjects' perception of lighting as a factor in arousal under the four different lighting conditions (730, 750, 930, and 950). Table 15 shows the mean and standard deviation scores for main effects, two-way interactions, and a three-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 16. Color temperature as a main effect was statistically significant at $F(1, 288) = 9.85$, $p = .002$. Also, a two-way interaction of culture by CRI was statistically significant at $F(1, 288) = 4.00$, $p = .046$.

Thus, the Hypotheses 4c and 4e were rejected. Although a main effect of color temperature and a two-way interaction of culture by CRI were significant, they were of little interest because a three-way interaction of culture by color rendering index by color temperature reached statistical significance at $\underline{F}$ (1, 288) = 8.83, $\underline{p}$ = .003. Therefore, Hypothesis 4g was rejected.

To assess the significance of such a finding, analysis of the simple effects was conducted. The outcomes are presented in Figure 7 and Table 17. As can be seen in Fig.7, American subjects perceived the higher color rendering index of 95 CRI (M = 10.20) as more comfortable, relaxing, and pleasant than the lower color rendering index of 75 CRI (M = 12.22) at the lower color temperature of 3000 K. Also, American subjects perceived the lower color temperature of 3000 K (M = 10.20) as more positive than the higher color temperature of 5000 K (M = 12.22) with the higher color rendering index of 95 CRI.

Korean subjects perceived the lower color rendering index of 75 CRI (M = 9.69) as more positive than the higher color rendering index of 95 CRI (M = 11.33) at the lower color temperature of 3000 K. Also, Korean subjects perceived the lower temperature of 3000 K (M = 9.69) as more positive than the higher color temperature of 5000 K (M = 12.16) with the lower color rendering index of 75 CRI. Korean subjects (M =9.69) estimated the 730 lighting condition as more positive in perception of pleasure than American subjects (M = 12.22). Thus, the results indicate that American subjects estimated the 930 lighting as best in perception of pleasure among the four lighting conditions, while Korean subjects estimated the 730 lighting as best in perception of pleasure among the four lighting conditions.

There was no significant difference in the pleasure measure with regard to the main effects of culture group and color rendering index. Thus, Hypotheses 4a and 4b were not rejected. Culture by CT and CRI by CT as a two-way interaction were not significant. Thus, Hypotheses 4d and 4f were not rejected.

Table 15

Mean and Standard Deviation Scores for Subjects' Perception of Lighting as a Factor in Pleasure[1] When Observed in the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	196	11.67	4.35	
Korean	196	11.21	3.11	
Color Rendering Index				N.S.
75 CRI	196	11.53	3.72	
95 CRI	196	11.35	3.83	
Color Temperatures				0.002
3000 K	196	10.86	3.90	
5000 K	196	12.02	3.58	
Culture by CRI				0.046.
American x 75 CRI	98	12.12	4.17	
American x 95 CRI	98	11.21	4.51	
Korean x 75 CRI	98	10.93	3.18	
Korean x 95 CRI	98	11.49	3.02	
Culture by CT				N.S.
American x 3000 K	98	11.21	4.32	
American x 5000 K	98	12.12	4.36	
Korean x 3000 K	98	10.51	3.42	
Korean x 5000 K	98	11.91	2.58	
CRI by CT				N.S.
75 CRI x 3000 K	98	10.96	3.84	
75 CRI x 5000 K	98	12.09	3.58	
95 CRI x 3000 K	98	10.77	3.98	
95 CRI x 5000 K	98	11.94	3.60	
Culture by CRI x CT				0.003.
American x 75 CRI x 3000 K	49	12.22	3.96	
American x 75 CRI x 5000 K	49	12.02	4.40	
American x 95 CRI x 3000 K	49	10.20	4.45	
American x 95 CRI x 5000 K	49	12.22	4.37	
Korean x 75 CRI x 3000 K	49	9.69	3.28	
Korean x 75 CRI x 5000 K	49	12.16	2.55	
Korean x 95 CRI x 3000 K	49	11.33	3.40	
Korean x 95 CRI x 5000 K	49	11.65	2.62	

[1]. Index score created for pleasure: 3 = the score that indicates the highest or best pleasure and 21 = the score that indicates the least or poorest pleasure

Note. N.S. = not significant at $p < .05$ (see ANOVA results in the next table).

Table 16

Analysis of Variance for Subjects' Perception of Lighting as a Factor in Pleasure When Observed in the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	20.66	20.66	1.36	0.246
Between Error	96	1454.37	15.15		
CRI	1	2.95	2.95	0.22	0.637
CT	1	130.30	130.30	9.85	0.002**
Culture x CRI	1	52.89	52.89	4.00	0.046*
Culture x CT	1	5.88	5.88	0.44	0.506
CRI x CT	1	0.04	0.04	0.00	0.956
Culture x CRI x CT	1	116.83	116.83	8.83	0.003**
Within Error	288	3808.61	13.22		

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

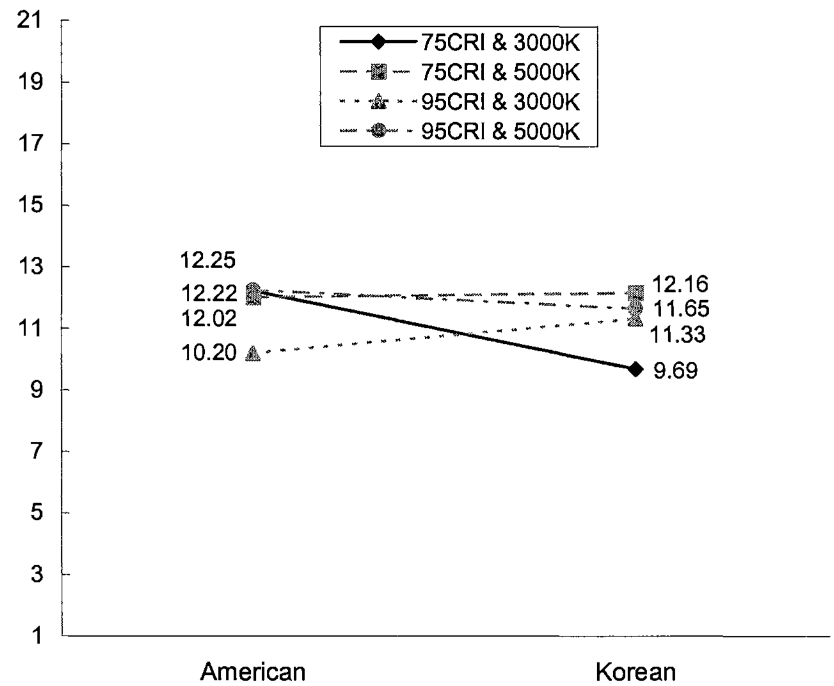


Figure 7. Three-Way Interaction of Culture by CRI by CT for Subjects' Perception of Lighting as a Factor in Pleasure When Observed in the Lighted Environment

Table 17

Analysis of Simple Effects (Culture x CRI x CT) for Subjects' Perception of Lighting as a Factor in Pleasure When Observed in the Lighted Environment

	1 [Ax7x30]	2 [Ax7x50]	3 [Ax9x30]	4 [Ax9x50]	5 [Kx7x30]	6 [Kx7x50]	7 [Kx9x30]	8 [Kx9x50]
1								
2	0.28 (0.7814)							
3	2.75** (0.0063)	2.47* (0.0140)						
4	-0.00 (1.0000)	-0.28 (0.7814)	-2.75** (0.0063)					
5	3.44*** (0.0007)	3.17** (0.0017)	0.69 (0.4880)	3.44*** (0.0007)				
6	-0.08 (0.9336)	-0.19 (0.8460)	-2.67** (0.0081)	0.08 (0.9336)	-3.36*** (0.0009)			
7	1.22 (0.2226)	0.94 (0.3457)	-1.53 (0.1277)	1.22 (0.2226)	-0.22* (0.0270)	1.14 (0.2557)		
8	-0.78 (0.4373)	0.50 (0.6175)	-1.97* (0.0495)	0.78 (0.4373)	-2.67*** (0.0081)	0.69 (0.4880)	-0.44 (0.6571)	

Note. Bracket Designation, "[ ]", indicates A = American, K = Korean, 7 = 75 CRI, 9 = 95 CRI, 30 = 3000K, and 50 = 5000K. Numeric value in parenthesis "( )" indicates p-value
*$p < .05$. **$p < .01$. ***$p < .001$

Hypothesis 5. There is no difference in the subjects' perception of lighting as a factor in visual clarity when observed in the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Responses using three bipolar adjectives, "bright/dim, distinct/vague, and clear/unclear," on a seven-point Likert-type scale were used to assess the subjects' perception of lighting as a factor in visual clarity under the four different lighting conditions (730, 750, 930, and 950). Table 18 shows the mean and standard deviation scores for main effects, two-way interactions, and a three-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 19. One main effect of color temperature was statistically very significant at $\underline{p} = .000$ with calculated $\underline{F}\,(1,288) = 40.30$. All respondents estimated the higher color temperature of 5000 K (M = 6.35) as higher in visual clarity than the lower color temperature of 3000 K (M = 7.92) regardless of the culture group and color rendering index differences. Therefore, Hypothesis 5c was rejected.

There was no significant difference in the subjects' perception of lighting as a factor in visual clarity with regard to the culture group and the color rendering index (CRI) of fluorescent light. Thus, Hypotheses 5a and 5b were not rejected. Culture by CRI, culture by CT, and CRI by CT as a two-way interaction and culture by CRI by CT as a three-way interaction were not significant. Thus, Hypotheses 5d, 5e, 5f, and 5g were not rejected.

Table 18

Mean and Standard Deviation Scores for Subjects' Perception of Lighting as a Factor in Visual Clarity[1] When Observed in the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	196	10.69	3.93	
Korean	196	10.98	4.07	
Color Rendering Index				N.S.
75 CRI	196	10.51	3.99	
95 CRI	196	11.17	3.99	
Color Temperatures				0.000
3000 K	196	12.04	3.91	
5000 K	196	9.64	3.72	
Culture by CRI				N.S.
American x 75 CRI	98	10.34	4.04	
American x 95 CRI	98	11.05	3.80	
Korean x 75 CRI	98	10.67	3.95	
Korean x 95 CRI	98	11.29	4.18	
Culture by CT				N.S.
American x 3000 K	98	11.87	3.92	
American x 5000 K	98	9.50	3.57	
Korean x 3000 K	98	12.18	3.92	
Korean x 5000 K	98	9.78	3.87	
CRI by CT				N.S.
75 CRI x 3000 K	98	11.65	3.89	
75 CRI x 5000 K	98	9.36	3.76	
95 CRI x 3000 K	98	12.42	3.91	
95 CRI x 5000 K	98	9.92	3.67	
Culture by CRI x CT				N.S.
American x 75 CRI x 3000 K	49	11.84	4.08	
American x 75 CRI x 5000 K	49	8.84	3.43	
American x 95 CRI x 3000 K	49	11.94	3.80	
American x 95 CRI x 5000 K	49	10.16	3.62	
Korean x 75 CRI x 3000 K	49	11.47	3.73	
Korean x 75 CRI x 5000 K	49	9.88	4.03	
Korean x 95 CRI x 3000 K	49	12.90	4.01	
Korean x 95 CRI x 5000 K	49	9.67	3.74	

[1] Index score created for visual clarity: 3 = the score that indicates the highest or best visual clarity and 21 = the score that indicates the least or poorest visual clarity

Note. N.S. = not significant at $p < .05$ (see ANOVA results in the next table).

Table 18

Mean and Standard Deviation Scores for Subjects' Perception of Lighting as a Factor in Visual Clarity[1] When Observed in the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	196	10.69	3.93	
Korean	196	10.98	4.07	
Color Rendering Index				N.S.
75 CRI	196	10.51	3.99	
95 CRI	196	11.17	3.99	
Color Temperatures				0.000
3000 K	196	12.04	3.91	
5000 K	196	9.64	3.72	
Culture by CRI				N.S.
American x 75 CRI	98	10.34	4.04	
American x 95 CRI	98	11.05	3.80	
Korean x 75 CRI	98	10.67	3.95	
Korean x 95 CRI	98	11.29	4.18	
Culture by CT				N.S.
American x 3000 K	98	11.87	3.92	
American x 5000 K	98	9.50	3.57	
Korean x 3000 K	98	12.18	3.92	
Korean x 5000 K	98	9.78	3.87	
CRI by CT				N.S.
75 CRI x 3000 K	98	11.65	3.89	
75 CRI x 5000 K	98	9.36	3.76	
95 CRI x 3000 K	98	12.42	3.91	
95 CRI x 5000 K	98	9.92	3.67	
Culture by CRI x CT				N.S.
American x 75 CRI x 3000 K	49	11.84	4.08	
American x 75 CRI x 5000 K	49	8.84	3.43	
American x 95 CRI x 3000 K	49	11.94	3.80	
American x 95 CRI x 5000 K	49	10.16	3.62	
Korean x 75 CRI x 3000 K	49	11.47	3.73	
Korean x 75 CRI x 5000 K	49	9.88	4.03	
Korean x 95 CRI x 3000 K	49	12.90	4.01	
Korean x 95 CRI x 5000 K	49	9.67	3.74	

1. Index score created for visual clarity: 3 = the score that indicates the highest or best visual clarity and 21 = the score that indicates the least or poorest visual clarity

Note. N.S. = not significant at $p < .05$ (see ANOVA results in the next table).

significance, it was of little interest because a significant two-way interaction (culture x color temperature) was obtained, F (1, 288) = 20.53, p = .000. Therefore, Hypothesis 6e was rejected.

To assess the significance of such a finding, analysis of the simple effects was conducted. The outcomes are presented in Figure 8 and Table 22. As can be seen in Fig.8, American subjects perceived their skin color as healthier, more acceptable and attractive under the lower color temperature of 3000 K (M = 8.98) than the higher color temperature of 5000 K (M = 11.86) regardless of the color rendering indices. American subjects (M = 8.98) perceived their perception of skin color appearance better than Korean subjects (M = 10.73) under the lower color temperature of 3000 K. However, Korean subjects (M = 10.04) perceived their skin color as healthier, more attractive and acceptable than the American subjects (M = 11.86) under the higher color temperature of 5000 K.

There was no significant difference in subjects' perception of skin color with regard to the main effects of the culture group (American and Korean) and color rendering index (75 CRI and 95 CRI). Therefore, Hypotheses 6a and 6b were not rejected. Culture by CRI, culture by CT, and CRI by CT as a two-way interaction were not significant for subjects' perception of skin color. Thus, Hypotheses 6d, 6e, and 6f were not rejected.

Table 20

Mean and Standard Deviation Scores for Subjects' Perception of Skin Color under Different Lighting Conditions[1] When Observed in the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	196	10.42	4.19	
Korean	196	10.39	3.90	
Color Rendering Index				N.S.
75 CRI	196	10.68	3.97	
95 CRI	196	10.13	4.10	
Color Temperatures				0.006
3000 K	196	9.86	4.16	
5000 K	196	10.95	3.85	
Culture by CRI				N.S.
American x 75 CRI	98	10.63	4.12	
American x 95 CRI	98	10.20	4.26	
Korean x 75 CRI	98	10.72	3.83	
Korean x 95 CRI	98	10.05	3.96	
Culture by CT				0.000
American x 3000 K	98	8.98	4.05	
American x 5000 K	98	11.86	3.83	
Korean x 3000 K	98	10.73	4.11	
Korean x 5000 K	98	10.04	3.67	
CRI by CT				N.S.
75 CRI x 3000 K	98	10.12	4.25	
75 CRI x 5000 K	98	11.23	3.61	
95 CRI x 3000 K	98	9.59	4.09	
95 CRI x 5000 K	98	10.66	4.07	
Culture by CRI x CT				N.S.
American x 75 CRI x 3000 K	49	9.51	4.14	
American x 75 CRI x 5000 K	49	11.76	3.82	
American x 95 CRI x 3000 K	49	8.45	3.93	
American x 95 CRI x 5000 K	49	11.96	3.87	
Korean x 75 CRI x 3000 K	49	10.73	4.30	
Korean x 75 CRI x 5000 K	49	10.71	3.34	
Korean x 95 CRI x 3000 K	49	10.73	3.96	
Korean x 95 CRI x 5000 K	49	9.37	3.88	

[1] Index score created for the skin color perception: 3 = the score that indicates the highest or best skin color perception and 21 = the score that indicates the least or poorest skin color perception

Note. N.S. = not significant at $p < .05$ (see ANOVA results in the next table).

Table 21

Analysis of Variance for Subjects' Perception of Skin Color under Different Lighting Conditions When Observed in the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	0.09	0.09	0.01	0.939
Between Error	96	1499.72	15.62		
CRI	1	29.76	29.76	1.95	0.163
CT	1	116.83	116.83	7.67	0.006*
Culture x CRI	1	1.47	1.47	0.10	0.756
Culture x CT	1	312.50	312.50	20.53	0.000***
CRI x CT	1	0.04	0.04	0.00	0.959
Culture x CRI x CT	1	41.80	41.80	2.75	0.099
Within Error	288	4384.11	15.22		

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

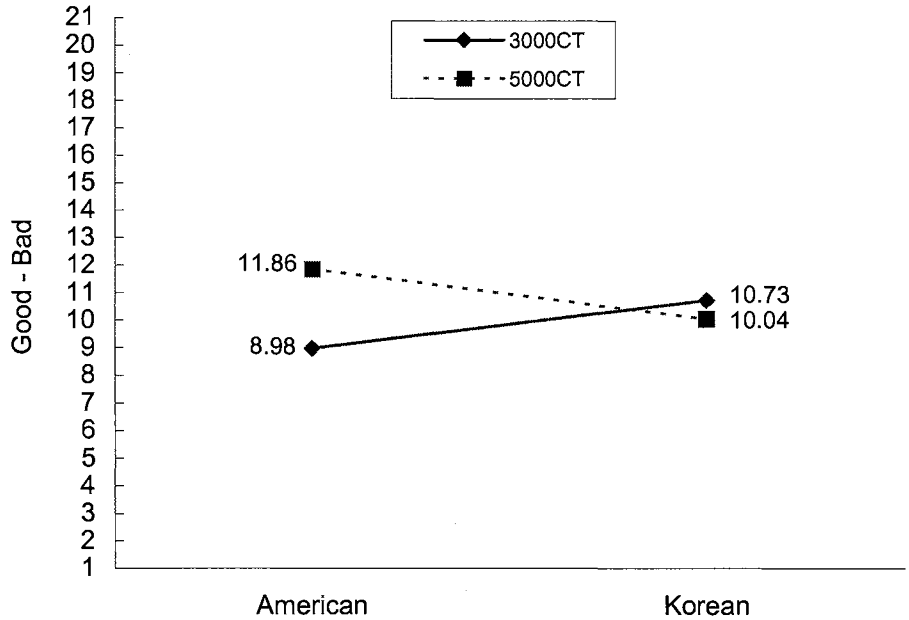


Figure 8. Two-Way Interaction of Culture by Color Temperature for Subjects' Perception of Skin Color under Different Lighting Conditions When Observed in the Lighted Environment

Table 22

Analysis of Simple Effects (Culture x CT) for Subjects' Perception of Skin Color under Different Lighting Conditions When Observed in the Lighted Environment

	1 [American x 3000 K]	2 [American x 5000 K]	3 [Korean x 3000 K]	4 [Korean x 5000 K]
1				
2	-5.16*** (0.0001)			
3	-3.15** (0.0018)	2.01* (0.0450)		
4	-1.90 (0.0579)	3.26** (0.0013)	1.24 (0.2142)	

Note. Numeric value in parenthesis "( )" indicates p-value
*$p < .05$. **$p < .01$. ***$p < .001$

Hypothesis 7. There is no difference in the subjects' perception of complexion appearance when observed in the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

For subjects' perception for complexion color under the four different lighting conditions, the mean and standard deviation scores for main effects, two-way interactions, and a three-way interaction are shown in Table 23.

The results of the analysis of variance (ANOVA) are summarized in Table 24. Color temperature as a main effect was statistically very significant at $p = .000$ with calculated F (1,288) =17.64. All respondents perceived their complexion color as healthier, more attractive and acceptable under the lower color temperature of 3000 K (M = 9.83) than the higher color temperature of 5000 K (M = 11.57) regardless of culture group and color rendering index differences. Therefore, Hypotheses 7c was rejected.

There was no significant difference in subjects' perception of complexion color with regard to the culture group and the color rendering index (CRI) of fluorescent light. Thus, Hypotheses 7a and 7b were not rejected. Culture by CRI, culture by CT, and CRI by CT as a two-way interaction and culture by CRI by CT as a three-way interaction were not significant. Therefore, Hypotheses 7d, 7e, 7f, and 7g were not rejected.

Table 23

Mean and Standard Deviation Scores for Subjects' Perception of Complexion Color under Different Lighting Conditions[1] When Observed in the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	196	10.58	4.57	
Korean	196	10.82	3.92	
Color Rendering Index				N.S.
75 CRI	196	10.77	4.13	
95 CRI	196	10.63	4.38	
Color Temperatures				0.000
3000 K	196	9.83	4.24	
5000 K	196	11.57	4.09	
Culture by CRI				N.S.
American x 75 CRI	98	10.81	4.35	
American x 95 CRI	98	10.35	4.79	
Korean x 75 CRI	98	10.72	3.93	
Korean x 95 CRI	98	10.92	3.92	
Culture by CT				N.S.
American x 3000 K	98	9.40	4.59	
American x 5000 K	98	11.76	4.25	
Korean x 3000 K	98	10.26	3.83	
Korean x 5000 K	98	11.39	3.94	
CRI by CT				N.S.
75 CRI x 3000 K	98	10.02	4.29	
75 CRI x 5000 K	98	11.51	3.84	
95 CRI x 3000 K	98	9.63	4.20	
95 CRI x 5000 K	98	11.63	4.34	
Culture by CRI x CT				N.S.
American x 75 CRI x 3000 K	49	10.00	4.72	
American x 75 CRI x 5000 K	49	11.61	3.82	
American x 95 CRI x 3000 K	49	8.80	4.43	
American x 95 CRI x 5000 K	49	11.90	4.67	
Korean x 75 CRI x 3000 K	49	10.04	3.87	
Korean x 75 CRI x 5000 K	49	11.41	3.90	
Korean x 95 CRI x 3000 K	49	10.47	3.81	
Korean x 95 CRI x 5000 K	49	11.37	4.02	

[1] Index score created for the complexion color perception: 3 = the score that indicates the highest or best complexion color perception and 21 = the score that indicates the least or poorest complexion color perception

Note. N.S. = not significant at $p < .05$ (see ANOVA results in the next table).

Table 24

Analysis of Variance for Subjects' Perception of Complexion Color under Different Lighting Conditions When Observed in the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	5.88	5.88	0.31	0.578
Between Error	96	1809.10	18.84		
CRI	1	1.72	1.72	0.10	0.750
CT	1	298.38	298.38	17.64	0.000***
Culture x CRI	1	10.45	10.45	0.62	0.433
Culture x CT	1	36.73	36.73	2.17	0.142
CRI x CT	1	6.38	6.38	0.38	0.540
Culture x CRI x CT	1	23.51	23.51	1.39	0.239
Within Error	288	4872.33	16.92		

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

Hypothesis 8. There is no difference in the subjects' impression of the light color when observed in the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)

To investigate the subjects' impression of the color of the light according to the important variables of culture, color rendering index, and color temperature, hypothesis 8 was tested. For this test, the subjects were asked to evaluate the color of the light by associating with six names of color including reddish, orangish, yellowish, greenish, bluish, and whitish. For this scale, Chi-square analysis was conducted. The results of the analysis are shown in Table 25.

The color temperature (3000 K and 5000 K) was statistically significant at $\chi^2 = 190.05$, $p = 0.0001$. Most of the subjects described the lower color temperature (3000 K) of the light source as warm colors, orangish (n: 64, 16.3 %) and yellowish (n: 88, 22.5 %), whereas they described the higher color temperature (5000 K) of the light source as cool colors, bluish (n: 66, 16.8 %) and whitish (n: 92, 23.5 %). The graph of the subjects' impression of the color of the light on color temperature is illustrated in Figure 9. As indicated in Figure 9, the color temperatures between 3000 K and 5000 K have a significant impact on the subjects' impression of the color of the light. Thus, Hypothesis 8c was rejected.

The culture group comparison between American and Korean shows very little difference in the subjects' impression of the color of the light. For the color rendering index, the percentage of the subjects' impression of the color of the light shows also very little differences between 75 CRI and 95 CRI. Therefore, Hypotheses 8a and 8b were not rejected.

Table 25

Chi-square Analysis of Subjects' Impression of the Light Color When Observed in the Lighted Environment

Possible color choices of the light	Culture group		Color Rendering Index		Color Temperature	
	American n (%)[a]	Korean n (%)[a]	75 CRI n (%)[a]	95 CRI n (%)[a]	3000 K n (%)[a]	5000 K n (%)[a]
Reddish	3 (0.8)	5 (1.3)	5 (1.3)	3 (0.8)	6 (1.5)	2 (0.5)
Orangish	31 (7.9)	38 (9.7)	30 (7.7)	39 (10.0)	64 (16.3)	5 (1.3)
Yellowish	50 (12.8)	54 (13.8)	51 (13.0)	53 (13.5)	88 (22.5)	16 (4.1)
Greenish	13 (3.3)	8 (2.0)	12 (3.1)	9 (2.3)	6 (1.5)	15 (3.8)
Bluish	47 (12.0)	30 (7.7)	35 (8.9)	42 (10.7)	11 (2.8)	16 (4.1)
Whitish	52 (13.3)	61 (15.6)	63 (16.1)	50 (12.8)	21 (5.4)	92 (23.5)
Total Subjects [b]	196	196	196	196	196	196
χ^2	7.02		4.27		190.05	
p	0.2188		0.5108		0.0001***	

[a] % based on 196 observations for each main effect.
[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 392 observations.
* $p < .05$. ** $p < .01$. *** $p < .001$.

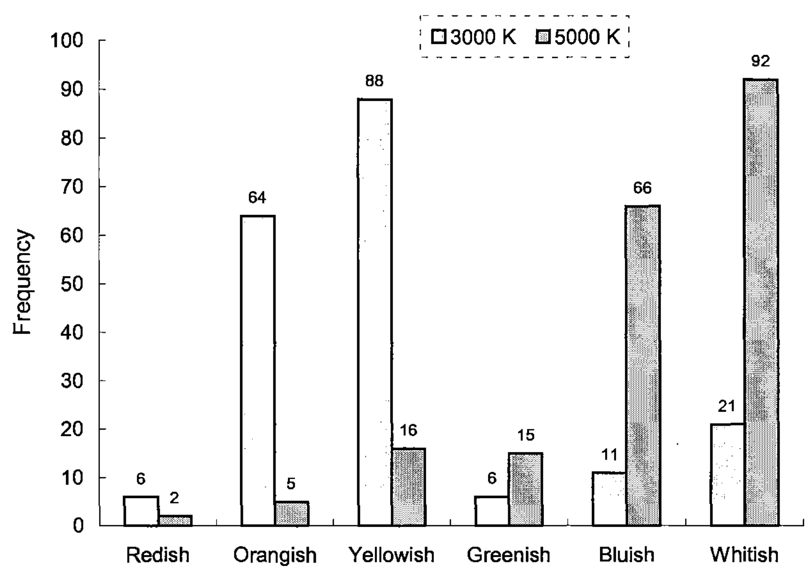


Figure 9. A Graph of the Subjects' Impression of the Light Color on Color Temperature When Observed in the Lighted Environment

Hypothesis 9. There is no difference in the subjects' preference for the light color when observed in the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Responses using the bipolar adjectives, "like or dislike," on a seven-point Likert-type scale were used to assess the subjects' preference of the color of the light under the four different lighting conditions (730, 750, 930, and 950). Table 26 shows the mean and standard deviation scores for main effects, two-way interactions, and a three-way interaction.

The results of the analysis of variance (ANOVA) are summarized in Table 27. There were no main effects of culture group, color rendering index, and color temperature for the subjects' preference of the color of the light. Thus, Hypotheses 9a, 9b, and 9c were not rejected. No statistical significance was indicated for the subjects' preference of the color of the light on two-way interactions of culture by CRI, culture by CT, and CRI by CT, and on three-way interaction of culture by CRI by CT. Therefore, Hypotheses 9d, 9e, 9f, and 9g were not rejected. The main effect of culture group, however, approached significance at $p = .085$ with an F ratio of 3.03.

Table 26

Mean and Standard Deviation Scores for Subjects' Preference of the Light Color[1] When Observed in the Lighted Environment

Source	$\underline{n}$	Mean	SD	$\underline{p}$
Culture group				N.S.
American	196	4.00	1.65	
Korean	196	3.73	1.55	
Color Rendering Index				N.S.
75 CRI	196	3.91	1.61	
95 CRI	196	3.82	1.60	
Color Temperatures				N.S.
3000 K	196	3.78	1.58	
5000 K	196	3.95	1.62	
Culture by CRI				N.S.
American x 75 CRI	98	4.07	1.66	
American x 95 CRI	98	3.93	1.63	
Korean x 75 CRI	98	3.76	1.55	
Korean x 95 CRI	98	3.70	1.56	
Culture by CT				N.S.
American x 3000 K	98	3.91	1.66	
American x 5000 K	98	4.09	1.63	
Korean x 3000 K	98	3.65	1.50	
Korean x 5000 K	98	3.81	1.60	
CRI by CT				N.S.
75 CRI x 3000 K	98	3.86	1.66	
75 CRI x 5000 K	98	3.97	1.57	
95 CRI x 3000 K	98	3.70	1.51	
95 CRI x 5000 K	98	3.93	1.68	
Culture by CRI x CT				N.S.
American x 75 CRI x 3000 K	49	4.10	1.73	
American x 75 CRI x 5000 K	49	4.04	1.61	
American x 95 CRI x 3000 K	49	3.71	1.58	
American x 95 CRI x 5000 K	49	4.14	1.67	
Korean x 75 CRI x 3000 K	49	3.61	1.55	
Korean x 75 CRI x 5000 K	49	3.90	1.54	
Korean x 95 CRI x 3000 K	49	3.69	1.46	
Korean x 95 CRI x 5000 K	49	3.71	1.67	

[1] 7 point Likert-type scale: 1 = like and 7 = dislike

Note. N.S = not significant at $\underline{p} < .05$ (see ANOVA results in the next table).

Table 27

Analysis of Variance for Subjects' Preference of the Light Color When Observed in the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	7.17	7.17	3.03	0.085
Between Error	96	226.92	2.36		
CRI	1	0.92	0.92	0.35	0.556
CT	1	2.78	2.78	1.05	0.306
Culture x CRI	1	0.21	0.21	0.08	0.780
Culture x CT	1	0.02	0.02	0.01	0.926
CRI x CT	1	0.31	0.31	0.12	0.733
Culture x CRI x CT	1	3.49	3.49	1.32	0.252
Within Error	288	762.02	2.65		

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

Hypothesis 10. There is no difference in the subjects' perception of fruit color as being natural or unnatural when observed in the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Responses using the bipolar adjectives, "natural or not natural," on a seven-point Likert-type scale were used to assess the subjects' perception of fruit color appearance as being natural or not natural under the four different lighting conditions (730, 750, 930, and 950). Table 28 shows the mean and standard deviation scores for main effects, two-way interactions, and a three-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 29. There were no main effects of culture group, color rendering index, and color temperature for the subjects' perception of fruit color. Thus, Hypotheses 10a, 10b, and 10c were not rejected. No statistical significance was indicated for the subjects' perception of the fruit color on two-way interactions of culture by CRI, culture by CT, and CRI by CT, and on three-way interaction of culture by CRI by CT. Therefore, Hypotheses 10d, 10e, 10f, and 10g were not rejected.

Table 28

Mean and Standard Deviation Scores for Subjects' Perception of Fruit Color[1] When Observed in the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	196	3.14	1.50	
Korean	196	3.44	1.39	
Color Rendering Index				N.S.
75 CRI	196	3.37	1.44	
95 CRI	196	3.21	1.46	
Color Temperatures				N.S.
3000 K	196	3.18	1.44	
5000 K	196	3.40	1.45	
Culture by CRI				N.S.
American x 75 CRI	98	3.28	1.52	
American x 95 CRI	98	3.00	1.47	
Korean x 75 CRI	98	3.46	1.36	
Korean x 95 CRI	98	3.43	1.41	
Culture by CT				N.S.
American x 3000 K	98	2.97	1.49	
American x 5000 K	98	3.31	1.50	
Korean x 3000 K	98	3.39	1.37	
Korean x 5000 K	98	3.50	1.41	
CRI by CT				N.S.
75 CRI x 3000 K	98	3.19	1.41	
75 CRI x 5000 K	98	3.54	1.46	
95 CRI x 3000 K	98	3.16	1.48	
95 CRI x 5000 K	98	3.27	1.44	
Culture by CRI x CT				N.S.
American x 75 CRI x 3000 K	49	3.06	1.49	
American x 75 CRI x 5000 K	49	3.49	1.53	
American x 95 CRI x 3000 K	49	2.88	1.49	
American x 95 CRI x 5000 K	49	3.12	1.45	
Korean x 75 CRI x 3000 K	49	3.33	1.33	
Korean x 75 CRI x 5000 K	49	3.59	1.40	
Korean x 95 CRI x 3000 K	49	3.45	1.42	
Korean x 95 CRI x 5000 K	49	3.41	1.43	

[1]: 7 point Likert-type scale: 1 = natural and 7 = not natural

Note. N.S. = not significant at $p < .05$ (see ANOVA results in the next table).

Table 29

Analysis of Variance for Subjects' Perception of Fruit Color When Observed in the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	9.18	9.18	2.63	0.108
Between Error	96	335.66	3.50		
CRI	1	2.30	2.30	1.42	0.234
CT	1	4.94	4.94	3.06	0.081
Culture x CRI	1	1.47	1.47	0.91	0.341
Culture x CT	1	1.23	1.23	0.77	0.382
CRI x CT	1	1.47	1.47	0.91	0.341
Culture x CRI x CT	1	0.09	0.09	0.06	0.812
Within Error	288	464.50	1.61		

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$

Hypothesis 11. There is no difference in the subjects' color perception for five different kinds of fruit when observed in the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)

To identify the subjects' color perception of natural objects under the four different lighting conditions (730, 750, 930, and 950), the colors of five different kinds of fruit in a bowl was tested. The five fruits were apple, orange, banana, lemon, and grape. The results of the Chi-square analysis are shown in Table 30.

The variable of culture group (American and Korean) was statistically significant for both the orange (χ^2 = 10.7561, p = 0.001) and banana color perception (χ^2 = 4.8785, p = 0.027). Although most of the respondents described all fruit colors as being not distorted from their natural color, a greater proportion of difference showed between the Americans and Koreans for the orange and the banana color perception. Forty-four American respondents (11.2%) out of 196 responded to the orange color as being distorted while only 20 Korean respondents (5.1%) perceived the orange color as being distorted. For the color perception of the banana, 59 Korean respondents (15.1%) out of 196 perceived it as being distorted while only 40 American respondents (10.2%) perceived it as being distorted. Thus, Hypothesis 11a was rejected.

The color rendering index showed a significant impact for lemon color perception (χ^2 = 20.9244, p = 0.0001). Although most of the respondents described the lemon color as being not distorted from the natural color, there is a big difference in color perception between 75 CRI and 95 CRI. Sixty subjects (15.3%), regardless of culture group differences, responded to the lemon color as being distorted under 75 CRI, while 23 subjects (5.9%) perceived the lemon color as being distorted under 95 CRI. Thus, Hypothesis 11b was rejected.

There was no statistical significance for the variable of color temperature on subjects' perception of the color of the five different fruits as being distorted or not distorted. The percentage of the subjects' responses to the color of the light shows very little difference between the two different color temperatures. Therefore, Hypothesis 11c was not rejected.

Table 30

Chi-square Analysis of Subjects' Perception of Fruit Color as Being Distorted or Not Distorted under the Lighting When Observed in the Lighted Environment

Variable		Culture group		Color Rendering Index		Color Temperature	
		American	Korean	75 CRI	95 CRI	3000 K	5000 K
		n (%)[a]	n (%)[a]	n (%)[a]	n (%)[a]	n (%)[a]	n (%)[a]
Apple	Distorted	54 (13.8)	52 (13.3)	48 (12.2)	58 (14.8)	58 (14.8)	48 (12.2)
	Not Distorted	142 (36.2)	144 (36.7)	148 (37.8)	138 (35.2)	138 (35.2)	148 (37.8)
	χ^2	0.05		1.29		1.29	
	p	0.8201		0.2555		0.2555	
Orange	Distorted	44 (11.2)	20 (5.1)	36 (9.2)	28 (7.1)	28 (7.1)	36 (9.2)
	Not Distorted	152 (38.8)	176 (44.9)	160 (40.8)	168 (42.9)	168 (42.9)	160 (40.8)
	χ^2	10.76		1.20		1.20	
	p	0.0010***		0.2743		0.2743	
Banana	Distorted	40 (10.2)	59 (15.1)	45 (11.5)	54 (13.8)	42 (10.7)	57 (14.5)
	Not Distorted	156 (39.8)	137 (35.0)	151 (38.5)	142 (36.2)	154 (39.3)	139 (35.5)
	χ^2	4.88		1.09		3.04	
	p	0.0272*		0.2954		0.0812	
Lemon	Distorted	41 (10.5)	42 (10.7)	60 (15.3)	23 (5.9)	46 (11.7)	37 (9.4)
	Not Distorted	155 (39.5)	154 (39.3)	136 (34.7)	173 (44.1)	150 (38.3)	159 (40.6)
	χ^2	0.01		20.92		1.24	
	p	0.9016		0.0001***		0.2658	
Grape	Distorted	77 (16.6)	95 (24.2)	89 (22.7)	83 (21.2)	80 (20.4)	92 (23.5)
	Not Distorted	119 (30.4)	101 (45.9)	107 (27.3)	113 (28.8)	116 (29.6)	104 (26.5)
	χ^2	3.36		0.37		1.49	
	p	0.0669		0.5414		0.2219	
Total Subjects [b]		196	196	196	196	196	196

[a] % based on 196 observations for each main effect.
[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 392 observations.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Hypothesis 12. There is no difference in the subjects' overall lighting preference when observed in the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Responses using the bipolar adjectives, "like or dislike," on a seven-point Likert-type scale were used to assess subjects' overall lighting preference under the four different lighting conditions (730, 750, 930, and 950). Table 31 shows the mean and standard deviation scores for main effects, two-way interactions, and a three-way interaction of subjects' perception of lighting.

Table 32 shows the results of analysis of variance (ANOVA) for subjects' overall lighting preferences. Color temperature (K) as a main effect was significant with an F (1, 288) = 8.25, p = .004. All participants preferred the lower color temperature of 3000 K (M = 3.64) more than the higher color temperature of 5000 K (M = 4.08) regardless of the culture group and color rendering index differences. Therefore, Hypothesis 12c was rejected.

There was no significant difference in subjects' lighting preference with regard to the culture group and the color rendering index (CRI) of fluorescent light. Thus, Hypotheses 12a and 12b were not rejected. Culture by CRI, culture by CT, and CRI by CT as a two-way interaction and culture by CRI by CT as a three-way interaction were not significant. Thus, Hypotheses 12d, 12e, 12f, and 12g were not rejected.

Table 31

Mean and Standard Deviation Scores for Subjects' Overall Lighting Preference[1] When Observed in the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	196	3.90	1.65	
Korean	196	3.82	1.54	
Color Rendering Index				N.S.
75 CRI	196	3.88	1.59	
95 CRI	196	3.84	1.61	
Color Temperatures				0.004
3000 K	196	3.64	1.59	
5000 K	196	4.08	1.58	
Culture by CRI				N.S.
American x 75 CRI	98	4.05	1.61	
American x 95 CRI	98	3.74	1.69	
Korean x 75 CRI	98	3.70	1.56	
Korean x 95 CRI	98	3.93	1.52	
Culture by CT				N.S.
American x 3000 K	98	3.53	1.63	
American x 5000 K	98	4.27	1.61	
Korean x 3000 K	98	3.74	1.56	
Korean x 5000 K	98	3.90	1.53	
CRI by CT				N.S.
75 CRI x 3000 K	98	3.73	1.58	
75 CRI x 5000 K	98	4.02	1.60	
95 CRI x 3000 K	98	3.54	1.61	
95 CRI x 5000 K	98	4.14	1.56	
Culture by CRI x CT				N.S.
American x 75 CRI x 3000 K	49	3.84	1.64	
American x 75 CRI x 5000 K	49	4.27	1.56	
American x 95 CRI x 3000 K	49	3.22	1.57	
American x 95 CRI x 5000 K	49	4.27	1.67	
Korean x 75 CRI x 3000 K	49	3.63	1.52	
Korean x 75 CRI x 5000 K	49	3.78	1.61	
Korean x 95 CRI x 3000 K	49	3.85	1.60	
Korean x 95 CRI x 5000 K	49	4.02	1.45	

[1] 7 point Likert-type scale: 1 = like and 7 = dislike

Note. N.S. = not significant at $p < .05$ (see ANOVA results in the next table).

Table 32

Analysis of Variance for Subjects' Overall Lighting Preference When Observed in the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	0.61	0.61	0.21	0.646
Between Error	96	276.34	2.88		
CRI	1	0.14	0.14	0.06	0.806
CT	1	19.53	19.53	8.25	0.004**
Culture x CRI	1	7.03	7.03	2.97	0.086
Culture x CT	1	8.14	8.14	3.44	0.065
CRI x CT	1	2.53	2.53	1.07	0.302
Culture x CRI x CT	1	2.07	2.07	0.88	0.350
Within Error	288	681.98	2.37		

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

Hypotheses in Section 2: Outside the Cubicle

The second part of the experiment was conducted outside the cubicle. Each subject was seated at a table thirteen feet from the front edge of the cubicle. Each individual subject evaluated each lighting condition by observing from outside the lighted environment. Therefore, there are ten hypotheses in Section 2.

Hypothesis 13. There is no difference in the subjects' perception of the lighting as being visually warm or visually cool by observing from outside the cubicle with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Responses using the bipolar adjectives "visually warm and visually cool," on a seven-point Likert-type scale were used to assess the subjects' perceptions of the four lighting conditions (730, 750, 930, and 950) when observed from outside the lighted environment. Table 33 shows the mean and standard deviation scores for the main effects, two-way interactions, and a three-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 34. There was a main effect of color temperature F (1, 288) = 24.04, p = .000. Thus, Hypothesis 13c was rejected. Although the main effect of color temperature reached statistical significance, it was of little interest because a significant two-way interaction of color rendering index by color temperature was obtained, F (1, 288) = 15.78, p = .000. Therefore, Hypotheses 13f was rejected.

To assess the significance of such a finding, analysis of the simple effects was conducted. The outcomes are presented in Figure 10 and Table 35. As can be seen in Fig.10, All respondents perceived the lower color temperature of 3000 K (M = 2.97) as warmer than the higher color temperature of 5000 K (M = 3.73) with 75 CRI. However, all respondents perceived the lower color rendering index of 75 CRI (M = 2.97) as warmer than the higher color rendering index of 95 CRI (M = 3.73) at the lower color temperature of 3000 K. In other words, the 730 lighting condition was estimated as significantly warmer across all lighting conditions when observed from outside the lighted environment.

There was no significant difference regarding the main effects of culture group (American and Korean) and color rendering index (75 CRI and 95 CRI). Therefore, Hypotheses 13a and 13b were not rejected. No significant difference resulted on two-way interaction of culture by CRI and culture by CT, and a three-way interaction of culture by CRI by CT. Thus, Hypotheses 13d, 13e, and 13g were not rejected.

Table 33

Mean and Standard Deviation Scores for Subjects' Perception of Lighting as Being Visually Warm or Visually Cool[1] When Observed from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	196	3.83	1.64	
Korean	196	3.57	1.43	
Color Rendering Index				N.S.
75 CRI	196	3.60	1.56	
95 CRI	196	3.80	1.52	
Color Temperatures				0.000
3000 K	196	3.35	1.54	
5000 K	196	4.05	1.47	
Culture by CRI				N.S.
American x 75 CRI	98	3.64	1.68	
American x 95 CRI	98	4.02	1.59	
Korean x 75 CRI	98	3.56	1.44	
Korean x 95 CRI	98	3.58	1.43	
Culture by CT				N.S.
American x 3000 K	98	3.41	1.62	
American x 5000 K	98	4.26	1.57	
Korean x 3000 K	98	3.30	1.47	
Korean x 5000 K	98	3.85	1.34	
CRI by CT				0.000
75 CRI x 3000 K	98	2.97	1.42	
75 CRI x 5000 K	98	4.23	1.45	
95 CRI x 3000 K	98	3.73	1.58	
95 CRI x 5000 K	98	3.87	1.48	
Culture by CRI by CT				N.S.
American x 75 CRI x 3000 K	49	2.98	1.49	
American x 75 CRI x 5000 K	49	4.31	1.61	
American x 95 CRI x 3000 K	49	3.84	1.64	
American x 95 CRI x 5000 K	49	4.20	1.54	
Korean x 75 CRI x 3000 K	49	2.96	1.35	
Korean x 75 CRI x 5000 K	49	4.16	1.28	
Korean x 95 CRI x 3000 K	49	3.63	1.52	
Korean x 95 CRI x 5000 K	49	3.53	1.34	

[1] 7 point Likert-type scale: 1 = visually warm and 7 = visually cool
Note. N.S = not significant at $p < .05$ (see ANOVA results in the next table).

Table 34

Analysis of Variance for Subjects' Perception of Lighting as Being Visually Warm or Visually Cool When Observed from Outside the Lighted Environment

Source	*df*	SS	MS	*F*	*p*
Culture	1	6.64	6.64	2.41	0.124
Between Error	96	264.69	2.76		
CRI	1	3.88	3.88	1.95	0.164
CT	1	47.88	47.88	24.04	0.000***
Culture x CRI	1	3.13	3.13	1.57	0.211
Culture x CT	1	2.15	2.15	1.08	0.300
CRI x CT	1	31.43	31.43	15.78	0.000***
Culture x CRI x CT	1	0.74	0.74	0.37	0.543
Within Error	288	573.55	1.99		

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

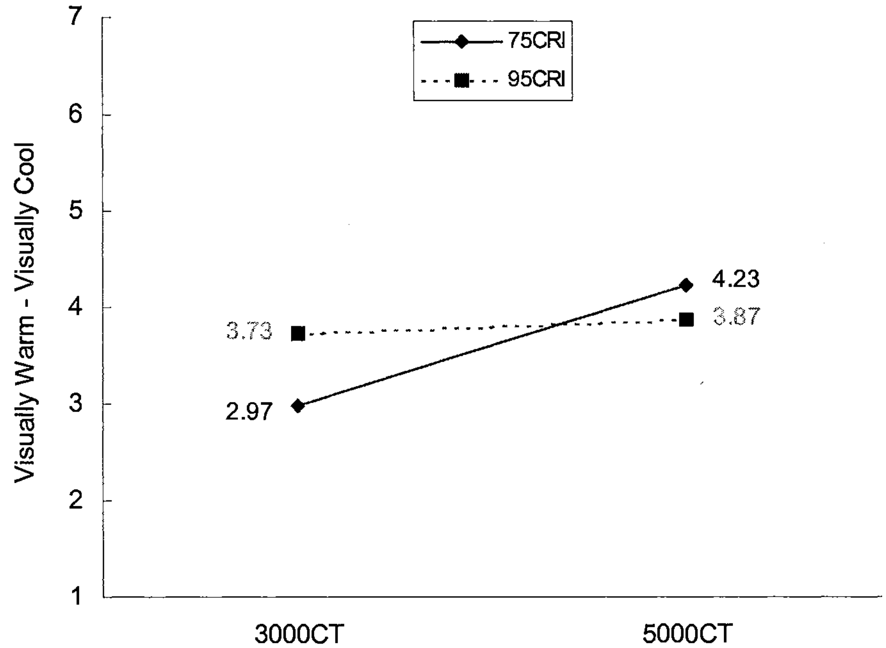


Figure 10. Two-Way Interaction of CRI by CT for Subjects' Perception of Lighting as Being Visually Warm or Visually Cool When Observed from Outside the Lighted Environment

Table 35

Analysis of Simple Effects (CRI x CT) for Subjects' Perception of Lighting as Being Visually Warm or Visually Cool When Observed from Outside the Lighted Environment

	1 [75 CRI x 3000 K]	2 [75 CRI x 5000 K]	3 [95 CRI x 3000 K]	4 [95 CRI x 5000 K]
1				
2	-6.28*** (0.0001)			
3	-3.80*** (0.0002)	2.48* (0.0137)		
4	-4.45*** (0.0001)	1.82 (0.0695)	-0.66 (0.5111)	

Note. Numeric value in parenthesis "( )" indicates p-value
*p < .05. **p < .01. ***p < .001

Hypothesis 14. There is no difference in the subjects' perception of the lighting as a factor in visual clarity by observing from outside the cubicle with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Responses using two bipolar adjectives, "bright/dim and clear/unclear," on a seven-point Likert-type scale were used to assess subjects' perceptions of the four different lighting conditions (730, 750, 930, and 950) when observed from outside the lighted environment. Table 36 shows the mean and standard deviation scores for main effects, two-way interactions, and a three-way interaction of subject's perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 37. There were significant differences for the main effects of culture group and color temperature. Culture group reached statistical significance at $p = .032$ with calculated $F(1,96) = 4.74$. American respondents ($M = 7.50$) estimated the room light as significantly brighter and clearer than Korean respondents ($M = 8.23$) regardless of color rendering indices and color temperatures. Color temperature reached statistical significance at $p = .000$ with calculated $F(1,288) = 66.02$. All respondents estimated the higher color temperature of 5000 K ($M = 6.84$) as significantly brighter and clearer than the lower color temperature of 3000 K ($M = 8.89$) regardless of the culture group and color rendering index differences. Therefore, Hypotheses 14a and 14c were rejected.

There was no significant difference in the subjects' perception of lighting as a factor in visual clarity with regard to the main effect of the color rendering index (CRI) of fluorescent light. Thus, Hypothesis 14b was not rejected. Culture by CRI, culture by CT, and CRI by CT as a two-way interaction and culture by CRI by CT as a three-way interaction were not significant. Thus, Hypotheses 14d, 14e, 14f, and 14g were not rejected.

Table 36

Mean and Standard Deviation Scores for Subjects' Perception of Lighting as a Factor in Visual Clarity[1] When Observed from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				0.032.
American	196	7.50	3.08	
Korean	196	8.23	2.73	
Color Rendering Index				N.S.
75 CRI	196	7.87	2.91	
95 CRI	196	7.86	2.95	
Color Temperatures				0.000
3000 K	196	8.89	2.79	
5000 K	196	6.84	2.70	
Culture by CRI				N.S.
American x 75 CRI	98	7.70	3.19	
American x 95 CRI	98	7.30	2.97	
Korean x 75 CRI	98	8.04	2.61	
Korean x 95 CRI	98	8.42	2.84	
Culture by CT				N.S.
American x 3000 K	98	8.51	3.06	
American x 5000 K	98	6.48	2.78	
Korean x 3000 K	98	9.27	2.45	
Korean x 5000 K	98	7.19	2.60	
CRI by CT				N.S.
75 CRI x 3000 K	98	8.73	2.79	
75 CRI x 5000 K	98	7.01	2.81	
95 CRI x 3000 K	98	9.04	2.82	
95 CRI x 5000 K	98	6.67	2.59	
Culture by CRI by CT				N.S.
American x 75 CRI x 3000 K	49	8.78	3.12	
American x 75 CRI x 5000 K	49	6.63	2.91	
American x 95 CRI x 3000 K	49	8.25	3.00	
American x 95 CRI x 5000 K	49	6.35	2.64	
Korean x 75 CRI x 3000 K	49	8.69	2.38	
Korean x 75 CRI x 5000 K	49	7.39	2.68	
Korean x 95 CRI x 3000 K	49	9.84	2.41	
Korean x 95 CRI x 5000 K	49	7.00	2.53	

[1] Index score created as a factor in visual clarity: 2 = the score that indicates the highest or best visual clarity and 14 = the score that indicates the least or poorest visual clarity

Note. N.S. = not significant at $p < .05$ (see ANOVA results in the next table).

Table 37

Analysis of Variance for Subjects' Perception of Lighting as Factor in Visual Clarity When Observed from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	52.17	52.17	4.74	0.032 *
Between Error	96	1055.42	10.99		
CRI	1	0.02	0.02	0.00	0.952
CT	1	410.21	410.21	66.02	0.000***
Culture x CRI	1	15.13	15.13	1.63	0.120
Culture x CT	1	0.06	0.06	2.43	0.920
CRI x CT	1	10.13	10.13	0.01	0.203
Culture x CRI x CT	1	19.31	19.31	3.11	0.079
Within Error	288	1789.40	6.21		

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

Hypothesis 15. There is no difference in the subjects' perception of the light for room attractiveness by observing from outside the cubicle with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Responses using the bipolar adjectives, "attractive/not attractive and inviting/not inviting," on a seven-point Likert-type scale were used to assess the room attractiveness for the four different lighting conditions (730, 750, 930, and 950) when observed from outside the lighted environment. Table 38 shows the mean and standard deviation scores for main effects, two-way interactions, and a three-way interaction of subject's perception of lighting.

Table 39 shows the results of analysis of variance (ANOVA) for the measure of the room attractiveness by observing from outside the lighted environment. There were main effects of culture group F (1, 96) = 8.91, p = .004 and color temperature F (1, 288) = 4.29, p = .039.

Therefore, Hypotheses 15a and 15c were rejected. Although the main effects of culture group and color temperatures reached statistical significance, they were of little interest because a significant three-way interaction of culture by CRI by CT was obtained, $F(1,288) = 8.86$, $p = .003$. Therefore, Hypothesis 15g was rejected.

To assess the significance of such a finding, analysis of the simple effects was conducted. The outcomes are presented in Figure 11 and Table 40. As shown in Figure 11, American subjects (M = 6.59) perceived the 930 lighting condition as more attractive than Korean subjects (M = 8.71). American subjects perceived the lower color temperature of 3000 K (M = 6.59) as more attractive than the higher color temperature of 5000 K (M = 7.92) with 95 CRI.

Korean subjects perceived the lower color temperature of 3000 K (M = 7.53) as more attractive than the higher color temperature of 5000 K (M = 9.16) with 75 CRI. Also, Korean subjects perceived the lower color rendering index of 75 CRI (M =7.53) as more attractive than the higher color rendering index of 95 CRI (M = 8.71) at the lower color temperature of 3000 K. In other words, American respondents estimated the 930 lighting condition as significantly more attractive across all lighting conditions, while Korean respondents estimated the 730 lighting condition as significantly more attractive across all lighting conditions.

There was no significant difference in the subjects' perception of lighting as a factor in room attractiveness with regard to the color rendering index (CRI) of fluorescent light. Thus, Hypothesis 15b was not rejected. Culture by CRI, culture by CT, and CRI by CT as a two-way interaction were not significant at the $\underline{p} = .05$ level. Thus, Hypotheses 15d, 15e, 15f, and 15g were not rejected.

Table 38

Mean and Standard Deviation Scores for Subjects' Perception of Lighting for Room Attractiveness[1] When Observed from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				0.004
American	196	7.46	3.16	
Korean	196	8.43	2.84	
Color Rendering Index				N.S.
75 CRI	196	8.01	3.02	
95 CRI	196	7.88	3.07	
Color Temperatures				0.039
3000 K	196	7.64	3.11	
5000 K	196	8.25	2.95	
Culture by CRI				N.S.
American x 75 CRI	98	7.67	3.19	
American x 95 CRI	98	7.26	3.14	
Korean x 75 CRI	98	8.35	2.83	
Korean x 95 CRI	98	8.51	2.87	
Culture by CT				N.S.
American x 3000 K	98	7.16	3.21	
American x 5000 K	98	7.77	3.10	
Korean x 3000 K	98	8.12	2.95	
Korean x 5000 K	98	8.73	2.71	
CRI by CT				N.S.
75 CRI x 3000 K	98	7.63	3.05	
75 CRI x 5000 K	98	8.39	2.97	
95 CRI x 3000 K	98	7.65	3.19	
95 CRI x 5000 K	98	8.11	2.94	
Culture by CRI by CT				0.003
American x 75 CRI x 3000 K	49	7.73	3.23	
American x 75 CRI x 5000 K	49	7.61	3.18	
American x 95 CRI x 3000 K	49	6.59	3.12	
American x 95 CRI x 5000 K	49	7.92	3.05	
Korean x 75 CRI x 3000 K	49	7.53	2.89	
Korean x 75 CRI x 5000 K	49	9.16	2.54	
Korean x 95 CRI x 3000 K	49	8.71	2.92	
Korean x 95 CRI x 5000 K	49	8.31	2.84	

[1] Index score created as a factor in room attractiveness: 2 = the score that indicates the highest or best room attractiveness and 14 = the score that indicates the least or poorest room attractiveness
Note. N.S = not significant at $p < .05$ (see ANOVA results in the next table).

Table 39

Analysis of Variance for Subjects' Perception of Lighting for Room Attractiveness When Observed from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	91.13	91.13	8.91	0.004*
Between Error	96	981.50	10.22		
CRI	1	1.59	1.59	0.19	0.664
CT	1	36.13	36.13	4.29	0.039*
Culture x CRI	1	8.29	8.29	0.98	0.322
Culture x CT	1	0.00	0.00	0.00	0.986
CRI x CT	1	2.15	2.15	0.25	0.614
Culture x CRI x CT	1	74.59	74.59	8.86	0.003**
Within Error	288	2424.50	8.42		

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

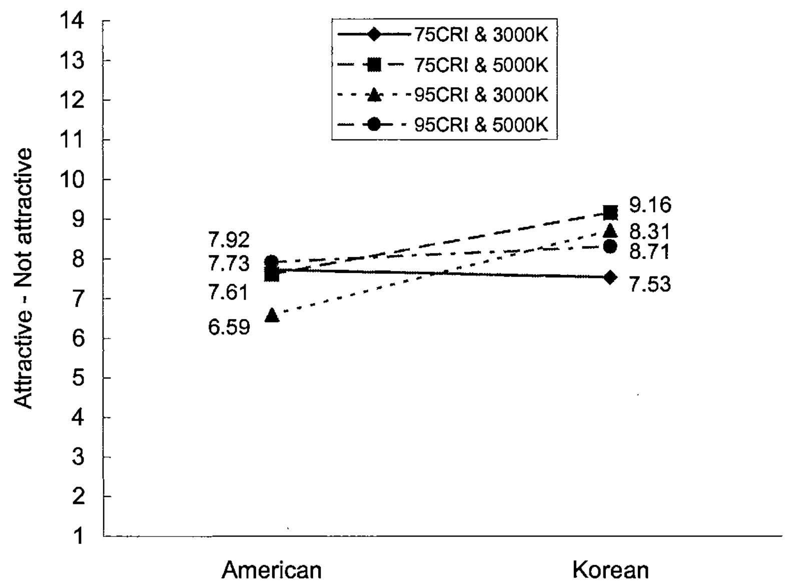


Figure 11. Three-Way Interaction of Culture by CRI by CT for Subjects' Perception of Lighting for Room Attractiveness When Observed from Outside the Lighted Environment

Table 40

Analysis of Simple Effects (Culture x CRI x CT) for Subjects' Perception of Lighting for Room Attractiveness When Observed from Outside the Lighted Environment

	1 [A x 7 x 30]	2 [A x 7 x 50]	3 [A x 9 x 30]	4 [A x 9 x 50]	5 [K x 7 x 30]	6 [K x 7 x 50]	7 [K x 9 x 30]	8 [K x 9 x 50]
1								
2	0.21 (0.8347)							
3	1.95 (0.0522)	1.74 (0.0828)						
4	-0.31 (0.7542)	-0.52 (0.6019)	-2.26* (0.0244)					
5	0.35 (0.7280)	0.14 (0.8893)	-1.60 (0.1104)	0.66 (0.5088)				
6	-2.44* (0.0154)	-2.65** (0.0086)	-4.39*** (0.0001)	-2.12* (0.0345)	-2.79** (0.0057)			
7	-1.67 (0.0958)	-1.88 (0.0611)	-3.62*** (0.0003)	-1.36 (0.1756)	-2.02* (0.0444)	0.77 (0.4443)		
8	-0.97 (0.3305)	-1.18 (0.2375)	-2.92** (0.0037)	-0.66 (0.5088)	-1.32 (0.1869)	1.46 (0.1448)	0.70 (0.4863)	

Note. Bracket Designation, "[ ]", indicates A = American, K = Korean, 7 = 75 CRI, 9 = 95 CRI, 30 = 3000K, and 50 = 5000K. Numeric value in parenthesis "( )" indicates p-value
*$p < .05$. **$p < .01$. ***$p < .001$

Hypothesis 16. There is no difference in the subjects' perception of lighting for approach-avoidance intention by observing from outside the cubicle with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Responses using the bipolar adjectives, "approach or avoid," on a seven point Likert-type scale were used to assess room approach for the four different lighting conditions (730, 750, 930, and 950) when observed from outside the lighted environment. Table 41 shows the mean and standard deviation scores for main effects, two-way interactions, and a three-way interaction of subject's perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 42. Regarding color temperature (K) as a main effect, there was statistical significance at $p = .000$ with an F ratio of 19.97. Thus, Hypothesis 16c was rejected. Although the main effect of color temperature reached statistical significance, it was of little interest because a significant two-way interaction of culture by CT was obtained $F(1, 288) = 4.02$, $p = .046$. Therefore, Hypothesis 16e was rejected.

To assess the significance of such a finding, analysis of the simple effects was conducted. The outcomes are presented in Figure 12 and Table 43. As can be seen in Fig.12, Korean subjects (M = 3.20) perceived the higher color rendering index of 5000 K as more approachable than American subjects (M = 3.68) regardless of the color rendering index differences. Korean subjects perceived the higher color temperature of 5000 K (M = 3.20) as more approachable than the lower color temperature of 3000 K (M = 4.14) regardless of color rendering indices.

There was no significant difference in subjects' perception of approach-avoidance intention with regard to the culture group and the color rendering index (CRI) as a main effect. Thus, Hypotheses 16a and 16b were not rejected. Culture by CRI and CRI by CT as a two-way interaction and culture by CRI by CT as a three-way interaction were not significant at the $p = .05$ level. Thus, Hypotheses 16d, 16f, and 16g were not rejected.

Table 41

Mean and Standard Deviation Scores for Subjects' Perception of Lighting for Approach-avoidance Intention[1] When Observed from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	196	3.86	1.56	
Korean	196	3.67	1.43	
Color Rendering Index				N.S.
75 CRI	196	3.85	1.56	
95 CRI	196	3.68	1.44	
Color Temperatures				0.000
3000 K	196	4.09	1.48	
5000 K	196	3.44	1.45	
Culture by CRI				N.S.
American x 75 CRI	98	4.08	1.52	
American x 95 CRI	98	3.64	1.57	
Korean x 75 CRI	98	3.62	1.56	
Korean x 95 CRI	98	3.72	1.30	
Culture by CT				0.046
American x 3000 K	98	4.04	1.60	
American x 5000 K	98	3.68	1.50	
Korean x 3000 K	98	4.14	1.35	
Korean x 5000 K	98	3.20	1.37	
CRI by CT				N.S.
75 CRI x 3000 K	98	4.22	1.60	
75 CRI x 5000 K	98	3.48	1.42	
95 CRI x 3000 K	98	3.96	1.34	
95 CRI x 5000 K	98	3.41	1.48	
Culture by CRI x CT				N.S.
American x 75 CRI x 3000 K	49	4.31	1.69	
American x 75 CRI x 5000 K	49	3.86	1.32	
American x 95 CRI x 3000 K	49	3.78	1.49	
American x 95 CRI x 5000 K	49	3.51	1.65	
Korean x 75 CRI x 3000 K	49	4.14	1.53	
Korean x 75 CRI x 5000 K	49	3.10	1.43	
Korean x 95 CRI x 3000 K	49	4.14	1.15	
Korean x 95 CRI x 5000 K	49	3.31	1.31	

[1]. 7 point Likert-type scale: 1 = approach and 7 = avoid
Note. N.S = not significant at $p < .05$ (see ANOVA results in the next table).

Table 42

Analysis of Variance for Subjects' Perception of Lighting for Approach-avoidance Intention When Observed from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	3.49	3.49	1.52	0.221
Between Error	96	220.63	2.30		
CRI	1	2.78	2.78	1.35	0.247
CT	1	41.15	41.15	19.97	0.000***
Culture x CRI	1	7.17	7.17	3.48	0.063
Culture x CT	1	8.29	8.29	4.02	0.046*
CRI x CT	1	0.92	0.92	0.45	0.504
Culture x CRI x CT	1	0.00	0.00	0.00	0.972
Within Error	288	593.45	2.06		

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

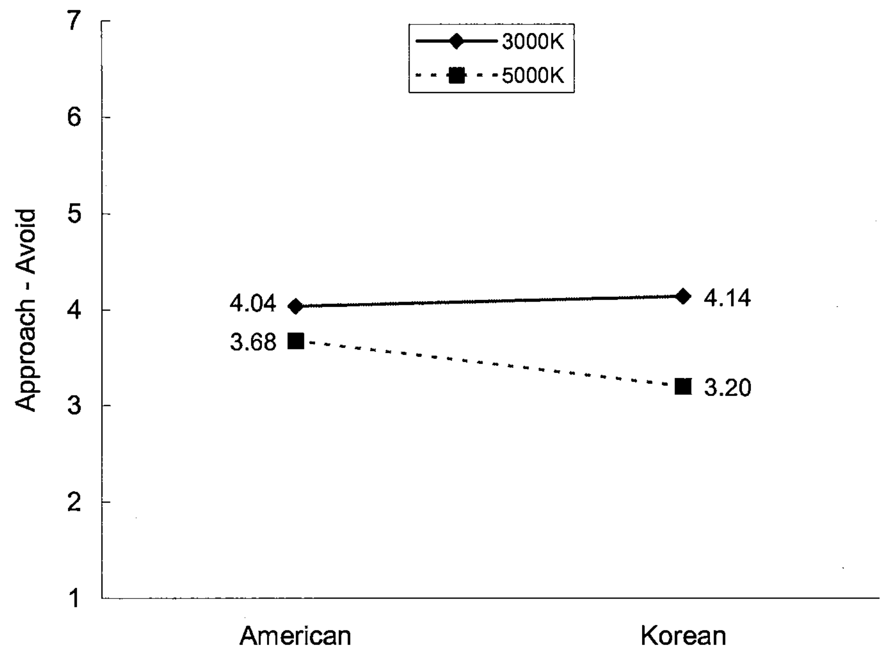


Figure 12. Two-Way Interaction of Culture by CT for Subjects' Perception of Lighting for Approach-avoidance Intention When Observed from Outside the Lighted Environment

Table 43

Analysis of Simple Effects (Culture x CT) for Subjects' Perception of Lighting for Approach-avoidance Intention When Observed from Outside the Lighted Environment

	1 [American x 3000 K]	2 [American x 5000 K]	3 [Korean x 3000 K]	4 [Korean x 5000 K]
1				
2	1.74 (0.0826)			
3	-0.50 (0.6191)	-2.24* (0.0259)		
4	4.08*** (0.0001)	2.34* (0.0200)	4.58*** (0.0001)	

Note. Numeric value in parenthesis "( )" indicates p-value
*p < .05. **p < .01. ***p < .001

Hypothesis 17. There is no difference in the subjects' overall lighting preference by observing from outside the cubicle with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Responses using the bipolar adjectives, "like or dislike," on a seven point Likert-type scale were used to assess the subjects' overall lighting preferences for the four different lighting conditions (730, 750, 930, and 950) when observed from outside the lighted environment. Table 44 shows the mean and standard deviation scores for main effects, two-way interactions, and a three-way interaction of subject's perception of lighting.

Table 45 shows the results of analysis of variance (ANOVA) for subjects' overall lighting preferences. Color rendering index (CRI) as a main effect was significant with an F (1, 288) = 15.58, p = .000. All participants preferred the higher color rendering index of 95 CRI (M = 3.14) more than the lower color rendering index of 75 CRI (M = 3.72) regardless of the culture group and color temperature differences. Therefore, Hypothesis 17b was rejected.

For the measure of the subjects' overall lighting preference, a significant two-way interaction of culture by CT was obtained, F (1, 288) = 4.84, p = .029. Therefore, Hypothesis 17e was rejected. To assess the significance of such a finding, analysis of the simple effects was conducted. The outcomes are presented in Figure 13 and Table 46. As can be seen in Fig.13, Korean subjects (M = 3.07) preferred the lower color temperature of 3000 K more than American subjects (M = 3.60) did. And also the Korean subjects preferred the lower color temperature of 3000 K (M = 3.07) more than the higher color temperature of 5000 K (M = 3.58).

There was no significant difference in the subjects' overall lighting preference with regard to the culture group and the color temperature (CT) of fluorescent light. the Hypotheses 17a and 17c were not rejected. Culture by CRI and CRI by CT as a two-way interaction and culture by CRI by CT as a three-way interaction were not statistically significant. Thus, Hypotheses 17d, 17f, and 17g were not rejected.

Table 44

Mean and Standard Deviation Scores for Subjects' Overall Lighting Preference[1] When Observed from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	196	3.54	1.56	
Korean	196	3.33	1.43	
Color Rendering Index				0.000
75 CRI	196	3.72	1.60	
95 CRI	196	3.14	1.33	
Color Temperatures				N.S.
3000 K	196	3.34	1.47	
5000 K	196	3.53	1.52	
Culture by CRI				N.S.
American x 75 CRI	98	3.96	1.64	
American x 95 CRI	98	3.11	1.37	
Korean x 75 CRI	98	3.48	1.54	
Korean x 95 CRI	98	3.17	1.29	
Culture by CT				0.029
American x 3000 K	98	3.60	1.52	
American x 5000 K	98	3.47	1.61	
Korean x 3000 K	98	3.07	1.38	
Korean x 5000 K	98	3.58	1.44	
CRI by CT				N.S.
75 CRI x 3000 K	98	3.58	1.64	
75 CRI x 5000 K	98	3.86	1.56	
95 CRI x 3000 K	98	3.09	1.24	
95 CRI x 5000 K	98	3.19	1.41	
Culture by CRI x CT				N.S.
American x 75 CRI x 3000 K	49	4.04	1.66	
American x 75 CRI x 5000 K	49	3.88	1.63	
American x 95 CRI x 3000 K	49	3.16	1.25	
American x 95 CRI x 5000 K	49	3.06	1.49	
Korean x 75 CRI x 3000 K	49	3.12	1.51	
Korean x 75 CRI x 5000 K	49	3.84	1.50	
Korean x 95 CRI x 3000 K	49	3.02	1.25	
Korean x 95 CRI x 5000 K	49	3.33	1.33	

[1]. 7 point Likert-type scale: 1 = like and 7 = dislike

Note. N.S = not significant at $p < .05$ (see ANOVA results in the next table).

Table 45

Analysis of Variance for Subjects' Overall Lighting Preference When Observed from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	4.29	4.29	1.91	0.170
Between Error	96	215.60	2.25		
CRI	1	32.57	32.57	15.56	0.000***
CT	1	3.49	3.49	1.67	0.198
Culture x CRI	1	7.17	7.17	3.42	0.065
Culture x CT	1	10.13	10.13	4.84	0.029*
CRI x CT	1	0.74	0.74	0.35	0.553
Culture x CRI x CT	1	1.35	1.35	0.64	0.426
Within Error	288	602.81	2.09		

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

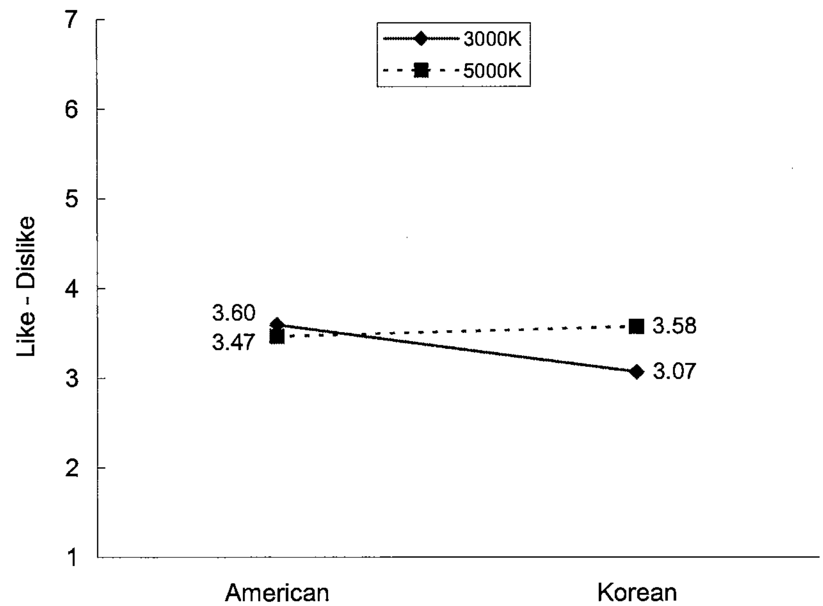


Figure 13. Two-Way Interaction of Culture by CT for Subjects' Overall Lighting Preference When Observed from Outside the Lighted Environment

Table 46

Analysis of Simple Effects (Culture x CT) for Subjects' Overall Lighting Preference When Observed from Outside the Lighted Environment

	1 [American x 3000 K]	2 [American x 5000 K]	3 [Korean x 3000 K]	4 [Korean x 5000 K]
1				
2	0.64 (0.5215)			
3	2.57* (0.0108)	1.93 (0.0552)		
4	0.10 (0.9214)	-0.54 (0.5875)	-2.47* (0.0141)	

Note. Numeric value in parenthesis "( )" indicates p-value
*$p < .05$. **$p < .01$. ***$p < .001$

Hypothesis 18. There is no difference in the subjects' impression of the light color by observing from outside the cubicle with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)

To investigate the impression of the light color according to the important variables of culture, color rendering index, and color temperature, the hypothesis 18 was tested. For this test, the subjects were asked to evaluate the color of the light from outside the cubicles associating six names of colors including reddish, orangish, yellowish, greenish, bluish, and whitish. For this test, chi-square analysis was conducted.

The results of the analysis for this measure are shown in Table 47. The color temperature (3000 K and 5000 K) was statistically significant at $\chi^2 = 242$, $p = 0.0001$. Most subjects described the lower color temperature of 3000 K as warm colors, orangish (n: 80, 20.4 %) and yellowish (n: 74, 18.9 %). However, the higher color temperature of 5000 K was estimated as cool colors, bluish (n: 58, 14.8 %) and whitish (n: 108, 27.6 %). The graph of the subjects' impression of the color of the light on color temperature is illustrated in Figure 14. As it can be seen in Figure 14, the color temperatures between 3000 K and 5000 K have a significant impact on the subjects' impression of the color of the light when observed from outside the lighted environment. Thus, Hypothesis 18c was rejected.

There was no statistical significance for culture group and color rendering index on the subjects' impression of the color of the light. Although most subjects perceived the color of the light as being orangish, yellowish, bluish, and whitish, there were very little differences in culture group between Americans and Koreans and in color rendering indices between 75 CRI and 95 CRI. Therefore, Hypotheses 18a and 18b were not rejected.

Table 47

Chi-square Analysis of Subjects' Impression of the Light Color When Observed from Outside the Lighted Environment

Possible color choices of the light	Culture group				Color Rendering Index				Color Temperature			
	American		Korean		75 CRI		95 CRI		3000 K		5000 K	
	n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
Reddish	9	(2.3)	12	(3.1)	8	(2.0)	13	(3.3)	19	(4.9)	2	(0.5)
Orangish	39	(10.0)	44	(11.2)	48	(12.2)	35	(8.9)	80	(20.4)	3	(0.8)
Yellowish	39	(10.0)	50	(12.8)	37	(9.4)	52	(13.5)	74	(18.9)	15	(3.8)
Greenish	9	(2.3)	3	(0.8)	6	(1.5)	6	(1.5)	2	(0.5)	10	(2.6)
Bluish	40	(10.2)	27	(6.9)	40	(10.2)	27	(6.9)	9	(2.3)	58	(14.8)
Whitish	60	(15.3)	60	(15.3)	57	(14.5)	63	(16.1)	12	(3.1)	108	(27.6)
Total Subjects [b]	196		196		196		196		196		196	
χ^2	7.61				8.58				242.28			
p	0.1790				0.1272				0.0001***			

[a] % based on 196 observations for each main effect.
[b] Total subject: 49 in American group and 49 in Korean group. Repeated measures designs yield four observations per person, thus a total of 392 observations.
* $p < .05$. ** $p < .01$. *** $p < .001$.

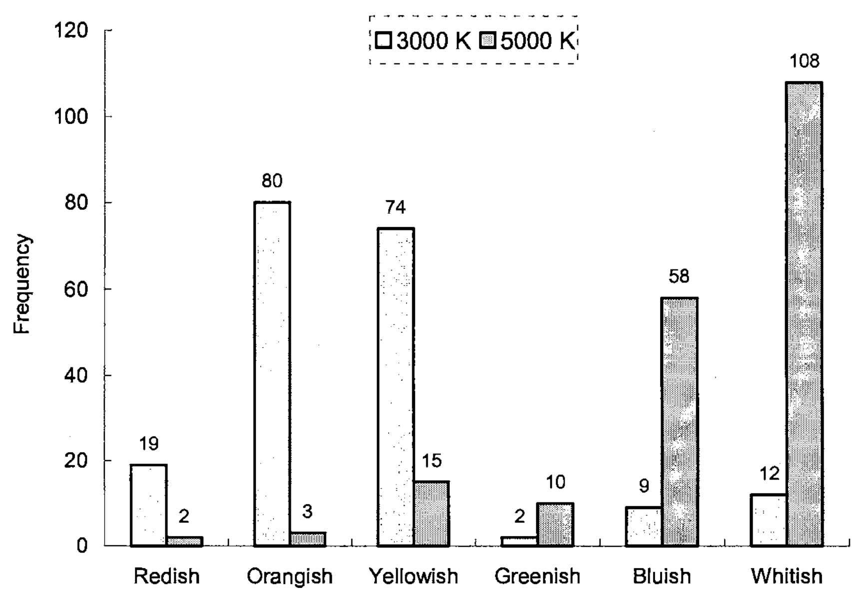


Figure 14. A Graph of the Subjects' Impression of the Light Color on Color Temperature When Observed from Outside the Lighted Environment

Hypothesis 19. There is no difference in the subjects' preference of the light color by observing from outside the cubicle with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Responses using the bipolar adjectives, "like or dislike," on a seven point Likert-type scale were used to assess the subjects' preference of the light color for the four different lighting conditions (730, 750, 930, and 950) when observed from outside the lighted environment. Table 48 shows the mean and standard deviation scores for main effects, two-way interactions, and a three-way interaction of subject's perception of lighting.

Table 49 shows the results of analysis of variance (ANOVA) for subjects' preferences of the color of the light. Color rendering index (CRI) as a main effect was significant at F (1,288) = 8.07, p = .005. All participants preferred the higher color rendering index of 95 CRI (M = 3.47) more for the color of the light than the lower color rendering index of 75 CRI (M = 3.90) regardless of the culture group and color temperature differences. Therefore, Hypothesis 19b was rejected.

There were no significant differences in preferences of the color of the light with regard to culture group and the color temperature (CT) of fluorescent light as a main effect. Thus, Hypothesis 19a and 19c were not rejected. Culture by CRI, Culture by CT, and CRI by CT as a two-way interaction and culture by CRI by CT as a three-way interaction were not significant for the preference of the color of the light at the p = .05 level. Therefore, Hypotheses 19d, 19e, 19f, and 19g were not rejected.

Table 48

Mean and Standard Deviation Scores for Subjects' Preference of the Light Color[1] When Observed from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	196	3.68	1.62	
Korean	196	3.70	1.43	
Color Rendering Index				0.005
75 CRI	196	3.90	1.55	
95 CRI	196	3.47	1.47	
Color Temperatures				N.S.
3000 K	196	3.77	1.53	
5000 K	196	3.61	1.52	
Culture by CRI				N.S.
American x 75 CRI	98	3.97	1.60	
American x 95 CRI	98	3.39	1.59	
Korean x 75 CRI	98	3.84	1.50	
Korean x 95 CRI	98	3.56	1.35	
Culture by CT				N.S.
American x 3000 K	98	3.66	1.62	
American x 5000 K	98	3.69	1.63	
Korean x 3000 K	98	3.87	1.44	
Korean x 5000 K	98	3.53	1.41	
CRI by CT				N.S.
75 CRI x 3000 K	98	3.89	1.62	
75 CRI x 5000 K	98	3.92	1.48	
95 CRI x 3000 K	98	3.64	1.43	
95 CRI x 5000 K	98	3.31	1.50	
Culture by CRI x CT				N.S.
American x 75 CRI x 3000 K	49	3.88	1.68	
American x 75 CRI x 5000 K	49	4.06	1.53	
American x 95 CRI x 3000 K	49	3.45	1.54	
American x 95 CRI x 5000 K	49	3.33	1.65	
Korean x 75 CRI x 3000 K	49	3.90	1.58	
Korean x 75 CRI x 5000 K	49	3.78	1.43	
Korean x 95 CRI x 3000 K	49	3.84	1.30	
Korean x 95 CRI x 5000 K	49	3.29	1.35	

[1]. 7 point Likert-type scale: 1 = like and 7 = dislike
Note. N.S = not significant at $p < .05$ (see ANOVA results in the next table).

Table 49

Analysis of Variance for Subjects' Preference of the Light Color When Observed from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	0.04	0.04	0.02	0.898
Between Error	96	238.49	2.48		
CRI	1	18.00	18.00	8.07	0.005**
CT	1	2.30	2.30	1.03	0.311
Culture x CRI	1	2.30	2.30	1.03	0.311
Culture x CT	1	3.31	3.31	1.48	0.224
CRI x CT	1	3.31	3.31	1.48	0.224
Culture x CRI x CT	1	0.09	0.09	0.04	0.839
Within Error	288	642.20	2.23		

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

Hypothesis 20. There is no difference in the subjects' perception of fruit color as being natural or unnatural by observing from outside the cubicle with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)
d) two-way interaction of CRI by CT
e) two-way interaction of culture by CRI
f) two-way interaction of culture by CT
g) three-way interaction of culture by CRI by CT

Responses using the bipolar adjectives, "natural or not natural," on a seven point Likert-type scale were used to assess the subjects' preference of fruit color for the four different lighting conditions (730, 750, 930, and 950) when observed from outside the lighted environment. Table 50 shows the mean and standard deviation scores for main effects, two-way interactions, and a three-way interaction of subject's perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 51. Color rendering index (CRI) as a main effect was significant at F (1,288) = 10.29, p = .002. All participants perceived the fruit color as more natural under the higher color rendering index of 95 CRI (M = 3.36) than under the lower color rendering index of 75 CRI (M = 3.84) regardless of culture group and color temperature differences. Therefore, Hypothesis 20b was rejected.

There were no significant differences in subjects' perception of fruit color with regard to culture group and the color temperature (CT) of fluorescent light as a main effect. Thus, Hypothesis 20a and 20c were not rejected. Culture by CRI, Culture by CT, and CRI by CT as a two-way interaction and culture by CRI by CT as a three-way interaction were not significant for the subjects' perception of fruit color at the p = .05 level. Therefore, Hypotheses 20d, 20e, 20f, and 20g were not rejected.

Table 50

Mean and Standard Deviation Scores for Subjects' Perception of Fruit Color[1] When Observed from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	196	3.61	1.59	
Korean	196	3.59	1.47	
Color Rendering Index				0.002
75 CRI	196	3.84	1.55	
95 CRI	196	3.36	1.47	
Color Temperatures				N.S
3000 K	196	3.62	1.51	
5000 K	196	3.58	1.55	
Culture by CRI				N.S
American x 75 CRI	98	3.91	1.64	
American x 95 CRI	98	3.32	1.49	
Korean x 75 CRI	98	3.77	1.46	
Korean x 95 CRI	98	3.41	1.46	
Culture by CT				N.S
American x 3000 K	98	3.66	1.53	
American x 5000 K	98	3.56	1.66	
Korean x 3000 K	98	3.57	1.51	
Korean x 5000 K	98	3.60	1.43	
CRI by CT				N.S
75 CRI x 3000 K	98	3.82	1.56	
75 CRI x 5000 K	98	3.86	1.55	
95 CRI x 3000 K	98	3.42	1.45	
95 CRI x 5000 K	98	3.31	1.50	
Culture by CRI x CT				N.S
American x 75 CRI x 3000 K	49	3.86	1.65	
American x 75 CRI x 5000 K	49	3.96	1.65	
American x 95 CRI x 3000 K	49	3.47	1.39	
American x 95 CRI x 5000 K	49	3.16	1.59	
Korean x 75 CRI x 3000 K	49	3.78	1.48	
Korean x 75 CRI x 5000 K	49	3.76	1.45	
Korean x 95 CRI x 3000 K	49	3.37	1.52	
Korean x 95 CRI x 5000 K	49	3.45	1.42	

[1]. 7 point Likert-type scale: 1 = natural and 7 = not natural
Note. N.S = not significant at $p < .05$ (see ANOVA results in the next table).

Table 51

Analysis of Variance for Subjects' Perception of Fruit Color When Observed from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	0.06	0.06	0.02	0.880
Between Error	96	268.31	2.79		
CRI	1	22.06	22.06	10.29	0.002**
CT	1	0.13	0.13	0.06	0.809
Culture x CRI	1	1.35	1.35	0.63	0.428
Culture x CT	1	0.43	0.43	0.20	0.654
CRI x CT	1	0.57	0.57	0.27	0.605
Culture x CRI x CT	1	1.59	1.59	0.74	0.389
Within Error	288	617.61	2.14		

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

Hypothesis 21. There is no difference in the subjects' color perception for five different kinds of fruit when observed from outside the lighted environment with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) color temperature of fluorescent light (3000 K and 5000 K)

To identify the subjects' color perception of natural objects under the four different lighting conditions, the colors of five different kinds of fruit in a bowl was tested by observing from the outside of the cubicles. The five fruits were apple, orange, banana, lemon, and grape. For this measure, Chi-square analysis was conducted.

The results of the analysis are shown in Table 52. The variable of culture group (American and Korean) was statistically significant for the orange color perception ($\chi^2 = 13.2182$, $p = 0.0003$). Although most of the respondents described orange color as being not distorted from its natural color, a greater proportion of difference showed between the Americans and Koreans for the orange color perception. Forty (10.2%) American subjects of 196 responded to the orange color as being distorted, while only fifteen (3.8%) Korean subjects perceived the orange color as being distorted. Therefore, Hypothesis 25a was rejected.

There was no statistical significance for the variables of color temperature and color rendering index on subjects' color perception for five fruits as being distorted or not distorted when each of the four different lighting conditions was observed from outside the lighted environment. The percentage of the subjects' perception of five fruit color shows very little difference between the two different color rendering indices and color temperatures. Therefore, Hypotheses 25b and 25c were not rejected.

Table 52

Chi-square Analysis of Subjects' Perception of Fruit Color as Being Distorted or Not Distorted When Observed from Outside the Lighted Environment

Variable		Culture group		Color Rendering Index		Color Temperature	
		American	Korean	75 CRI	95 CRI	3000 K	5000 K
		n (%)[a]	n (%)[a]	n (%)[a]	n (%)[a]	n (%)[a]	n (%)[a]
Apple	Distorted	42 (10.7)	47 (12.0)	38 (9.7)	51 (13.0)	42 (10.7)	47 (12.0)
	Not Distorted	154 (39.3)	149 (38.0)	158 (40.3)	145 (37.0)	154 (39.3)	149 (38.0)
	χ^2	0.36		2.46		0.36	
	p	0.5466		0.1170		0.5466	
Orange	Distorted	40 (10.2)	15 (3.8)	28 (7.1)	27 (6.9)	29 (7.4)	26 (6.6)
	Not Distorted	156 (39.8)	181 (46.2)	168 (42.9)	169 (43.1)	167 (42.6)	170 (43.4)
	χ^2	13.22		0.02		0.19	
	p	0.0003***		0.8844		0.6626	
Banana	Distorted	39 (10.0)	42 (10.7)	46 (11.7)	35 (8.9)	43 (11.0)	38 (9.7)
	Not Distorted	157 (40.1)	154 (39.3)	150 (38.3)	161 (41.1)	153 (39.0)	158 (40.3)
	χ^2	0.14		1.88		0.39	
	p	0.7082		0.1700		0.5328	
Lemon	Distorted	51 (13.0)	38 (9.7)	49 (12.5)	40 (10.2)	48 (12.2)	41 (10.5)
	Not Distorted	145 (37.0)	158 (40.3)	147 (37.5)	156 (39.8)	148 (37.8)	155 (38.5)
	χ^2	2.46		1.18		0.71	
	p	0.1170		0.2779		0.3987	
Grape	Distorted	56 (14.3)	67 (17.1)	57 (14.5)	66 (16.8)	65 (16.6)	58 (14.8)
	Not Distorted	140 (35.7)	129 (32.9)	139 (35.5)	130 (33.2)	131 (33.4)	138 (35.2)
	χ^2	1.43		0.96		0.58	
	p	0.2312		0.3273		0.4461	
Total Subjects [b]		196	196	196	196	196	196

[a] % based on 196 observations for each main effect.
[b] Total subjects: 49 in American group and 49 in Korean group. Repeated measures designs yield four observations per person, thus a total of 392 observations.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Hypothesis 22. There is no difference in the subjects' ability to match and designate product colors with regard to culture, color rendering index, and color temperature for T-shirts dyed

a) red
b) yellow
c) blue
d) purple blue

To investigate the difference in the ability to match color under the four different lighting conditions when each of the four different lighting conditions was observed from outside the lighted environment, the four hues from the Munsell' color system were tested using the four different color T-shirts. The four Munsell hues of the T-shirts were 5R 4/14 for the red shirt, 5Y 8.5/14 for the yellow shirt, 5B 5/10 for the blue shirt, and 5PB 5/10 for purple blue shirt.

To measure this hypothesis, the subjects were asked to match and designate the color of the shirts using four color cards. Four color cards were designed by the researcher based on the New Munsell Student Color Set by adding more Munsell color chips from the Munsell Book of Color in order to provide various color choices. Therefore, each of the four color cards had fourteen color chips in relation to hue, value and chroma. Chi-square analysis was conducted to test color match and designation of individuals with two different culture groups under four different lighting conditions for four different color T-shirts.

The results of the chi-square analysis for the red shirt (Munsell Hue 5R 4/14) are shown in Table 53. Only six observations in both culture groups described the red shirt as its original color (Munsell Hue 5R 4/14) under all lighting conditions. Color temperatures (3000K and 5000K) were statistically significant ($\chi^2 = 42.8389$, $p = 0.0001$) on the color matching of the red shirt. More than 90% of the subjects perceived and matched the red T-shirt (Munsell Hue 5R 4/14) as 5/14 (5R 5/14), 6/14 (7.5R 5/16) and 7/14 (7.5R 5/14) under both color temperatures of lighting conditions.

For the Munsell hue of 5/14 (5R 5/14) in color temperature, 30 (7.7%) of the 196 subjects designated the red shirt under 5000 K, while 10 (2.6%) of 196 subjects designated the red shirt under 3000 K. For the Munsell hue of 6/14 (7.5R 5/16), 86 (21.9 %) of the 196 observations designated it under 3000 K, while 37 (9.4%) of the 196 observations designated it under 5000 K.

For the Munsell hue of 7/14 (7.5R 5/14), 108 (27.6 %) of the 196 observations designated it under 5000 K, while 90 (23.0%) of the 196 observations designated it under 3000 K. More than 50% (198 of 392) of the subjects matched the red shirt (Munsell 5R 4/14) to 7/14 (7.5R 5/14) as the best color description.

The results of the red T-shirt designation regarding the variable of color temperature show that there are hue, value, and chroma shift perceived according to color temperature differences. Under the lower color temperature (3000 K), a greater proportion of the subjects indicated a trend of hue, value and chroma. Hue shifted from 5R to 7.5R, which is toward the yellow red portion of the Munsell color wheel. Value increased from 4 to 5 and chroma increased from 14 to 16. In other words, under the lower color temperature (3000 K), the perception of the red shirt changed slightly toward higher hue, lighter value, and stronger chroma than its original red.

Under the higher color temperature (5000 K), a greater proportion of the subjects indicated a trend of hue and value. Hue shift showed from 5R to 7.5R on 7.5R 5/14 which is toward the yellow red portion of the Munsell color wheel. Value increased from 4 to 5 for both 5R 5/14 and 7.5R 5/14. In other words, the perception of the red shirt changed slightly toward higher hue and lighter value than its original red under the higher color temperature (5000 K). There was no chroma change perceived unlike the lower color temperature of 3000 K.

Regarding the variable of culture group, there was no significant difference for the perception of the red shirt (Munsell Hue 5R 4/14). Although the differences are not significant, a greater proportion of the American subjects (n: 108, 27.6 %) designated the red shirt as 7/14 (7.5R 5/14) than Korean subjects (n: 90, 23 %). A greater proportion of the Korean subjects (n: 72, 18.4 %) designated the red shirt as 6/14 (7.5R 5/16) than American subjects (n: 51, 13 %).

Color rendering index did not have a significant impact on perception of the red shirt (Munsell 5R 4/14). However, 109 (27.8%) of the 196 observations designated 7/14 (7.5R 5/14) as the best color description for the red shirt under the higher color rendering index (95 CRI) whereas 89 (22.6 %) of the 196 observations designated the red shirt as 7/14 (Pantone 185C) under the lower color rendering index (75 CRI).

Table 53

Chi-square Analysis for the Color Designation of the Red Shirt When Observed from Outside the Lighted Environment

Original Research Color Chip Designation in Card A	Munsell Designation for All Possible Red Choices	Culture				Color Rendering Index				Color Temperature			
		American		Korean		75 CRI		95 CRI		3000 K		5000 K	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
3/12	2.5R 5/10	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
3/14	2.5R 4/14	2	(0.5)	0	(0)	1	(0.3)	1	(0.3)	0	(0)	2	(0.5)
4/10	5R 4/10	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
4/12	5R 4/12	0	(0)	2	(0.5)	1	(0.3)	1	(0.3)	0	(0)	2	(0.5)
<u>4/14</u>	<u>5R 4/14</u>	3	(0.8)	3	(0.8)	2	(0.5)	4	(1.0)	2	(0.5)	4	(1.0)
5/10	5R 5/10	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
5/12	5R 5/12	3	(0.8)	0	(0)	3	(0.8)	0	(0)	1	(0.3)	2	(0.5)
5/14	5R 5/14	17	(4.3)	23	(5.9)	22	(5.6)	18	(4.6)	10	(2.6)	30	(7.7)
6/10	5R 6/10	1	(0.3)	0	(0)	0	(0)	1	(0.3)	0	(0)	1	(0.3)
6/12	5R 6/12	4	(1.0)	4	(1.0)	6	(1.5)	2	(0.5)	5	(1.3)	3	(0.8)
6/14	7.5R 5/16	51	(13.0)	72	(18.4)	68	(17.4)	55	(14.0)	86	(21.9)	37	(9.4)
7/10	5R 7/10	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
7/12	2.5R 6/12	7	(1.8)	2	(0.5)	4	(1.0)	5	(1.3)	2	(0.5)	7	(1.8)
7/14	7.5R 5/14	108	(27.6)	90	(23.0)	89	(22.7)	109	(27.8)	90	(23.0)	108	(27.6)
Total Subjects [b]		196		196		196		196		196		196	
χ^2		16.92				12.20				42.84			
p		0.0762				0.2716				0.0001***			

Note. Underlined Munsell Designation, "___", indicates the "true" color match for the shirt under natural light, thus, no color distortion of the shirt.
[a] % based on 196 observations for each main effect.
[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measured design yields four observations per person, thus a total of 392 observations.
* $p < .05$. ** $p < .01$. *** $p < .001$.

The results of chi-square analysis for the color matching and designation to the blue shirt (5/10, Munsell 5B 5/10) are shown in Table 54. All three variables have a significant impact on perception of the blue shirt. Culture group (American and Korean) was statistically significant (χ^2 = 28.23, p = 0.0051) for the blue shirt. The most frequent color chips designated by both the American and Korean subjects were 5/10 (Munsell 5B 5/10), 6/8 (Munsell 5B 6/8), 6/10 (Munsell 5B 6/10), and 7/10 (Munsell 7.5B 7/8) regardless of the different lighting conditions.

For the color chip of 5/10 (Munsell 5B 5/10), the original color of the blue shirt, 45 (11.5%) of 196 Korean subjects designated it likewise, while 32 (8.2%) of 196 American subjects designated it likewise. For the color chip of 6/8 (Munsell 5B 6/8), 26 (6.6%) of 196 American subjects designated the blue shirt, while 17 (4.3%) of 196 Korean subjects designated it. For the color chip of 6/10 (Munsell 5B 6/10), 49 (12.5%) of 196 Korean subjects designated the blue shirt, while 43 (11.0%) of 196 American subjects designated it.

For the color chip of 7/10 (Munsell 7.5B 7/8), 58 (14.8%) of 196 American subjects designated the blue shirt, while 44 (11.2%) of 196 Korean subjects designated it. These results of the blue shirt designation indicate that the Korean subjects perceived the blue shirt as its original color or closer to the original color of the blue shirt, whereas the American subjects perceived the blue shirt as a different hue, value, and chroma regardless of the different lighting conditions.

Color rendering index was also significant for the blue shirt (χ^2 = 37.38, p = 0.0002). The most frequent color chips selected under the color rendering indices were 5/10 (Munsell 5B 5/10), 6/8 (Munsell 5B 6/8), 6/10 (Munsell 5B 6/10), 7/8 (Munsell 5B 7/8), 7/10 (Munsell 7.5B 7/8), and 8/8 (10BG 7/8). For the color chip of 5/10 (Munsell 5B 5/10), the original color of the blue shirt, 46 (11.7%) of 196 subjects in both culture groups designated the blue shirt under 95 CRI, while 31 (7.9%) of 196 observations designated it under 75 CRI.

For the color chip of 6/8 (Munsell 5B 6/8), 27 (6.9%) of 196 subjects designated the blue shirt under 75 CRI, while 16 (4.1%) of 196 observations designated it under 95 CRI. For the color chip of 6/10 (Munsell 5B 6/10), 58 (14.8%) of 196 subjects designated the blue shirt under 95 CRI, while 34 (8.7%) of 196 observations designated it under 75 CRI. For the color chip of 7/8

(Munsell 5B 7/8), 17 (4.3%) of 196 subjects designated the blue shirt under 75 CRI, while 10 (2.6%) of 196 observations designated it under 95 CRI. For the color chip of 7/10 (Munsell 7.5B 7/8), 64 (16.3%) of 196 subjects designated the blue shirt under 75 CRI, while 38 (9.7%) of 196 observations designated it under 95 CRI.

For the color chip of 8/8 (Munsell 10BG 7/8), 13 (3.3%) of 196 subjects designated the blue shirt under 95 CRI, while 3 (0.8%) of 196 observations designated it under 75 CRI. These results of the blue shirt designation indicate that there are hue, value, and chroma changes according to color rendering index differences. Under the lower color rendering index (75 CRI), the value changed to light, and chroma decreased to weak, while chroma increased to vivid and strong under 95 CRI.

Color temperature (3000 K and 5000 K) had a significant impact ($\chi^2 = 111.03$, $\underline{p} = 0.0001$) on the subjects' perception of the blue shirt (5/10, Munsell 5B 5/10). The results of the blue shirt designation indicate significant differences between 3000 K and 5000 K for 4/10 (Munsell 2.5B 5/10), 5/10 (Munsell 5B 5/10), 6/6 (Munsell 5B 6/6), 6/8 (Munsell 5B 6/8), 6/10 (Munsell 5B 6/10), 7/6 (Munsell 5B 7/6), 7/8 (Munsell 5B 7/8), 7/10 (Munsell 7.5B 7/8), and 8/8 (Munsell 10BG 7/8).

Under the lower color temperature (3000 K), a greater proportion of the subjects in both groups designated the blue shirt as 4/10 (Munsell 2.5B 5/10), 6/6 (Munsell 5B 6/6), 6/8 (Munsell 5B 6/8), 6/10 (Munsell 5B 6/10), 7/6 (Munsell 5B 7/6), 7/8 (Munsell 5B 7/8), and 8/8 (Munsell 10BG 7/8). Under the higher color temperature (5000 K), a greater proportion of subjects in both groups designated the blue shirt as 5/10 (Munsell 5B 5/10) and 7/10 (Munsell 7.5B 7/8).

These results of the blue shirt designation indicate that there are hue, value, and chroma changes according to color temperature differences. The hue was perceived to shift for the blue shirt toward the blue green sector, the value increased to light, and chroma decreased to weak under 3000 K. However, under 5000 K, the subjects in both groups perceived the blue shirt as its original color and as having a different hue which is toward the purple blue sector.

Table 54

Chi-square Analysis for the Color Designation of the Blue Shirt When Observed from Outside the Lighted Environment

Original Research Color Chip Designation in Card B	Munsell Designation for All Possible Blue Choices	**Culture**				**Color Rendering Index**				**Color Temperature**			
		American		Korean		75 CRI		95 CRI		3000 K		5000 K	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
4/6	5B 4/6	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
4/8	10BG 5/10	2	(0.5)	0	(0)	0	(0)	2	(0.5)	1	(0.3)	1	(0.3)
4/10	2.5B 5/10	0	(0)	7	(1.8)	4	(1.0)	3	(0.8)	7	(1.8)	0	(0)
5/6	5B 5/6	0	(0)	1	(0.3)	1	(0.3)	0	(0)	1	(0.3)	0	(0)
5/8	5B 5/8	1	(0.3)	5	(1.3)	2	(0.5)	4	(1.0)	5	(1.3)	1	(0.3)
<u>5/10</u>	<u>5B 5/10</u>	32	(8.2)	45	(11.5)	31	(7.9)	46	(11.7)	34	(8.7)	43	(11.0)
6/6	5B 6/6	8	(2.0)	2	(0.5)	8	(2.0)	2	(0.5)	9	(2.3)	1	(0.3)
6/8	5B 6/8	26	(6.6)	17	(4.3)	27	(6.9)	16	(4.1)	24	(6.1)	19	(4.9)
6/10	5B 6/10	43	(11.0)	49	(12.5)	34	(8.7)	58	(14.8)	61	(15.6)	31	(7.9)
7/6	5B 7/6	5	(1.3)	2	(0.5)	5	(1.3)	2	(0.5)	7	(1.8)	0	(0)
7/8	5B 7/8	14	(3.6)	13	(3.3)	17	(4.3)	10	(2.6)	16	(4.1)	11	(2.8)
7/10	7.5B 7/8	58	(14.8)	44	(11.2)	64	(16.3)	38	(9.7)	13	(3.3)	89	(22.7)
8/6	10BG 7/6	2	(0.5)	0	(0)	0	(0))	2	(0.5)	2	(0.5)	0	(0)
8/8	10BG 7/8	5	(1.3)	11	(2.8)	3	(0.8)	13	(3.3)	16	(4.1)	0	(0)
Total Subjects [b]		196		196		196		196		196		196	
χ^2		28.23				37.38				111.03			
p		0.0051**				0.0002***				0.0001***			

Note. Underlined Munsell Designation, "___", indicates the "true" color match for the shirt under natural light, thus, no color distortion of the shirt.

[a] % based on 196 observations for each main effect.

[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measured design yields four observations per person, thus a total of 392 observations.

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

The results of the chi-square analysis for the color matching and designation to the yellow shirt (6/14, Munsell 5Y 8.5/14) are shown in Table 55. The culture group differences were not significant for the yellow shirt designation. Even though there were no significant differences between the two groups, the most frequent color chips designated under this variable were 6/14 (Munsell 5Y 8.5/14), 7/12 (Munsell 7.5Y 8.5/12), and 7/14 (Munsell 5Y 8.5/12).

Regarding the variable of color rendering index, there was a significant difference for the yellow shirt ($\chi^2 = 50.54$, $p = 0.0001$). The results of the yellow shirt designation indicate significant differences between 75 CRI and 95 CRI for 5/12 (Munsell 2.5Y 8.5/12), 6/10 (Munsell 2.5Y 8.5/10), 6/12 (Munsell 2.5Y 8/12), 6/14 (Munsell 5Y 8.5/14), 7/12 (Munsell 7.5Y 8.5/12), 7/14 (Munsell 5Y 8.5/12), and 8/14 (Munsell 7.5Y 8.5/8). Under the lower color rendering index (75 CRI), a greater proportion of subjects in both groups designated the yellow shirt as 5/12 (Munsell 2.5Y 8.5/12), 6/10 (Munsell 2.5Y 8.5/10), 6/12 (Munsell 2.5Y 8/12), and 6/14 (Munsell 5Y 8.5/14). Under the higher color rendering index (95 CRI), a greater proportion of subjects in both groups designated the yellow shirt as 7/12 (Munsell 7.5Y 8.5/12), 7/14 (Munsell 5Y 8.5/12), and 8/14 (Munsell 7.5Y 8.5/8). These results indicate that under 75 CRI, the hue was perceived to change for the yellow shirt toward the green yellow sector and chroma decreased to weak. However, under 95 CRI, the subjects in both groups perceived the yellow shirt as its original color and as different hue which is toward the yellow red sector.

Color temperatures (3000 K and 5000 K) had a significant impact ($\chi^2 = 47.65$, $p = 0.0001$) on the subjects' perception of the yellow shirt (6/14, Munsell 5Y 8.5/14). The results of the yellow shirt designation indicate significant differences between 3000 K and 5000 K for 5/12 (Munsell 2.5Y 8.5/12), 6/10 (Munsell 2.5Y 8.5/10), 6/14 (Munsell 5Y 8.5/14), 7/12 (Munsell 7.5Y 8.5/12), and 8/14 (Munsell 7.5Y 8.5/8). Under the lower color temperature (3000 K), a greater proportion of subjects in both groups designated the yellow shirt as 5/12 (Munsell 2.5Y 8.5/12), 6/10 (Munsell 2.5Y 8.5/10), and 6/14 (Munsell 5Y 8.5/14). Under the higher color temperature (5000 K), a greater proportion of subjects in both groups designated the yellow shirt as 7/12 (Munsell 7.5Y 8.5/12) and 8/14 (Munsell 7.5Y 8.5/8). These results indicate that the subjects in both groups perceived the yellow shirt as its original color or as a warmer hue which is toward the red yellow sector under 3000 K. However, under 5000 K the hue changed for the yellow shirt toward the green yellow sector and chroma decreased to weak.

Table 55

Chi-square Analysis for the Color Designation of the Yellow Shirt When Observed from Outside the Lighted Environment

Original Research Color Chip Designation in Card C	Munsell Designation for All Possible Yellow Choices	Culture				Color Rendering Index				Color Temperature			
		American		Korean		75 CRI		95 CRI		3000 K		5000 K	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
5/10	2.5Y 8.5/8	0	(0)	1	(0.3)	1	(0.3)	0	(0)	1	(0.3)	0	(0)
5/12	2.5Y 8.5/12	7	(1.8)	6	(1.5)	0	(0)	13	(3.3)	10	(2.6)	3	(0.8)
5/14	5Y 8/14	0	(0)	1	(0.3)	0	(0)	1	(0.3)	1	(0.3)	0	(0)
6/10	2.5Y 8.5/10	20	(5.1)	18	(4.6)	13	(3.3)	25	(6.4)	24	(6.1)	14	(3.6)
6/12	2.5Y 8/12	2	(0.5)	8	(2.0)	1	(0.3)	9	(2.3)	6	(1.5)	4	(1.0)
6/14	5Y 8.5/14	48	(12.2)	55	(14.0)	43	(11.0)	60	(15.3)	68	(17.4)	35	(8.9)
7/8	5Y 7/8	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
7/10	5Y 7/10	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
7/12	7.5Y 8.5/12	46	(11.7)	31	(7.9)	40	(10.2)	37	(9.4)	20	(5.1)	57	(14.5)
7/14	5Y 8.5/12	60	(15.3)	66	(16.8)	77	(19.6)	49	(12.5)	62	(15.8)	64	(16.3)
8/8	5Y 8/8	1	(0.3)	0	(0)	1	(0.3)	0	(0)	0	(0)	1	(0.3)
8/10	5Y 8/10	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
8/12	5Y 8/12	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
8/14	7.5Y 8.5/8	12	(3.1)	10	(2.6)	20	(5.1)	2	(0.5)	4	(1.0)	18	(4.6)
Total Subjects [b]		196		196		196		196		196		196	
χ^2		11.57				50.54				47.65			
p		0.3149				0.0001***				0.0001***			

Note. Underlined Munsell Designation, "___", indicates the "true" color match for the shirt under natural light, thus, no color distortion of the shirt.
[a] % based on 196 observations for each main effect.
[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measured design yields four observations per person, thus a total of 392 observations.
* $p < .05$. ** $p < .01$. *** $p < .001$.

The results of the chi-square analysis for the color matching and designation to the purple blue shirt (5/10, Munsell 5PB 5/10) are shown in Table 56. All three variables have a significant impact for the purple blue shirt. The culture group differences (American and Korean) were statistically significant (χ^2 = 25.16, p = 0.0220). Only 19 observations in both culture groups described the purple blue shirt as its original color under all lighting conditions.

The results of the purple blue shirt designation indicate significant differences between American and Korean subjects for 5/8 (Munsell 5PB 5/8), 5/10 (Munsell 5PB 5/10), 6/8 (Munsell 5PB 6/8), 6/10 (Munsell 5PB 6/10), and 6/12 (Munsell 2.5PB 6/10). For the color chip of 5/8 (Munsell 5PB 5/8), 34 (8.4%) of 196 Korean subjects designated the purple blue shirt, while 16 (4.1%) of 196 American subjects designated it. For the color chip of 5/10 (Munsell 5PB 5/10), the original color of the purple blue shirt, 13 (3.3%) of 196 Korean subjects designated it, while 6 (1.5%) of 196 American subjects designated it. For the color chip of 6/8 (Munsell 5PB 6/8), 63 (16.1%) of 196 American subjects designated the purple blue shirt, while 49 (12.5%) of 196 Korean subjects designated it. For the color chip of 6/10 (Munsell 5PB 6/10), 53 (13.5%) of 196 American subjects designated the purple blue shirt, while 37 (9.4%) of 196 Korean subjects designated it. For the color chip of 6/12 (Munsell 2.5PB 6/10), 28 (7.4%) of 196 Korean subjects designated the purple blue shirt, while 18 (4.6%) of 196 American subjects designated it. These results of the blue shirt designation indicate that the Korean subjects perceived the purple blue shirt as its original color or closer to its original color, whereas the American subjects perceived the blue shirt as lighter value or having weaker chroma than its original purple blue regardless of the different lighting conditions.

Color rendering index was also significant for the purple blue shirt (χ^2 = 57.94, p = 0.0001). The results of the purple blue shirt designation indicate significant differences between 75 CRI and 95 CRI for 5/8 (Munsell 5PB 5/8), 5/10 (Munsell 5PB 5/10), 6/10 (Munsell 5PB 6/10), and 6/12 (Munsell 2.5PB 6/10). Under the lower color rendering index (75 CRI), a greater proportion of the subjects in both groups designated the purple blue shirt as 5/8 (Munsell 5PB 5/8), 5/10 (Munsell 5PB 5/10), and 6/10 (Munsell 5PB 6/10). Under the higher color rendering index (95 CRI), a greater proportion of subjects in both groups designated the purple blue shirt as

6/12 (Munsell 2.5PB 6/10). Theses results indicate that under 75 CRI, the subjects in both groups perceived the purple blue shirt as its original hue or having lighter value and weaker chroma. However, under 95 CRI the subjects in both groups perceived the purple blue shirt as having a different hue which is toward the blue sector.

Color temperatures (3000 K and 5000 K) had a significant impact ($\chi^2 = 47.65$, $\underline{p} = 0.0001$) on the subjects' perception of the purple blue shirt (5/10, Munsell 5PB 5/10). The results of the purple blue shirt designation indicate significant differences between 3000 K and 5000 K for 4/12 (Munsell 2.5PB 5/12), 5/8 (Munsell 5PB 5/8), 5/12 (Munsell 10PB 6/10), 6/6 (Munsell 5PB 6/6), 6/8 (Munsell 5PB 6/8), 6/10 (Munsell 5PB 6/10), and 6/12 (Munsell 2.5PB 6/10). Under the lower color temperature (3000 K), a greater proportion of the subjects in both groups designated the purple blue shirt as 5/8 (Munsell 5PB 5/8), 6/6 (Munsell 5PB 6/6), and 6/8 (Munsell 5PB 6/8). Under the higher color temperature (5000 K), a greater proportion of subjects in both groups designated the purple blue shirt as 4/12 (Munsell 2.5PB 5/12), 5/12 (Munsell 10PB 6/10), 6/10 (Munsell 5PB 6/10), and 6/12 (Munsell 2.5PB 6/10). Theses results indicate that the subjects in both groups perceived the purple blue shirt as having lighter value and a weaker chroma under 3000 K. However, under 5000 K, the hue changed for the purple blue shirt toward the blue sector with a lighter value and higher chroma.

Table 56

Chi-square Analysis for the Color Designation of the Purple Blue Shirt When Observed from Outside the Lighted Environment

Original Research Color Chip Designation in Card D	Munsell Designation for All Possible Purple Blue Choices	Culture				Color Rendering Index				Color Temperature			
		American		Korean		75 CRI		95 CRI		3000 K		5000 K	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
4/8	5PB 4/8	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
4/10	5PB 4/10	1	(0.3)	0	(0)	0	(0)	1	(0.3)	0	(0)	1	(0.3)
4/12	2.5PB 5/12	8	(2.0)	10	(2.6)	8	(2.0)	10	(2.6)	1	(0.3)	17	(4.3)
5/8	5PB 5/8	16	(4.1)	34	(8.4)	31	(7.9)	19	(4.6)	30	(7.4)	20	(5.1)
<u>5/10</u>	<u>5PB 5/10</u>	6	(1.5)	13	(3.3)	13	(3.3)	6	(1.5)	10	(2.6)	9	(2.3)
5/12	10B 6/10	9	(2.3)	13	(3.3)	1	(0.3)	21	(5.4)	1	(0.3)	21	(5.4)
6/6	5PB 6/6	9	(2.3)	4	(1.0)	7	(1.8)	6	(1.5)	13	(3.3)	0	(0)
6/8	5PB 6/8	63	(16.1)	49	(12.5)	57	(14.6)	55	(18.7)	82	(20.9)	30	(7.7)
6/10	5PB 6/10	53	(13.5)	37	(9.4)	58	(14.8)	32	(8.2)	34	(8.7)	56	(14.3)
6/12	2.5PB 6/10	18	(4.6)	28	(7.1)	12	(3.1)	34	(8.7)	13	(3.3)	33	(8.4)
7/6	5PB 7/6	5	(1.3)	1	(0.3)	0	(0)	6	(1.5)	6	(1.5)	0	(0)
7/8	5PB 7/8	8	(2.0)	8	(2.0)	9	(2.3)	7	(1.8)	7	(1.8)	9	(2.3)
7/10	7.5PB 7/6	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
7/12	7.5PB 7/8	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)	0	(0)
Total Subjects [b]		196		196		196		196		196		196	
χ^2		25.16				57.94				95.45			
p		0.0220*				0.0001***				0.0001***			

Note. Underlined Munsell Designation, "___", indicates the "true" color match for the shirt under natural light, thus, no color distortion of the shirt.

[a] % based on 196 observations for each main effect.

[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measured design yields four observations per person, thus a total of 392 observations.

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

To summarize the findings of the chi-square analysis of Hypothesis 22 above, there are significant differences in the subjects' ability to designate and match four colors of the T-shirts with regard to culture group, color rendering index, and color temperature when observed from outside the lighted environment. Therefore, Hypothesis 22 was supported.

The results of the color perception of the T-shirts show there was a difference between the American and Korean subjects for the perception of blue and purple blue as cool colors on Munsell color wheel, while there was no difference between the American and Korean subjects for the perception of red and yellow as warm colors on Munsell color wheel. Regarding the color perception of blue and purple blue, the Korean subjects designated both colors as their original colors or closer to their original colors regardless of the different lighting conditions. However, the American subjects perceived the blue and purple blue as having lighter value and weaker chroma.

Regarding the study variable of the color rendering index, there was no relationship between color rendering index and red color perception when observed from outside the lighted environment according to all respondents. However, there was a significant difference between 75 CRI and 95 CRI for the color perception of yellow, blue, and purple blue shirts. The subjects in both groups designated the blue and yellow shirts as their original colors under the higher color rendering index (95 CRI) whereas they designated the purple blue shirt as its original color under 75 CRI. Two different color rendering indices introduced some distortion of yellow, blue, and purple blue colors. Under 75 CRI, the pure hue of yellow (5Y) appeared as 7.5 yellow, the color on a clockwise direction of the color wheel, while under 95 CRI, it appeared as 2.5 yellow, the color on a counterclockwise direction of the color wheel. Also, under 75 CRI, the chroma of yellow changed from strong intensity (14) to weak intensity (12). For the blue color of the shirt, under 75 CRI, the blue color of 5B 5/10 appeared as 7.5B, the color on a counterclockwise direction of the color wheel or as having the same hue of blue with lighter value (6 or 7) and weaker intensity (6 or 8). However, under 95 CRI, the blue color of 5B 5/10 appeared as 2.5B, the color on a clockwise direction of the color wheel or as having the same hue and chroma of blue with a lighter value. For the purple blue color of the shirt, under 75 CRI, the purple blue color of 5PB 5/10 appeared as having the same hue with a lighter value or with weaker chroma.

However, under 95 CRI, the purple blue appeared as 10 B or 2.5 PB, the colors on a counterclockwise direction of the color wheel.

Regarding the study variable of color temperature, there was a significant difference between 3000 K and 5000 K for the color perception of all four color T-shirts of red, yellow, blue, and purple blue. Under 3000 K, the red shirt appeared as the hue of 7.5R, the color on a clockwise direction of the color wheel with a lighter value and stronger chroma, while it appeared as having the same hue with lighter value under 5000 K. Under 3000 K, the yellow shirt appeared as its original color or the hue of 2.5Y, the color on a counterclockwise direction of the color wheel, while under 5000 K, it appeared as the hue of 7.5Y, the color on a clockwise direction of the color wheel. Under 3000 K, the blue shirt appeared as the hues of 10BG and 2.5B, the colors on a counterclockwise direction of the color wheel or having the same hue with a lighter value and weaker chroma, while under 5000 K, it appeared as its original color or as having the hue of 7.5B, the color on a clockwise direction of the color wheel. Under 3000 K, the purple blue shirt appeared as having the same hue with a lighter value and weaker chroma, while under 5000 K, it appeared to have the hues of 10B and 2.5 PB, the colors on a counterclockwise direction of the color wheel. In other words, the warm colors of red and yellow were enhanced in their color qualities under 3000 K, while the color qualities were reduced under 5000 K. The cool colors of blue and purple blue were enhanced in their color qualities under 5000 K, while their color qualities were reduced under 3000 K.

Hypotheses in Section 3: Comparison between Inside and Outside the Lighted Environment

Hypotheses in Section 3 address the comparison of the subjects' responses to each of four lighting conditions from inside and outside the cubicle. Thus, the subjects' perceptions of lighting are made when viewed inside and outside the lighted environment. There are eight hypotheses in Section 3.

Hypothesis 23. There is no difference in the subjects' perception of the lighting as being visually warm or visually cool with regard to

a) culture (American and Korean)
b) location (inside and outside)
c) color rendering index of fluorescent light (75 CRI and 95 CRI)
d) color temperature of fluorescent light (3000 K and 5000 K)
e) two-way interaction of culture by location
f) two-way interaction of culture by CRI
g) two-way interaction of culture by CT
h) two-way interaction of location by CRI
i) two-way interaction of location by CT
j) two-way interaction of CRI by CT
k) three-way interaction of culture by location by CRI
l) three-way interaction of culture by location by CT
m) three-way interaction of culture by CRI by CT
n) three-way interaction of location by CRI by CT
o) four-way interaction of culture by location by CRI by CT

Responses using the bipolar adjectives "visually warm and visually cool," on a seven-point Likert-type scale were used to assess the subjects' perceptions of lighting by comparing responses made from inside and outside the lighted environments. Table 57 shows the mean and standard deviation scores for main effects, two-way interactions, three-way interactions, and a four-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 58. There was a main effect of color rendering index $F(1, 672) = 4.10$, $p = .043$. All participants perceived the higher color rendering index of 95 CRI (M = 3.67) as warmer than the lower color rendering index of 75 CRI (M = 3.85) regardless of culture group, color temperature, and location differences. Thus, the Hypothesis 23c was rejected.

There was a main effect of color temperature F (1, 672) = 606.04, p = .000. All participants perceived the lower color temperature of 3000 K (M = 2.66) as warmer than the higher color temperature of 5000 K (M = 4.86) regardless of culture group, color rendering index, and location differences. Thus, the Hypothesis 23d was rejected.

Results showed two significant two-way interactions, namely culture by color temperature F (1,672) = 6.45, p = .011 and location by color temperature F (1, 672) = 5.08, p = .025. Thus, the Hypotheses 23g and 23i were rejected. To assess the significance of such findings, analysis of the simple effects was conducted.

The outcomes for two-way interaction of culture by color temperature are presented in Figure 15 and Table 59. Both American and Korean subjects perceived the lower color temperature of 3000 K as warmer than the higher color temperature of 5000 K regardless of color rendering index and location differences. However, for the lower color temperature of 3000 K, American subjects (M = 2.54) perceived as visually warmer than Korean subjects (M = 2.79) regardless of color rendering index and location differences.

The outcomes for two-way interaction of location by color temperature are presented in Figure 16 and Table 60. All respondents perceived the lower color temperature of 3000 K as being visually warm and the higher color temperature of 5000 K as being visually cool from inside and outside the lighted environments regardless of culture group and color rendering index differences.

There was no significant difference regarding to the main effects of culture groups (American and Korean) and locations (inside and outside the lighted environment). Thus, the Hypotheses 23a and 23b were not rejected. No significant difference resulted on two-way interaction of culture by CRI, culture by location, location by CRI and CRI by CT. Thus, the Hypotheses 23e, 23f, 23h, and 23j were not rejected. There were also no significant differences regarding to all three-way interactions of culture, location, and CRI and a four-way interaction of culture, location, CRI, and CT. Thus, the Hypotheses 23k, 23l, 23m, 23n and 23o were not rejected.

Table 57

A Comparison of the Mean and Standard Deviation Scores for Subjects' Perception of Lighting as Being Visually Warm or Visually Cool[1] When Observed from Inside and Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S
American	392	3.75	1.85	
Korean	392	3.77	1.62	
Location				N.S
Inside	392	3.75	1.71	
Outside	392	3.77	1.77	
Color Rendering Index				0.043
75 CRI	392	3.85	1.72	
95 CRI	392	3.67	1.75	
Color Temperature				0.000
3000 K	392	2.66	1.23	
5000 K	392	4.86	1.45	
Culture by Location				N.S
American x Inside	196	3.79	1.80	
American x Outside	196	3.71	1.90	
Korean x Inside	196	3.71	1.62	
Korean x Outside	196	3.84	1.62	
Culture by CRI				N.S
American x 75 CRI	196	3.84	1.81	
American x 95 CRI	196	3.66	1.89	
Korean x 75 CRI	196	3.86	1.64	
Korean x 95 CRI	196	3.68	1.60	
Culture by CT				0.011
American x 3000 K	196	2.54	1.24	
American x 5000 K	196	4.96	1.54	
Korean x 3000 K	196	2.79	1.22	
Korean x 5000 K	196	4.76	1.35	
Location by CRI				N.S.
Inside x 75 CRI	196	3.86	1.70	
Inside x 95 CRI	196	3.64	1.72	
Outside x 75 CRI	196	3.85	1.75	
Outside x 95 CRI	196	3.70	1.79	
Location by CT				0.025
Inside x 3000 K	196	2.75	1.29	
Inside x 5000 K	196	4.75	1.49	
Outside x 3000 K	196	2.57	1.17	
Outside x 5000 K	196	4.97	1.41	

Table 57 (Continued)

Source	n	Mean	SD	p
CRI by CT				N.S.
75 CRI x 3000 K	196	2.80	1.28	
75 CRI x 5000 K	196	4.91	1.44	
95 CRI x 3000 K	196	2.53	1.17	
95 CRI x 5000 K	196	4.82	1.47	
Culture by Location by CRI				N.S.
American x Inside x 75 CRI	98	3.95	1.78	
American x Inside x 95 CRI	98	3.63	1.82	
American x Outside x 75 CRI	98	3.73	1.85	
American x Outside x 95 CRI	98	3.68	1.97	
Korean x Inside x 75 CRI	98	3.77	1.63	
Korean x Inside x 95 CRI	98	3.65	1.61	
Korean x Outside x 75 CRI	98	3.96	1.64	
Korean x Outside x 95 CRI	98	3.71	1.60	
Culture by Location by CT				N.S
American x Inside x 3000 K	98	2.70	1.31	
American x Inside x 5000 K	98	4.88	1.56	
American x Outside x 3000 K	98	2.37	1.14	
American x Outside x 5000 K	98	5.05	1.53	
Korean x Inside x 3000 K	98	2.80	1.27	
Korean x Inside x 5000 K	98	4.62	1.40	
Korean x Outside x 3000	98	2.78	1.17	
Korean x Outside x 5000 K	98	4.90	1.28	
Culture by CRI by CT				N.S
American x 75 CRI x 3000 K	98	2.71	1.35	
American x 75 CRI x 5000 K	98	4.97	1.48	
American x 95 CRI x 3000 K	98	2.36	1.09	
American x 95 CRI x 5000 K	98	4.96	1.61	
Korean x 75 CRI x 3000 K	98	2.88	1.21	
Korean x 75 CRI x 5000 K	98	4.85	1.39	
Korean x 95 CRI x 3000 K	98	2.69	1.22	
Korean x 95 CRI x 5000 K	98	4.67	1.30	
Location by CRI by CT				N.S.
Inside x 75 CRI x 3000 K	98	2.97	1.42	
Inside x 75 CRI x 5000 K	98	4.74	1.49	
Inside x 95 CRI x 3000 K	98	2.53	1.10	
Inside x 95 CRI x 5000 K	98	4.76	1.49	
Outside x 75 CRI x 3000 K	98	2.62	1.12	
Outside x 75 CRI x 5000 K	98	5.07	1.36	
Outside x 95 CRI x 3000 K	98	2.52	1.23	
Outside x 95 CRI x 5000 K	98	4.88	1.45	

Table 57 (Continued)

Source	n	Mean	SD	p
Culture by Location by CRI by CT				N.S.
American x Inside x 75 CRI x 3000 K	49	2.98	1.49	
American x Inside x 75 CRI x 5000 K	49	4.92	1.50	
American x Inside x 95 CRI x 3000 K	49	2.43	1.04	
American x Inside x 95 CRI x 5000 K	49	4.84	1.64	
American x Outside x 75 CRI x 3000 K	49	2.45	1.16	
American x Outside x 75 CRI x 5000 K	49	5.02	1.48	
American x Outside x 95 CRI x 3000 K	49	2.29	1.14	
American x Outside x 95 CRI x 5000 K	49	5.08	1.59	
Korean x Inside x 75 CRI x 3000 K	49	2.96	1.35	
Korean x Inside x 75 CRI x 5000 K	49	4.57	1.49	
Korean x Inside x 95 CRI x 3000 K	49	2.63	1.17	
Korean x Inside x 95 CRI x 5000 K	49	4.67	1.33	
Korean x Outside x 75 CRI x 3000 K	49	2.80	1.06	
Korean x Outside x 75 CRI x 5000 K	49	5.12	1.25	
Korean x Outside x 95 CRI x 3000 K	49	2.76	1.28	
Korean x Outside x 95 CRI x 5000 K	49	4.67	1.28	

[1]. 7 point Likert-type scale: 1 = visually warm and 7 = visually cool
Note. N.S = not significant at $p < .05$ (see ANOVA results in the next table).

Table 58

Analysis of Variance for Subjects' Perception of Lighting as Being Visually Warm or Visually Cool When Observed from Inside and Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	0.10	0.10	0.03	0.862
Between Error	96	325.92	3.39		
Location	1	0.10	0.10	0.07	0.798
CRI	1	6.43	6.43	4.10	0.043 *
CT	1	949.96	949.96	606.04	0.000 ***
Culture x Location	1	2.14	2.14	1.37	0.243
Culture x CRI	1	0.00	0.00	0.00	0.977
Culture x CT	1	10.10	10.10	6.45	0.011 *
Location x CRI	1	0.22	0.22	0.14	0.711
Location x CT	1	7.96	7.96	5.08	0.025 *
CRI x CT	1	1.56	1.56	1.00	0.318
Culture x Location x CRI	1	1.94	1.94	1.24	0.266
Culture x Location x CT	1	0.56	0.56	0.36	0.549
Culture x CRI x CT	1	1.39	1.39	0.89	0.347
Location x CRI x CT	1	3.58	3.58	2.29	0.131
Culture x Location x CRI x CT	1	1.07	1.07	0.68	0.408
Within Error	672	1053.35	1.57		

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

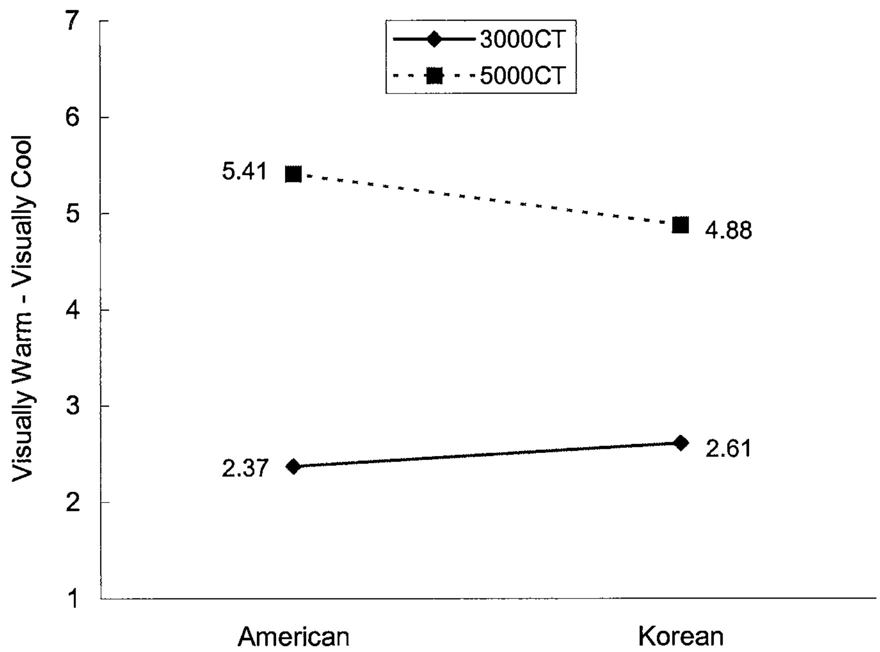


Figure 15. Two-Way Interaction of Culture by CT for Subjects' Perception of Lighting as Being Visually Warm or Visually Cool When Observed from Inside and Outside the Lighted Environment

Table 59

<u>Analysis of Simple Effects (Culture x CT) for Subjects' Perception of Lighting as Being Visually Warm or Visually Cool When Observed from Inside and Outside the Lighted Environment</u>

	1 [American x 3000 K]	2 [American x 5000 K]	3 [Korean x 3000 K]	4 [Korean x 5000 K]
1				
2	-19.23*** (0.0001)			
3	-1.98 * (0.0485)	17.23*** (0.0001)		
4	-17.59*** (0.0001)	1.61 (0.1071)	-15.61*** (0.0001)	

<u>Note.</u> Numeric value in parenthesis "( )" indicates p-value
*$p < .05$. **$p < .01$. ***$p < .001$

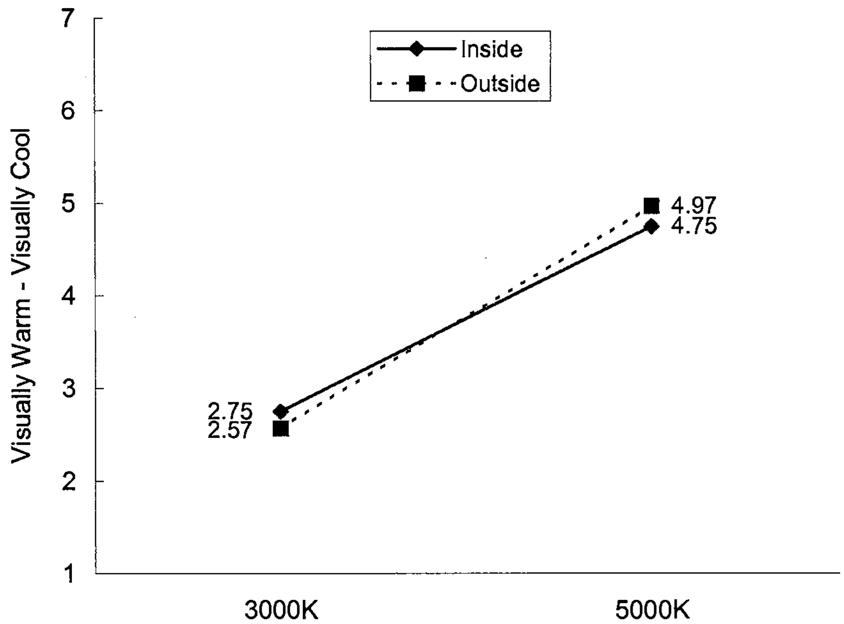


Figure 16. Two-Way Interaction of Location by CT for Subjects' Perception of Lighting as Being Visually Warm or Visually Cool When Observed from Inside and Outside the Lighted Environment

Table 60

Analysis of Simple Effects (Location by CT) for Subjects' Perception of Lighting as Being Visually Warm or Visually Cool When Observed from Inside and Outside the Lighted Environment

	1 [Inside x 3000 K]	2 [Inside x 5000 K]	3 [Outside x 3000 K]	4 [Outside x 5000 K]
1				
2	-15.81*** (0.0001)			
3	1.41 (0.1584)	17.23*** (0.0001)		
4	-17.59*** (0.0001)	-1.78 (0.0763)	-19.00*** (0.0001)	

Note. Numeric value in parenthesis "( )" indicates p-value
*p < .05. **p < .01. ***p < .001

Hypothesis 24. There is no difference in the subjects' perception of the lighting as a factor in visual clarity with regard to

a) culture (American and Korean)
b) location (inside and outside)
c) color rendering index of fluorescent light (75 CRI and 95 CRI)
d) color temperature of fluorescent light (3000 K and 5000 K)
e) two-way interaction of culture by location
f) two-way interaction of culture by CRI
g) two-way interaction of culture by CT
h) two-way interaction of location by CRI
i) two-way interaction of location by CT
j) two-way interaction of CRI by CT
k) three-way interaction of culture by location by CRI
l) three-way interaction of culture by location by CT
m) three-way interaction of culture by CRI by CT
n) three-way interaction of location by CRI by CT
o) four-way interaction of culture by location by CRI by CT

Responses using two bipolar adjectives "bright/dim and clear/unclear," on a seven-point Likert-type scale were used to assess the subjects' perceptions of visual clarity by comparing responses made from inside and outside the lighted environments. Table 61 shows the mean and standard deviation scores for main effects, two-way interactions, three-way interactions, and a four-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 62. Regarding location between inside and outside the lighted environment as a main effect, there was statistical significance at $p = .000$ with an F ratio of 16.17. All participants perceived the lighting conditions as brighter and clearer when observed inside the lighted environment (M = 7.17) than when observed outside the lighted environment (M = 7.86) regardless of the culture group, the color temperature, and color rendering index differences. Thus, Hypothesis 24b was rejected.

Color temperature as a main effect was significant with an F (1, 672) = 114.79, $p = .000$. All participants perceived the higher color temperature of 5000 K (M = 6.58) as brighter and clearer than the lower color temperature of 3000 K (M = 8.45) regardless of the culture group, location, and color rendering index differences. Thus, Hypothesis 24d was rejected.

Results showed a significant three-way interaction, namely culture by color temperature by color rendering index F (1,672) = 8.28, $p = .004$. Thus, Hypothesis 24m was rejected. To assess the significance of such a finding, analysis of the simple effects was conducted. The outcomes are presented in Figure 17 and Table 63.

As can be seen in Fig.17, there were significant differences between American and Korean subjects for the perception of visual clarity under 750 and 930 lighting conditions. The American subjects (M = 6.24) perceived the 750 lighting condition as brighter and clearer than the Korean subjects (M = 6.93) did. Also, for the 930 lighting condition, the American subjects (M = 8.04) estimated as brighter and clearer than Korean subjects (M = 9.25) did.

American subjects perceived the higher color temperature of 5000 K (M = 6.24) as brighter and clearer than the lower color temperature of 3000 K (M = 8.37) with the lower color temperature of 75 CRI. Also, American subjects perceived the higher color temperature of 5000 K (M = 6.52) as brighter and clearer than the lower color temperature of 3000 K (M = 8.04) with the higher color temperature of 95 CRI.

Korean subjects perceived the higher color temperature of 5000 K (M = 6.93) as brighter and clearer than the lower color temperature of 3000 K (M = 8.13) with the lower color temperature of 75 CRI. Korean subjects perceived the higher color temperature of 5000 K (M = 6.65) as brighter and clearer than the lower color temperature of 3000 K (M = 9.25) with the higher color temperature of 95 CRI. However, for the color rendering index, Korean subjects perceived 75 CRI (M = 8.13) as clearer than 95 CRI (M = 9.25) at the lower color temperature of 3000 K.

Therefore, this interaction finding can be summarized that American subjects estimated both 750 and 930 lighting conditions as brighter and clearer than Korean subjects did. Both American and Korean estimated the higher color temperature of 5000 K as brighter and clearer than the lower color temperature of 3000 K with both 75 and 95 CRI. Korean subjects estimated the 930 lighting as the least clear cross all lighting conditions.

There was no significant difference regarding the main effects of culture groups (American and Korean) and color rendering index (75 CRI and 95 CRI). Thus, Hypotheses 24a and 24c were not rejected. No significant difference resulted on all two-way interactions regarding to the study variables of culture, location, CRI, and CT. Thus, the Hypotheses 24e, 24f, 24g, 24h, 24i, and 24j were not rejected. There were also no significant differences regarding to the three-way interactions of culture by location by CRI, culture by location by CT, and location by CRI by CT and a four-way interaction of culture by location by CRI by CT. Thus, Hypotheses 24k, 24l, 24n, and 24o were not rejected.

Table 61

A Comparison of the Mean and Standard Deviation Scores for Subjects' Perception of Lighting as a Factor in Visual Clarity[1] When Observed from Inside and Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S
American	392	7.29	2.88	
Korean	392	7.74	2.73	
Location				0.000
Inside	392	7.17	2.66	
Outside	392	7.86	2.93	
Color Rendering Index				N.S
75 CRI	392	7.42	2.81	
95 CRI	392	7.61	2.82	
Color Temperatures				0.000
3000 K	392	8.45	2.73	
5000 K	392	6.58	2.59	
Culture by Location				N.S
American x Inside	196	7.08	2.67	
American x Outside	196	7.50	3.08	
Korean x Inside	196	7.25	2.65	
Korean x Outside	196	8.23	2.73	
Culture by CRI				N.S
American x 75 CRI	196	7.30	2.99	
American x 95 CRI	196	7.28	2.78	
Korean x 75 CRI	196	7.53	2.63	
Korean x 95 CRI	196	7.95	2.83	
Culture by CT				N.S
American x 3000 K	196	8.20	2.89	
American x 5000 K	196	6.38	2.58	
Korean x 3000 K	196	8.69	2.54	
Korean x 5000 K	196	6.79	2.58	
Location by CRI				N.S.
Inside x 75 CRI	196	6.96	2.64	
Inside x 95 CRI	196	7.37	2.66	
Outside x 75 CRI	196	7.87	2.91	
Outside x 95 CRI	196	7.86	2.95	
Location by CT				N.S
Inside x 3000 K	196	8.01	2.59	
Inside x 5000 K	196	6.33	2.45	
Outside x 3000 K	196	8.89	2.79	
Outside x 5000 K	196	6.84	2.70	

Table 61 (Continued)

Source	n	Mean	SD	p
CRI by CT				N.S.
75 CRI x 3000 K	196	8.25	2.69	
75 CRI x 5000 K	196	6.59	2.68	
95 CRI x 3000 K	196	8.64	2.75	
95 CRI x 5000 K	196	6.59	2.50	
Culture by Location by CRI				N.S.
American x Inside x 75 CRI	98	6.89	2.73	
American x Inside x 95 CRI	98	7.27	2.60	
American x Outside x 75 CRI	98	7.70	3.19	
American x Outside x 95 CRI	98	7.30	2.97	
Korean x Inside x 75 CRI	98	7.02	2.56	
Korean x Inside x 95 CRI	98	7.48	2.74	
Korean x Outside x 75 CRI	98	8.04	2.61	
Korean x Outside x 95 CRI	98	8.42	2.84	
Culture by Location by CT				N.S
American x Inside x 3000 K	98	7.90	2.69	
American x Inside x 5000 K	98	6.27	2.39	
American x Outside x 3000 K	98	8.51	3.06	
American x Outside x 5000 K	98	6.49	2.77	
Korean x Inside x 3000 K	98	8.11	2.51	
Korean x Inside x 5000 K	98	6.38	2.52	
Korean x Outside x 3000 K	98	9.26	2.45	
Korean x Outside x 5000 K	98	7.19	2.60	
Culture by CRI by CT				0.004
American x 75 CRI x 3000 K	98	8.37	2.96	
American x 75 CRI x 5000 K	98	6.24	2.63	
American x 95 CRI x 3000 K	98	8.04	2.82	
American x 95 CRI x 5000 K	98	6.52	2.54	
Korean x 75 CRI x 3000 K	98	8.13	2.41	
Korean x 75 CRI x 5000 K	98	6.93	2.70	
Korean x 95 CRI x 3000 K	98	9.25	2.55	
Korean x 95 CRI x 5000 K	98	6.65	2.47	
Location by CRI by CT				N.S.
Inside x 75 CRI x 3000 K	98	7.77	2.55	
Inside x 75 CRI x 5000 K	98	6.15	2.49	
Inside x 95 CRI x 3000 K	98	8.25	2.63	
Inside x 95 CRI x 5000 K	98	6.50	2.42	
Outside x 75 CRI x 3000 K	98	8.73	2.76	
Outside x 75 CRI x 5000 K	98	7.01	2.81	
Outside x 95 CRI x 3000 K	98	9.04	2.82	
Outside x 95 CRI x 5000 K	98	6.67	2.59	

Table 61 Continued)

Source	n	Mean	SD	p
Culture by Location by CRI by CT				N.S.
American x Inside x 75 CRI x 3000 K	49	7.96	2.76	
American x Inside x 75 CRI x 5000 K	49	5.84	2.28	
American x Inside x 95 CRI x 3000 K	49	7.84	2.64	
American x Inside x 95 CRI x 5000 K	49	6.69	2.45	
American x Outside x 75 CRI x 3000 K	49	8.77	3.11	
American x Outside x 75 CRI x 5000 K	49	6.63	2.91	
American x Outside x 95 CRI x 3000 K	49	8.25	3.00	
American x Outside x 95 CRI x 5000 K	49	6.34	2.64	
Korean x Inside x 75 CRI x 3000 K	49	7.57	2.33	
Korean x Inside x 75 CRI x 5000 K	49	6.46	2.67	
Korean x Inside x 95 CRI x 3000 K	49	8.65	2.58	
Korean x Inside x 95 CRI x 5000 K	49	6.30	2.39	
Korean x Outside x 75 CRI x 3000 K	49	8.69	2.38	
Korean x Outside x 75 CRI x 5000 K	49	7.39	2.68	
Korean x Outside x 95 CRI x 3000 K	49	9.84	2.40	
Korean x Outside x 95 CRI x 5000 K	49	7.00	2.52	

[1]. 7 point Likert-type scale: 1 = clear and 7 = unclear
Note. N.S = not significant at $p < .05$ (see ANOVA results in the next table).

Table 62

Analysis of Variance for Subjects' Perception of Lighting as a Factor in Visual Clarity When Observed from Inside and Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	39.51	39.51	2.92	0.091
Between Error	96	1301.06	13.55		
Location	1	95.76	95.76	16.17	0.000***
CRI	1	7.76	7.76	1.31	0.253
CT	1	679.72	679.72	114.79	0.000***
Culture x Location	1	15.43	15.43	2.61	0.107
Culture x CRI	1	9.43	9.43	1.59	0.207
Culture x CT	1	0.25	0.25	0.04	0.837
Location x CRI	1	9.00	9.00	1.52	0.218
Location x CT	1	6.61	6.61	1.12	0.291
CRI x CT	1	7.37	7.37	1.24	0.265
Culture x Location x CRI	1	5.90	5.90	1.00	0.319
Culture x Location x CT	1	0.02	0.02	0.00	0.953
Culture x CRI x CT	1	49.00	49.00	8.28	0.004**
Location x CRI x CT	1	3.19	3.19	0.54	0.463
Culture x Location x CRI x CT	1	0.62	0.62	0.10	0.747
Within Error	672	3979.19	5.92		

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$

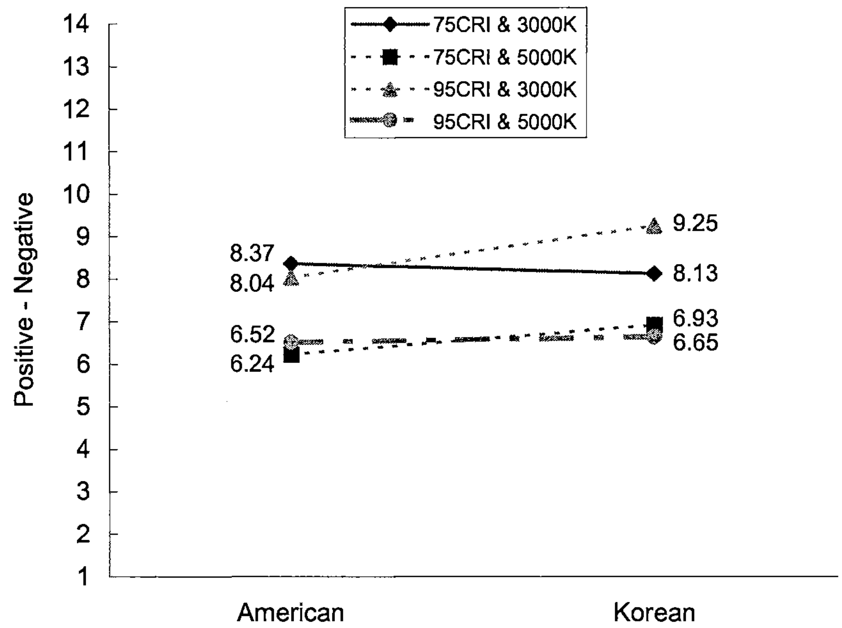


Figure 17. Three-Way Interaction of Culture by CRI by CT for Subjects' Perception of Lighting as a Factor in Visual Clarity When Observed from Inside and Outside the Lighted Environment

Table 63

Analysis of Simple Effects (Culture x CRI x CT) for Subjects' Perception of Lighting as a Factor in Visual Clarity When Observed from Inside and Outside the Lighted Environment

	1 [Ax7x30]	2 [Ax7x50]	3 [Ax9x30]	4 [Ax9x50]	5 [Kx7x30]	6 [Kx7x50]	7 [Kx9x30]	8 [Kx9x50]
1								
2	6.13*** (0.0001)							
3	0.94 (0.3479)	-5.20*** (0.0001)						
4	5.31*** (0.0001)	-0.82 (0.4114)	4.37*** (0.0001)					
5	0.68 (0.4998)	-5.46*** (0.0001)	-0.26 (0.7917)	-4.64*** (0.0001)				
6	4.14*** (0.0001)	-2.00* (0.0463)	3.20** (0.0014)	-1.17 (0.2408)	3.46*** (0.0006)			
7	-2.52* (0.0118)	-8.66*** (0.0001)	-3.46*** (0.0006)	-7.84*** (0.0001)	-3.20*** (0.0014)	-6.66*** (0.0001)		
8	4.93*** (0.0001)	-1.20 (0.2292)	3.99*** (0.0001)	-0.38 (0.7029)	4.26*** (0.0001)	0.79 (0.4283)	7.46*** (0.0001)	

Note. Bracket Designation, "[ ]", indicates A = American, K = Korean, 7 = 75 CRI, 9 = 95 CRI, 30 = 3000K, and 50 = 5000K. Numeric value in parenthesis "( )" indicates p-value
*$p < .05$. **$p < .01$. ***$p < .001$

Hypothesis 25. There is no difference in the subjects' overall lighting preference with regard to

a) culture (American and Korean)
b) location (inside and outside)
c) color rendering index of fluorescent light (75 CRI and 95 CRI)
d) color temperature of fluorescent light (3000 K and 5000 K)
e) two-way interaction of culture by location
f) two-way interaction of culture by CRI
g) two-way interaction of culture by CT
h) two-way interaction of location by CRI
i) two-way interaction of location by CT
j) two-way interaction of CRI by CT
k) three-way interaction of culture by location by CRI
l) three-way interaction of culture by location by CT
m) three-way interaction of culture by CRI by CT
n) three-way interaction of location by CRI by CT
o) four-way interaction of culture by location by CRI by CT

Responses using the bipolar adjectives "like and dislike," on a seven-point Likert-type scale were used to assess the subjects' overall lighting preference by comparing responses made from inside and outside the lighted environments. Table 64 shows the mean and standard deviation scores for main effects, two-way interactions, three-way interactions, and a four-way interaction of subjects' perception of lighting.

Results of the analysis of variance (ANOVA) are summarized in Table 65. Results showed a significant three way interactions, namely culture by color rendering index by color temperature $F(1,672) = 4.67$, $p = .031$. Thus, the Hypothesis 25m was rejected. To assess the significance of such a finding, analysis of the simple effects was conducted. The outcomes are presented in Figure 18 and Table 66.

As can be seen in Fig.18, there was a significant difference between American and Korean subjects for the overall lighting preference with 930 lighting regardless of location differences. American subjects (M = 3.36) preferred the 930 lighting better than Korean subjects (M = 4.04) did. However, the American subjects preferred 95 CRI (M = 3.36) better than 75 CRI (M = 4.00) at color temperature of 3000 K and they preferred the lower color temperature of 3000 K (M = 3.36) better than the higher color temperature 5000 K (M = 4.12) with 95 CRI. In other words, American respondents preferred the 930 lighting the best across all lighting conditions.

There was a significant difference for main effect of color temperature at p = .022 with an F ratio of 5.30. Thus, the Hypothesis 25d was rejected. All respondents preferred the lower color temperature of 3000 K (M = 3.80) better than the higher color temperature of 5000 K (M = 4.05). However, since there was a significant finding of a three-way interaction (culture by CRI by CT), the main effect of color temperature was of little interest.

There was no significant difference regarding to the main effects of culture groups (American and Korean), locations (inside and outside the lighted environment), and color rendering index (75 CRI and 95 CRI). Thus, the Hypotheses 25a, 25b,and 25c were not rejected. No significant difference resulted on all two-way interactions regarding to the study variables of culture, location, CRI, and CT. Thus, the Hypotheses 25e, 25f, 25g, 25h, 25i, and 25j were not rejected. There were also no significant differences regarding to the three-way interactions of culture by location by CRI, culture by location by CT, and location by CRI by CT and a four-way interaction of culture by location by CRI by CT. Thus, the Hypotheses 25k, 25l, 25n, and 25o were not rejected.

Table 64

A Comparison of the Mean and Standard Deviation Scores for Subjects' Overall Lighting Preference[1] When Observed from Inside and Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S
American	392	3.88	1.66	
Korean	392	3.98	1.50	
Location				N.S
Inside	392	3.86	1.60	
Outside	392	3.99	1.57	
Color Rendering Index				N.S
75 CRI	392	3.96	1.57	
95 CRI	392	3.89	1.60	
Color Temperatures				0.022
3000 K	392	3.80	1.60	
5000 K	392	4.05	1.57	
Culture by Location				N.S
American x Inside	196	3.90	1.65	
American x Outside	196	3.86	1.68	
Korean x Inside	196	3.82	1.54	
Korean x Outside	196	4.13	1.45	
Culture by CRI				N.S
American x 75 CRI	196	4.02	1.62	
American x 95 CRI	196	3.74	1.70	
Korean x 75 CRI	196	3.91	1.53	
Korean x 95 CRI	196	4.04	1.47	
Culture by CT				N.S
American x 3000 K	196	3.68	1.63	
American x 5000 K	196	4.08	1.67	
Korean x 3000 K	196	3.93	1.55	
Korean x 5000 K	196	4.03	1.46	
Location by CRI				N.S.
Inside x 75 CRI	196	3.88	1.59	
Inside x 95 CRI	196	3.84	1.61	
Outside x 75 CRI	196	4.05	1.56	
Outside x 95 CRI	196	3.94	1.59	
Location by CT				N.S
Inside x 3000 K	196	3.64	1.59	
Inside x 5000 K	196	4.08	1.58	
Outside x 3000 K	196	3.97	1.59	
Outside x 5000 K	196	4.02	1.56	

Table 64 (Continued)

Source	n	Mean	SD	p
CRI by CT				N.S.
75 CRI x 3000 K	196	3.91	1.57	
75 CRI x 5000 K	196	4.02	1.58	
95 CRI x 3000 K	196	3.70	1.62	
95 CRI x 5000 K	196	4.08	1.56	
Culture by Location by CRI				N.S.
American x Inside x 75 CRI	98	4.05	1.61	
American x Inside x 95 CRI	98	3.74	1.69	
American x Outside x 75 CRI	98	3.98	1.64	
American x Outside x 95 CRI	98	3.73	1.71	
Korean x Inside x 75 CRI	98	3.70	1.56	
Korean x Inside x 95 CRI	98	3.94	1.52	
Korean x Outside x 75 CRI	98	4.12	1.48	
Korean x Outside x 95 CRI	98	4.14	1.43	
Culture by Location by CT				N.S
American x Inside x 3000 K	98	3.53	1.63	
American x Inside x 5000 K	98	4.27	1.61	
American x Outside x 3000 K	98	3.83	1.64	
American x Outside x 5000 K	98	3.89	1.72	
Korean x Inside x 3000 K	98	3.74	1.56	
Korean x Inside x 5000 K	98	3.90	1.53	
Korean x Outside x 3000 K	98	4.11	1.53	
Korean x Outside x 5000 K	98	4.15	1.37	
Culture by CRI by CT				0.031
American x 75 CRI x 3000 K	98	4.00	1.61	
American x 75 CRI x 5000 K	98	4.03	1.64	
American x 95 CRI x 3000 K	98	3.36	1.61	
American x 95 CRI x 5000 K	98	4.12	1.71	
Korean x 75 CRI x 3000 K	98	3.82	1.54	
Korean x 75 CRI x 5000 K	98	4.01	1.52	
Korean x 95 CRI x 3000 K	98	4.04	1.56	
Korean x 95 CRI x 5000 K	98	4.04	1.39	
Location by CRI by CT				N.S.
Inside x 75 CRI x 3000 K	98	3.73	1.58	
Inside x 75 CRI x 5000 K	98	4.02	1.60	
Inside x 95 CRI x 3000 K	98	3.54	1.61	
Inside x 95 CRI x 5000 K	98	4.14	1.56	
Outside x 75 CRI x 3000 K	98	4.08	1.56	
Outside x 75 CRI x 5000 K	98	4.02	1.57	
Outside x 95 CRI x 3000 K	98	3.86	1.62	
Outside x 95 CRI x 5000 K	98	4.02	1.56	

Table 64 (Continued)

Source	n	Mean	SD	p
Culture by Location by CRI by CT				N.S.
American x Inside x 75 CRI x 3000 K	49	3.84	1.64	
American x Inside x 75 CRI x 5000 K	49	4.27	1.56	
American x Inside x 95 CRI x 3000 K	49	3.22	1.57	
American x Inside x 95 CRI x 5000 K	49	4.27	1.67	
American x Outside x 75 CRI x 3000 K	49	4.16	1.57	
American x Outside x 75 CRI x 5000 K	49	3.80	1.70	
American x Outside x 95 CRI x 3000 K	49	3.49	1.65	
American x Outside x 95 CRI x 5000 K	49	3.98	1.76	
Korean x Inside x 75 CRI x 3000 K	49	3.63	1.52	
Korean x Inside x 75 CRI x 5000 K	49	3.78	1.61	
Korean x Inside x 95 CRI x 3000 K	49	3.86	1.59	
Korean x Inside x 95 CRI x 5000 K	49	4.02	1.45	
Korean x Outside x 75 CRI x 3000 K	49	4.00	1.55	
Korean x Outside x 75 CRI x 5000 K	49	4.24	1.41	
Korean x Outside x 95 CRI x 3000 K	49	4.22	1.52	
Korean x Outside x 95 CRI x 5000 K	49	4.06	1.34	

[1]. 7 point Likert-type scale: 1 = like and 7 = dislike
Note. N.S = not significant at $p < .05$ (see ANOVA results in the next table).

Table 65

Analysis of Variance for Subjects' Overall Lighting Preference When Observed from Inside and Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	1.94	1.94	0.49	0.486
Between Error	96	380.04	3.96		
Location	1	3.58	3.58	1.58	0.209
CRI	1	1.07	1.07	0.47	0.492
CT	1	12.00	12.00	5.30	0.022 *
Culture x Location	1	6.07	6.07	2.68	0.102
Culture x CRI	1	7.96	7.96	3.52	0.061
Culture x CT	1	4.44	4.44	1.96	0.162
Location x CRI	1	0.29	0.29	0.13	0.722
Location x CT	1	7.56	7.56	3.34	0.068
CRI x CT	1	3.58	3.58	1.58	0.209
Culture x Location x CRI	1	0.93	0.93	0.41	0.522
Culture x Location x CT	1	3.86	3.86	1.70	0.192
Culture x CRI x CT	1	10.56	10.56	4.67	0.031 *
Location x CRI x CT	1	0.10	0.10	0.05	0.831
Culture x Location x CRI x CT	1	1.39	1.39	0.61	0.434
Within Error	672	1521.47	2.26		

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

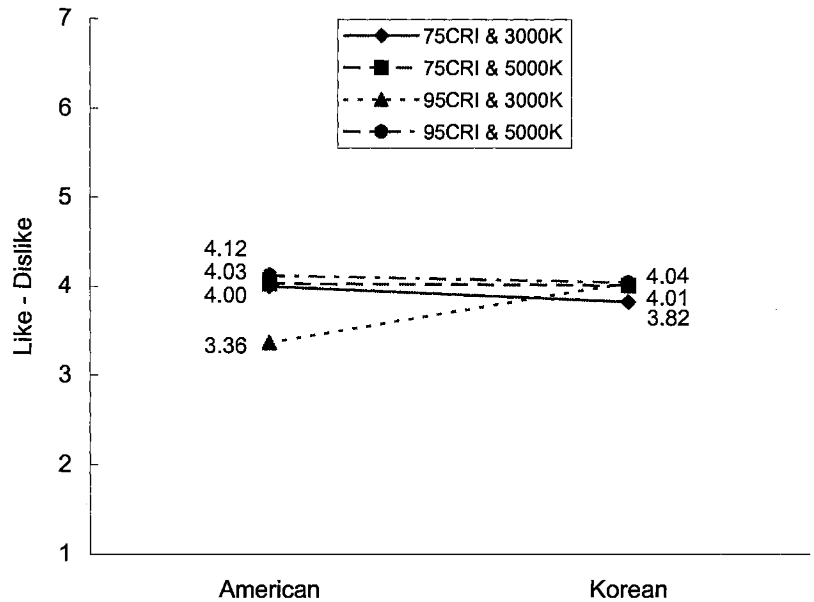


Figure 18. Three-Way Interaction of Culture by CRI by CT for Subjects' Overall Lighting Preference When Observed from Inside and Outside the Lighted Environment

Table 66

Analysis of Simple Effects (Culture x CRI x CT) for Subjects' Overall Lighting Preference When Observed from Inside and Outside the Lighted Environment

	1 [A x 7 x 30]	2 [A x 7 x 50]	3 [A x 9 x 30]	4 [A x 9 x 50]	5 [K x 7 x 30]	6 [K x 7 x 50]	7 [K x 9 x 30]	8 [K x 9 x 50]
1								
2	-0.14 (0.8868)							
3	2.99** (0.0029)	3.13** (0.0018)						
4	-0.57 (0.5691)	-0.43 (0.6693)	-3.56*** (0.0004)					
5	0.85 (0.3931)	1.00 (0.3192)	-2.14* (0.0330)	1.42 (0.1549)				
6	-0.05 (0.9622)	0.09 (0.9244)	-3.04** (0.0025)	0.52 (0.6017)	-0.90 (0.3674)			
7	-0.19 (0.8495)	-0.05 (0.9622)	-3.18** (0.0015)	0.38 (0.7042)	-1.04 (0.2967)	-0.14 (0.8868)		
8	-0.19 (0.8495)	-0.05 (0.9622)	-3.18** (0.0015)	0.38 (0.7042)	-1.04 (0.2967)	-0.14 (0.8868)	0.00 (1.0000)	

Note. Bracket Designation, "[ ]", indicates A = American, K = Korean, 7 = 75 CRI, 9 = 95 CRI, 30 = 3000K, and 50 = 5000K. Numeric value in parenthesis "( )" indicates p-value
*$p < .05$. **$p < .01$. ***$p < .001$

Hypothesis 26. There is no difference in the subjects' impression of the light color with regard to

a) culture (American and Korean)
b) location (inside and outside)
c) color rendering index of fluorescent light (75 CRI and 95 CRI)
d) color temperature of fluorescent light (3000 K and 5000 K)

To investigate the impression of the light color according to the study variables when observed from inside and outside the lighted environment, the hypothesis 26 was tested. For this test, chi-square analysis was conducted to evaluate the color of the light associating with six names of color including reddish, orangish, yellowish, greenish, bluish, and whitish.

The results of the analysis for this measure are shown in Table 67. Culture group between the American and Korean was statistically significant at $\chi^2 = 13.24$, $p = 0.0212$. The graph of the subjects' impression of the color of the light between American and Korean subjects is illustrated in Figure 19. More Korean subjects than American subjects described the color of the light as being orangish, yellowish, and whitish, while more American subjects than Korean subjects described the color of the light as being greenish and bluish regardless of location, color rendering index, and color temperature differences. Thus, the Hypothesis 26a was rejected.

The location between inside and outside was statistically significant at $\chi^2 = 11.64$, $p = 0.0400$. From inside the lighted environment, the subjects described the color of the light as being more yellowish (n: 104, 13.3%), greenish (n: 21, 2.7%), and bluish (n: 77, 9.8%), than from outside the lighted environment. However, from outside the lighted environment, all respondents described the color of the light as being more reddish (n: 21, 2.7%), orangish (n: 83, 10.6%), and whitish (n: 120, 15.3%) than from inside the lighted environment. The graph of the subjects' color impression of the light between inside and outside the lighted environments is shown in Figure 20. As indicated in Figure 20, the two different location had a strong effect on the subjects' impression of the light color regardless of culture group, color rendering index, and color temperature differences. Thus, the Hypothesis 26b was rejected.

Color temperature (3000 K and 5000 K) was statistically significant at $\chi^2 = 429.37$, $p = 0.0001$. Most of the subjects described the lower color temperature (3000 K) of the light source as warm colors, reddish (n: 25, 3.2%), orangish (n: 144, 18.4%) and yellowish (n: 162, 20.7%), whereas they described the higher color temperature (5000 K) of the light source as cool colors, greenish (n: 25, 3.2%), bluish (n: 124, 15.8 %) and whitish (n: 200 25.5 %). The graph of the subjects' impression of the color of the light on the two different color temperatures is illustrated in Figure 21. As indicated in Figure 21, the color temperature had a strong effect on the subjects' impression of the light color regardless of culture group, location, and color rendering index differences. Thus, the Hypothesis 26d was rejected.

For color rendering index, there was no statistical significance. Although most subjects perceived the color of the light as being orangish, yellowish, bluish, and whitish, there were little differences in color rendering indices between 75 CRI and 95 CRI. Therefore, the Hypothesis 26c was not rejected.

Table 67

Chi-square Analysis of Subjects' Impression of the Light Color When Observed from Inside and Outside the Lighted Environment

Variable	Total subject [a]	Reddish n	Reddish (%)[b]	Orangish n	Orangish (%)[b]	Yellowish n	Yellowish (%)[b]	Greenish n	Greenish (%)[b]	Bluish n	Bluish (%)[b]	Whitish n	Whitish (%)[b]	χ^2	p
Culture group														13.24	0.0212*
American	392	12	(1.5)	70	(8.9)	89	(11.4)	22	(2.8)	87	(11.1)	112	(14.3)		
Korean	392	17	(2.2)	82	(10.5)	104	(13.3)	11	(1.4)	57	(7.3)	121	(15.4)		
Location														11.64	0.0400*
Inside	392	8	(1.0)	69	(8.8)	104	(13.3)	21	(2.7)	77	(9.8)	113	(14.4)		
Outside	392	21	(2.7)	83	(10.6)	89	(11.4)	12	(1.5)	67	(8.6)	120	(15.3)		
Color Rendering Index														2.65	0.7544
75 CRI	392	13	(1.7)	78	(10.0)	88	(11.2)	18	(2.3)	75	(9.6)	120	(15.3)		
95 CRI	392	16	(2.0)	74	(9.4)	105	(13.4)	15	(1.9)	69	(8.8)	113	(14.4)		
Color Temperature														429.37	0.0001***
3000 K	392	25	(3.2)	144	(18.4)	162	(20.7)	8	(1.0)	20	(2.6)	33	(4.2)		
5000 K	392	4	(0.5)	8	(1.0)	31	(4.0)	25	(3.2)	124	(15.8)	200	(25.5)		

[a] Total subjects: 49 in American group and 49 in Korean group. Repeated measures designs yield four observations per person, thus a total of 784 observations.
[b] % based on 392 observations for each main effect.
* $p < .05$. ** $p < .01$. *** $p < .001$

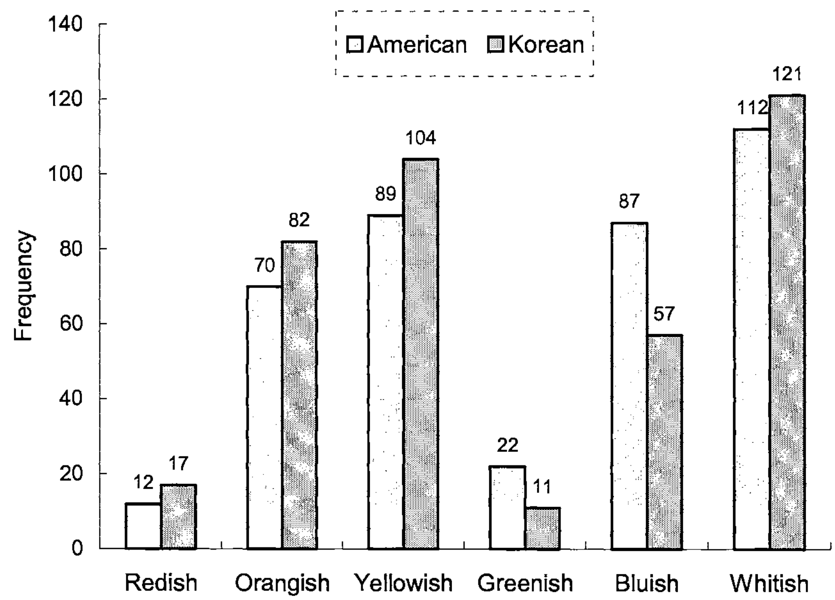


Figure 19. A Graph of the Subjects' Impression of the light color by two different culture groups When Observed from Inside and outside the Lighted Environment

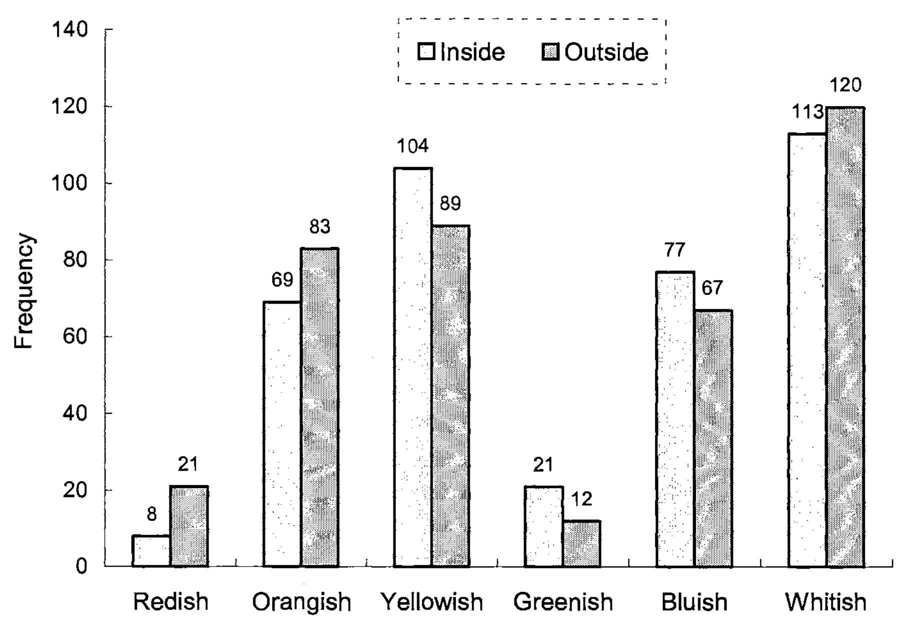


Figure 20. A Graph of the Subjects' Impression of the Light Color When Observed between Inside and Outside the Lighted Environment

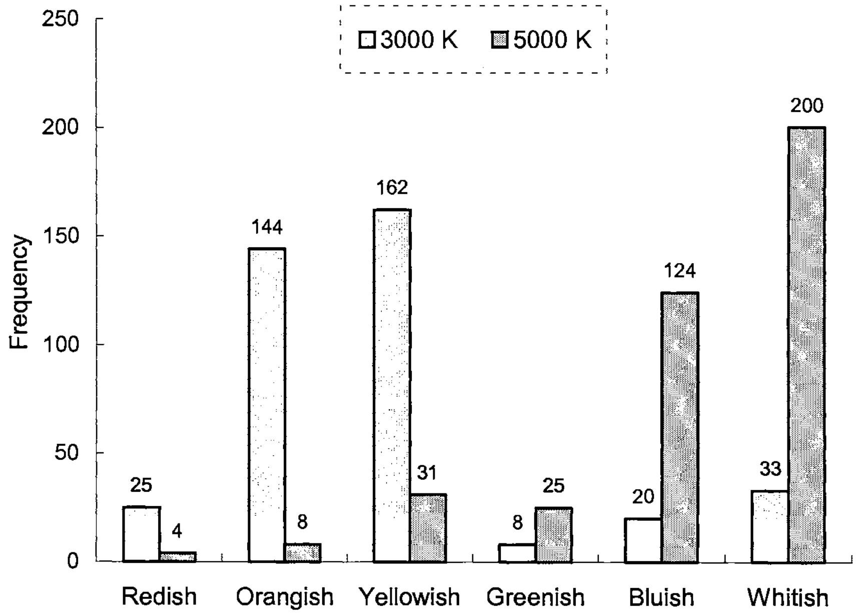


Figure 21. A Graph of the Subjects' Impression of the Light Color by Two Different Color Temperatures When Observed from Inside and Outside the Lighted Environment

Hypothesis 27. There is no difference in the subjects' preference of the light color with regard to

a) culture (American and Korean)
b) location (inside and outside)
c) color rendering index of fluorescent light (75 CRI and 95 CRI)
d) color temperature of fluorescent light (3000 K and 5000 K)
e) two-way interaction of culture by location
f) two-way interaction of culture by CRI
g) two-way interaction of culture by CT
h) two-way interaction of location by CRI
i) two-way interaction of location by CT
j) two-way interaction of CRI by CT
k) three-way interaction of culture by location by CRI
l) three-way interaction of culture by location by CT
m) three-way interaction of culture by CRI by CT
n) three-way interaction of location by CRI by CT
o) four-way interaction of culture by location by CRI by CT

Responses using the bipolar adjectives "like and dislike," on a seven-point Likert-type scale were used to assess the subjects' preference of the light color by comparing responses made from inside and outside the lighted environments. Table 68 shows the mean and standard deviation scores for main effects, two-way interactions, three-way interactions, and a four-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 69. Results showed a significant a two-way interaction and a three-way interaction, namely culture by location $\underline{F}$ (1, 672) = 4.97, $\underline{p}$ = .026 and culture by color rendering index by color temperature $\underline{F}$ (1,672) = 9.57, $\underline{p}$ = .002. Therefore, the Hypotheses 27e and 27m were rejected.

To assess the significance of such findings, analysis of the simple effects was conducted. The outcomes for a two-way interaction of culture by location are presented in Figure 22 and Table 70. There was no difference between American and Korean subjects regarding inside (M = 3.73) and outside (M = 4.08) lighted environment for their preference of the color of the light. However, Korean subjects preferred the color of the light by observing from inside lighted environment better than by observing from outside the environment.

The outcomes for a three-way interaction of culture by CRI by CT are presented in Figure 23 and Table 71. As can be seen in Fig.23, there was significant differences between American and Korean subjects for the preference of the color of the light under 930 lighting condition regardless of location differences. American subjects (M = 3.50) preferred the color of the 930 lighting better than Korean subjects (M = 3.95) did. The American subjects preferred the color of the light with the lower color temperature of 3000 K (M = 3.50) better than the higher color temperature of 5000 K (M = 4.10) with 95 CRI. Also, American subjects preferred the color of the light with 95 CRI (M = 3.50) better than 75 CRI (M = 4.13) at the color temperature of 3000 K. However, Korean subjects preferred the color of the light with 3000 K better than 5000 K with 75 CRI. In other words, the findings of this three-way interaction indicate that American respondents preferred the color of 930 lighting as the best across all lighting conditions.

There were no significant differences regarding to the main effects of culture groups (American and Korean), locations (inside and outside the lighted environment), color rendering indices (75 CRI and 95 CRI), and color temperatures (3000 K and 5000 K). Therefore, the Hypotheses 27a, 27b, 27c, and 27d were not rejected. No significant differences resulted in two-way interactions of culture by CRI, culture by CT, location by CRI, location by CT, and CRI by CT. Therefore, the Hypotheses 27f, 27g, 27h, 27i, and 27j were not rejected. There were also no significant differences regarding to three-way interactions of culture by location by CRI, culture by location by CT, and location by CRI by CT, and a four-way interaction of culture, location, CRI, and CT. Therefore, the Hypotheses 27k, 27l, 27n, and 72o were not rejected.

Table 68

A Comparison of the Mean and Standard Deviation Scores for Subjects' Preference of the Light Color[1] When Observed from Inside and Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S
American	392	3.92	1.69	
Korean	392	3.90	1.53	
Location				N.S
Inside	392	3.86	1.60	
Outside	392	3.96	1.62	
Color Rendering Index				N.S
75 CRI	392	3.99	1.59	
95 CRI	392	3.84	1.63	
Color Temperatures				N.S
3000 K	392	3.82	1.59	
5000 K	392	4.00	1.63	
Culture by Location				0.026
American x Inside	196	4.00	1.65	
American x Outside	196	3.85	1.73	
Korean x Inside	196	3.73	1.55	
Korean x Outside	196	4.08	1.49	
Culture by CRI				N.S
American x 75 CRI	196	4.05	1.69	
American x 95 CRI	196	3.80	1.68	
Korean x 75 CRI	196	3.93	1.49	
Korean x 95 CRI	196	3.87	1.57	
Culture by CT				N.S
American x 3000 K	196	3.82	1.67	
American x 5000 K	196	4.03	1.71	
Korean x 3000 K	196	3.83	1.51	
Korean x 5000 K	196	3.98	1.55	
Location by CRI				N.S.
Inside x 75 CRI	196	3.91	1.61	
Inside x 95 CRI	196	3.82	1.60	
Outside x 75 CRI	196	4.07	1.58	
Outside x 95 CRI	196	3.86	1.66	
Location by CT				N.S
Inside x 3000 K	196	3.78	1.58	
Inside x 5000 K	196	3.95	1.62	
Outside x 3000 K	196	3.86	1.60	
Outside x 5000 K	196	4.06	1.63	

Table 68 (Continued)

Source	n	Mean	SD	p
CRI by CT				N.S.
75 CRI x 3000 K	196	3.92	1.60	
75 CRI x 5000 K	196	4.06	1.59	
95 CRI x 3000 K	196	3.72	1.58	
95 CRI x 5000 K	196	3.95	1.67	
Culture by Location by CRI				N.S.
American x Inside x 75 CRI	98	4.07	1.66	
American x Inside x 95 CRI	98	3.93	1.63	
American x Outside x 75 CRI	98	4.02	1.73	
American x Outside x 95 CRI	98	3.67	1.73	
Korean x Inside x 75 CRI	98	3.76	1.55	
Korean x Inside x 95 CRI	98	3.70	1.56	
Korean x Outside x 75 CRI	98	4.11	1.41	
Korean x Outside x 95 CRI	98	4.04	1.57	
Culture by Location by CT				N.S
American x Inside x 3000 K	98	3.91	1.66	
American x Inside x 5000 K	98	4.09	1.63	
American x Outside x 3000 K	98	3.72	1.68	
American x Outside x 5000 K	98	3.97	1.78	
Korean x Inside x 3000 K	98	3.65	1.50	
Korean x Inside x 5000 K	98	3.81	1.60	
Korean x Outside x 3000 K	98	4.00	1.51	
Korean x Outside x 5000 K	98	4.15	1.47	
Culture by CRI by CT				0.002
American x 75 CRI x 3000 K	98	4.13	1.71	
American x 75 CRI x 5000 K	98	3.96	1.68	
American x 95 CRI x 3000 K	98	3.50	1.57	
American x 95 CRI x 5000 K	98	4.10	1.74	
Korean x 75 CRI x 3000 K	98	3.70	1.46	
Korean x 75 CRI x 5000 K	98	4.16	1.49	
Korean x 95 CRI x 3000 K	98	3.95	1.56	
Korean x 95 CRI x 5000 K	98	3.80	1.59	
Location by CRI by CT				N.S.
Inside x 75 CRI x 3000 K	98	3.86	1.66	
Inside x 75 CRI x 5000 K	98	3.97	1.57	
Inside x 95 CRI x 3000 K	98	3.70	1.51	
Inside x 95 CRI x 5000 K	98	3.93	1.68	
Outside x 75 CRI x 3000 K	98	3.98	1.55	
Outside x 75 CRI x 5000 K	98	4.15	1.61	
Outside x 95 CRI x 3000 K	98	3.74	1.65	
Outside x 95 CRI x 5000 K	98	3.97	1.67	

Table 68 (Continued)

Source	n	Mean	SD	p
Culture by Location by CRI by CT				N.S.
American x Inside x 75 CRI x 3000 K	49	4.10	1.73	
American x Inside x 75 CRI x 5000 K	49	4.04	1.61	
American x Inside x 95 CRI x 3000 K	49	3.71	1.58	
American x Inside x 95 CRI x 5000 K	49	4.14	1.67	
American x Outside x 75 CRI x 3000 K	49	4.16	1.70	
American x Outside x 75 CRI x 5000 K	49	3.88	1.76	
American x Outside x 95 CRI x 3000 K	49	3.29	1.55	
American x Outside x 95 CRI x 5000 K	49	4.06	1.82	
Korean x Inside x 75 CRI x 3000 K	49	3.61	1.55	
Korean x Inside x 75 CRI x 5000 K	49	3.90	1.54	
Korean x Inside x 95 CRI x 3000 K	49	3.69	1.46	
Korean x Inside x 95 CRI x 5000 K	49	3.71	1.67	
Korean x Outside x 75 CRI x 3000 K	49	3.80	1.37	
Korean x Outside x 75 CRI x 5000 K	49	4.43	1.40	
Korean x Outside x 95 CRI x 3000 K	49	4.20	1.63	
Korean x Outside x 95 CRI x 5000 K	49	3.88	1.51	

[1] 7 point Likert-type scale: 1 = like and 7 = dislike
Note. N.S = not significant at $p < .05$ (see ANOVA results in the next table).

Table 69

Analysis of Variance for Subjects' Preference of the Light Color When Observed from Inside and Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	0.08	0.08	0.02	0.875
Between Error	96	316.52	3.30		
Location	1	1.84	1.84	0.75	0.388
CRI	1	4.59	4.59	1.86	0.173
CT	1	6.61	6.61	2.68	0.102
Culture x Location	1	12.25	12.25	4.97	0.026 *
Culture x CRI	1	1.65	1.65	0.67	0.413
Culture x CT	1	0.18	0.18	0.07	0.785
Location x CRI	1	0.62	0.62	0.25	0.617
Location x CT	1	0.05	0.05	0.02	0.892
CRI x CT	1	0.33	0.33	0.13	0.716
Culture x Location x CRI	1	0.41	0.41	0.17	0.682
Culture x Location x CT	1	0.05	0.05	0.02	0.892
Culture x CRI x CT	1	23.59	23.59	9.57	0.002 **
Location x CRI x CT	1	0.05	0.05	0.02	0.892
Culture x Location x CRI x CT	1	4.90	4.90	1.99	0.159
Within Error	672	1656.38	2.46		

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

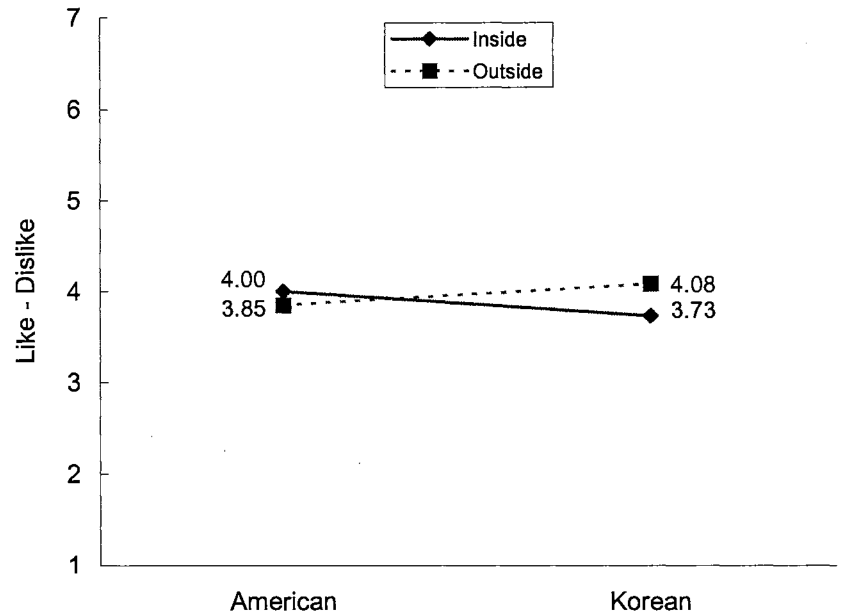


Figure 22. Two-Way Interaction of Culture by Location for Subjects' Preference of the Light Color When Observed from Inside and Outside the Lighted Environment

Table 70

Analysis of Simple Effects (Culture x Location) for Subjects' Preference of the Light Color When Observed from Inside and Outside the Lighted Environment

	1 [American x Inside]	2 [American x Outside]	3 [Korean x Inside]	4 [Korean x Outside]
1				
2	0.97 (0.3348)			
3	1.71 (0.0886)	0.74 (0.4596)		
4	-0.48 (0.6296)	-1.45 (0.1482)	-2.19* (0.0290)	

Note. Numeric value in parenthesis "( )" indicates p-value
*p < .05. **p < .01. ***p < .001

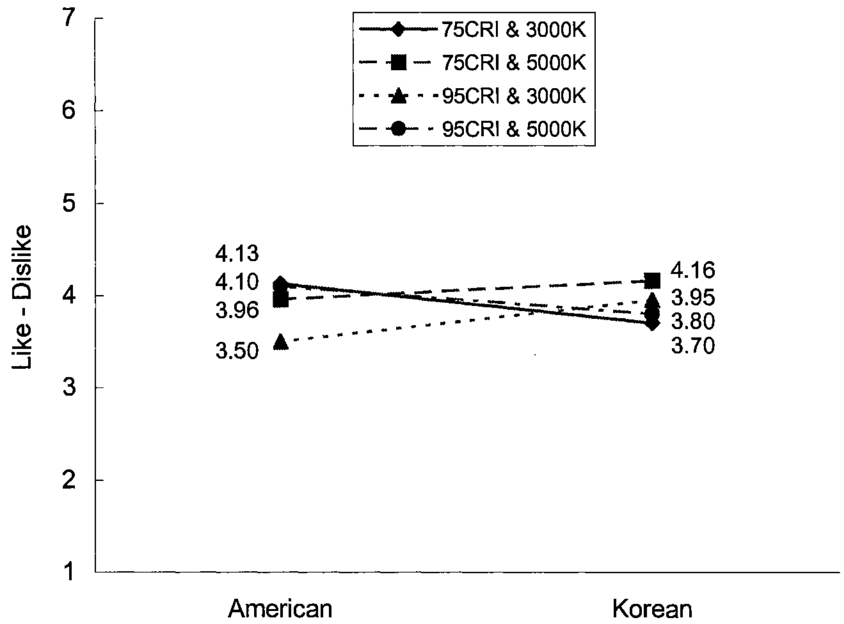


Figure 23. Three-Way Interaction of Culture by CRI by CT for Subjects' Preference of the Light Color When Observed from Inside and Outside the Lighted Environment

Table 71

Analysis of Simple Effects (Culture x CRI x CT) for Subjects' Preference of the Light Color When Observed from Inside and Outside the Lighted Environment

	1 [Ax7x30]	2 [Ax7x50]	3 [Ax9x30]	4 [Ax9x50]	5 [Kx7x30]	6 [Kx7x50]	7 [Kx9x30]	8 [Kx9x50]
1								
2	0.77 (0.4395)							
3	2.82** (0.0049)	2.05* (0.0410)						
4	0.14 (0.8915)	-0.64 (0.5244)	-2.68** (0.0074)					
5	1.91 (0.0564)	1.14 (0.2558)	-0.91 (0.3632)	1.77 (0.0765)				
6	-0.14 (0.8915)	-0.91 (0.3632)	-2.96** (0.0032)	-0.27 (0.7850)	-2.05* (0.0410)			
7	0.82 (0.4131)	0.05 (0.9637)	-2.00* (0.0457)	0.68 (0.4952)	-1.09 (0.2753)	0.96 (0.3397)		
8	1.50 (0.1337)	0.73 (0.4669)	-1.32 (0.1875)	1.36 (0.1727)	-0.41 (0.6823)	1.64 (0.1019)	0.68 (0.4952)	

Note. Bracket Designation, "[ ]", indicates A = American, K = Korean, 7 = 75 CRI, 9 = 95 CRI, 30 = 3000K, and 50 = 5000K. Numeric value in parenthesis "( )" indicates p-value
*$p < .05$. **$p < .01$. ***$p < .001$

Hypothesis 28. There is no difference in the subjects' perception of fruit color as being natural or unnatural with regard to

a) culture (American and Korean)
b) location (inside and outside)
c) color rendering index of fluorescent light (75 CRI and 95 CRI)
d) color temperature of fluorescent light (3000 K and 5000 K)
e) two-way interaction of culture by location
f) two-way interaction of culture by CRI
g) two-way interaction of culture by CT
h) two-way interaction of location by CRI
i) two-way interaction of location by CT
j) two-way interaction of CRI by CT
k) three-way interaction of culture by location by CRI
l) three-way interaction of culture by location by CT
m) three-way interaction of culture by CRI by CT
n) three-way interaction of location by CRI by CT
o) four-way interaction of culture by location by CRI by CT

Responses using the bipolar adjectives "natural or not natural," on a seven-point Likert-type scale were used to assess the subjects' perception of fruit color for the four different lighting conditions by comparing responses made from inside and outside the lighted environments. Table 72 shows the mean and standard deviation scores for main effects, two-way interactions, three-way interactions, and a four-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 73. Culture group as a main effect was significant at $\underline{p} = .004$ with calculated $\underline{F}$ (1,96 = 8.54). American respondents estimated the colors of the fruit as more natural than Korean subjects did regardless of location, color rendering index, and color temperature differences. Therefore, the Hypothesis 28a was rejected.

There were no significant differences regarding to the main effects of locations (inside and outside the lighted environment), color rendering indices (75 CRI and 95 CRI), and color temperatures (3000 K and 5000 K). Therefore, the Hypotheses 28b, 28c, and 28d were not rejected. There were no significant differences regarding to all two-way interactions, all three-way interactions and a four-way interaction of culture, location, CRI, and CT. Therefore, the Hypotheses 28e, 28f, 28g, 28h, 28i, 28j, 28k, 28l, 28m, 28n, and 28o were not rejected.

Table 72

A Comparison of the Mean and Standard Deviation Scores for Subjects' Perception of Fruit Color[1] When Observed from Inside and Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				0.004
American	392	3.16	1.53	
Korean	392	3.59	1.41	
Location				N.S
Inside	392	3.29	1.45	
Outside	392	3.46	1.53	
Color Rendering Index				N.S
75 CRI	392	3.42	1.48	
95 CRI	392	3.33	1.51	
Color Temperatures				N.S
3000 K	392	3.31	1.51	
5000 K	392	3.44	1.47	
Culture by Location				N.S
American x Inside	196	3.14	1.50	
American x Outside	196	3.17	1.57	
Korean x Inside	196	3.44	1.39	
Korean x Outside	196	3.74	1.43	
Culture by CRI				N.S
American x 75 CRI	196	3.22	1.54	
American x 95 CRI	196	3.09	1.53	
Korean x 75 CRI	196	3.62	1.39	
Korean x 95 CRI	196	3.56	1.44	
Culture by CT				N.S
American x 3000 K	196	3.09	1.53	
American x 5000 K	196	3.22	1.54	
Korean x 3000 K	196	3.52	1.46	
Korean x 5000 K	196	3.66	1.37	
Location by CRI				N.S.
Inside x 75 CRI	196	3.37	1.44	
Inside x 95 CRI	196	3.21	1.46	
Outside x 75 CRI	196	3.47	1.51	
Outside x 95 CRI	196	3.44	1.55	
Location by CT				N.S
Inside x 3000 K	196	3.18	1.44	
Inside x 5000 K	196	3.40	1.45	
Outside x 3000 K	196	3.43	1.57	
Outside x 5000 K	196	3.48	1.49	

Table 72 (Continued)

Source	n	Mean	SD	p
CRI by CT				N.S.
75 CRI x 3000 K	196	3.26	1.47	
75 CRI x 5000 K	196	3.58	1.47	
95 CRI x 3000 K	196	3.35	1.55	
95 CRI x 5000 K	196	3.30	1.47	
Culture by Location by CRI				N.S.
American x Inside x 75 CRI	98	3.28	1.52	
American x Inside x 95 CRI	98	3.00	1.47	
American x Outside x 75 CRI	98	3.16	1.56	
American x Outside x 95 CRI	98	3.18	1.59	
Korean x Inside x 75 CRI	98	3.46	1.36	
Korean x Inside x 95 CRI	98	3.43	1.41	
Korean x Outside x 75 CRI	98	3.79	1.40	
Korean x Outside x 95 CRI	98	3.69	1.47	
Culture by Location by CT				N.S
American x Inside x 3000 K	98	2.97	1.49	
American x Inside x 5000 K	98	3.31	1.50	
American x Outside x 3000 K	98	3.21	1.56	
American x Outside x 5000 K	98	3.13	1.59	
Korean x Inside x 3000 K	98	3.39	1.37	
Korean x Inside x 5000 K	98	3.50	1.41	
Korean x Outside x 3000 K	98	3.65	1.55	
Korean x Outside x 5000 K	98	3.83	1.31	
Culture by CRI by CT				N.S
American x 75 CRI x 3000 K	98	3.05	1.52	
American x 75 CRI x 5000 K	98	3.39	1.54	
American x 95 CRI x 3000 K	98	3.13	1.54	
American x 95 CRI x 5000 K	98	3.05	1.53	
Korean x 75 CRI x 3000 K	98	3.47	1.40	
Korean x 75 CRI x 5000 K	98	3.78	1.37	
Korean x 95 CRI x 3000 K	98	3.57	1.53	
Korean x 95 CRI x 5000 K	98	3.55	1.36	
Location by CRI by CT				N.S.
Inside x 75 CRI x 3000 K	98	3.19	1.41	
Inside x 75 CRI x 5000 K	98	3.54	1.46	
Inside x 95 CRI x 3000 K	98	3.16	1.48	
Inside x 95 CRI x 5000 K	98	3.27	1.44	
Outside x 75 CRI x 3000 K	98	3.33	1.53	
Outside x 75 CRI x 5000 K	98	3.62	1.48	
Outside x 95 CRI x 3000 K	98	3.54	1.60	
Outside x 95 CRI x 5000 K	98	3.34	1.50	

Table 72 (Continued)

Source	n	Mean	SD	p
Culture by Location by CRI by CT				N.S.
American x Inside x 75 CRI x 3000 K	49	3.06	1.49	
American x Inside x 75 CRI x 5000 K	49	3.49	1.53	
American x Inside x 95 CRI x 3000 K	49	2.88	1.49	
American x Inside x 95 CRI x 5000 K	49	3.12	1.45	
American x Outside x 75 CRI x 3000 K	49	3.04	1.55	
American x Outside x 75 CRI x 5000 K	49	3.29	1.57	
American x Outside x 95 CRI x 3000 K	49	3.39	1.57	
American x Outside x 95 CRI x 5000 K	49	2.98	1.61	
Korean x Inside x 75 CRI x 3000 K	49	3.33	1.33	
Korean x Inside x 75 CRI x 5000 K	49	3.59	1.40	
Korean x Inside x 95 CRI x 3000 K	49	3.45	1.42	
Korean x Inside x 95 CRI x 5000 K	49	3.41	1.43	
Korean x Outside x 75 CRI x 3000 K	49	3.61	1.47	
Korean x Outside x 75 CRI x 5000 K	49	3.96	1.32	
Korean x Outside x 95 CRI x 3000 K	49	3.69	1.64	
Korean x Outside x 95 CRI x 5000 K	49	3.69	1.29	

[1]. 7 point Likert-type scale: 1 = natural and 7 = not natural
Note. N.S = not significant at $p < .05$ (see ANOVA results in the next table).

Table 73

Analysis of Variance for Subjects' Perception of Fruit Color as Observed from Inside and outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	37.30	37.30	8.54	0.004*
Between Error	96	419.08	4.37		
Location	1	5.39	5.39	2.89	0.090
CRI	1	1.75	1.75	0.94	0.334
CT	1	3.58	3.58	1.92	0.166
Culture x Location	1	3.32	3.32	1.78	0.183
Culture x CRI	1	0.22	0.22	0.12	0.734
Culture x CT	1	0.01	0.01	0.01	0.938
Location x CRI	1	0.67	0.67	0.36	0.548
Location x CT	1	1.56	1.56	0.84	0.361
CRI x CT	1	6.80	6.80	3.64	0.057
Culture x Location x CRI	1	1.56	1.56	0.84	0.361
Culture x Location x CT	1	2.82	2.82	1.51	0.220
Culture x CRI x CT	1	0.10	0.10	0.06	0.814
Location x CRI x CT	1	0.80	0.80	0.43	0.514
Culture x Location x CRI x CT	1	0.56	0.56	0.30	0.583
Within Error	672	1253.98	1.87		

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

Hypothesis 29. There is no difference in the subjects' color perception for five different kinds of fruit with regard to

a) culture (American and Korean)
b) location (inside and outside)
c) color rendering index of fluorescent light (75 CRI and 95 CRI)
d) color temperature of fluorescent light (3000 K and 5000 K)

To identify the subjects' color perception of natural objects under the four different lighting conditions, the colors of five different kinds of fruit in a bowl was tested by observing from inside and outside the lighted environments. The five fruits were apple, orange, banana, lemon, and grape. For this measure, chi-square analysis was conducted. The results of the analysis are shown in Table 74.

The variable of culture group (American and Korean) was statistically significant for both the orange ($\chi^2 = 28.79$, $\underline{p} = 0.0001$) and grape color perception ($\chi^2 = 4.57$, $\underline{p} = 0.0325$). Although most of the respondents described all fruit color as being not distorted from their natural color, the differences between the Americans and Koreans were found for the orange color perception. Eighty-five (10.7%) out of 392 American subjects responded to the orange color as being distorted from its natural color, while 35 (4.5%) out of 392 Korean subjects responded to the orange color as being distorted. For the grape color perception, there was a difference between the American and Korean subjects. One hundred sixty-two (20.7%) out of 392 Korean subjects responded to the grape color as being distorted, while 133 (17.0%) out of 392 American subjects responded to the grape color as being distorted. In other words, for the orange color perception, the American respondents estimated as more distorted than the Korean respondents. However, for the grape color perception, the Korean respondents estimated as more distorted than the American respondents. Therefore, the Hypothesis 29a was rejected.

The variable of location between inside and outside was statistically significant for the grape color perception ($\chi^2 = 13.05$, $\underline{p} = 0.0003$). Although more than half of the respondents described the grape color as being not distorted from its natural color, there was a big difference between inside and outside location. One hundred seventy-two (21.9%) subjects by observing from inside the lighted environment responded to the grape color as being distorted, while 123

(15.7%) subjects by observing from outside the lighted environment responded to the grape color as being distorted. Therefore, the Hypothesis 29b was rejected.

Color rendering index had a significant impact for the lemon color perception ($\chi^2 = 15.76$, $p = 0.0001$). Although most of the respondents described the lemon color as being not distorted from its natural color, there is a big difference between 75 CRI and 95 CRI by both the American and Korean subjects for the lemon color perception. One hundred nine (13.9%) subjects in both groups responded to the lemon color as being distorted under 75 CRI, while 63 (8.0%) subjects estimated the lemon color as being distorted under 95 CRI. Therefore, the Hypothesis 29c was rejected.

There was no statistical significance for the variable of color temperature on subjects' color perception for five fruits as being distorted or not distorted under the four different lighting conditions. The percentage of the subjects' color perception of five fruits shows very little difference between the two different color temperatures. Therefore, the Hypothesis 29d was not rejected.

Table 74

Chi-square Analysis of Subjects' Perception of Fruit Color as Being Distorted or Not Distorted When Observed from Inside and Outside the Lighted Environment

Variable	Total subject[a]	Apple		Orange		Banana		Lemon		Grape	
		Distorted	Not distorted	Distorted	Not distorted	Distorted	Not distorted	Distorted	Not distorted	Distorted	Not distorted
		n (%)[b]	n (%)[b]	n (%)[b]	n (%)[b]	n (%)[b]	n (%)[b]	n (%)[b]	n (%)[b]	n (%)[b]	n (%)[b]
Culture group											
American	392	96 (12.2)	296 (37.8)	84 (10.7)	308 (39.3)	79 (10.1)	313 (39.9)	92 (11.7)	300 (38.3)	133 (17.0)	259 (33.0)
Korean	392	99 (12.6)	293 (37.4)	35 (4.5)	357 (45.5)	101 (12.9)	291 (37.1)	80 (10.2)	312 (39.8)	162 (20.7)	230 (29.3)
χ^2		0.0614		23.7870		3.4902		1.0725		4.5707	
p		0.8042		0.0001 ***		0.0617		0.3004		0.0325 *	
Location											
Inside	392	106 (13.5)	286 (36.5)	64 (8.2)	328 (41.8)	99 (12.6)	293 (37.4)	83 (10.6)	309 (39.4)	172 (21.9)	220 (28.1)
Outside	392	89 (11.4)	303 (38.7)	55 (7.0)	337 (43.0)	81 (10.3)	311 (39.7)	89 (11.4)	303 (38.7)	123 (15.7)	269 (34.3)
χ^2		1.9727		0.8025		2.3364		0.2681		13.0490	
p		0.1602		0.3704		0.1264		0.6046		0.0003 ***	
CRI											
75 CRI	392	86 (11.0)	306 (39.0)	64 (8.2)	328 (41.8)	91 (11.6)	301 (38.4)	109 (13.9)	283 (36.1)	146 (18.6)	246 (31.4)
95 CRI	392	109 (13.9)	283 (36.1)	55 (7.0)	337 (43.0)	89 (11.4)	303 (38.7)	63 (8.0)	329 (42.0)	149 (19.0)	243 (31.0)
χ^2		3.6110		0.8025		0.0288		15.7598		0.0489	
p		0.0574		0.3704		0.8651		0.0001 ***		0.8250	
CT											
3000 K	392	100 (12.8)	292 (37.2)	57 (7.3)	335 (42.7)	85 (10.8)	307 (39.2)	94 (12.0)	298 (38.0)	145 (18.5)	247 (31.5)
5000 K	392	95 (12.1)	297 (37.9)	62 (7.9)	330 (42.1)	95 (12.1)	297 (37.9)	78 (10.0)	314 (40.0)	150 (19.1)	242 (30.9)
χ^2		0.1706		0.2477		0.7211		1.9067		0.1359	
p		0.6795		0.6187		0.3958		0.1673		0.7214	

[a] Total subjects: 49 in American group and 49 in Korean group. Repeated measures designs yield four observations per person, thus a total of 784 observations.
[b] % based on 392 observations for each main effect. * $p < .05$. ** $p < .01$. *** $p < .001$

Hypotheses in Section 4: Side-by-Side Evaluation

In this section, there are four sets of lighting comparisons according to two different color temperatures and color rendering indices. Two lighting conditions from cubicle one (left) and cubicle two (right) are turned on at the same time, and each subject observed and compared two lighting conditions simultaneously from outside the cubicle. This simultaneous and "side-by-side" evaluation allowed the comparison of two different color rendering indices by holding one of two color temperatures constant and the comparison of two different color temperatures by holding one of two color rendering indices constant. Thus:

- Set 1: 730 and 930 lamps were compared simultaneously (different CRI, 75 v. 95 at same CT, 3000K).
- Set 2: 750 and 950 lamps were compared simultaneously (different CRI, 75 v. 95 at same CT, 5000K).
- Set 3: 730 and 750 lamps were compared simultaneously (different CT, 3000K v. 5000K with same CRI, 75).
- Set 4: 930 and 950 lamps were compared simultaneously (different CT, 3000K v. 5000K with same CRI, 95).

Therefore, the results of the statistical analyses for each hypothesis are presented based on each set of the comparisons. Each set of the comparison has the same number of ten hypotheses.

Set 1: 730 lamps (75 CRI, 3000 K) vs. 930 lamps (95 CRI, 3000 K)

The comparison of 730 and 930 lighting conditions: two color rendering indices of 75 CRI and 95 CRI are compared when the color temperature of 3000 K is being held constant

Hypothesis 30. When two lighting conditions (730 and 930) are evaluated simultaneously, there is no difference in the subjects' perception of lighting as being visually warm or visually cool with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Responses using the bipolar adjectives, “visually warm or visually cool,” on a seven-point Likert-type scale were used to assess subjects' perception of lighting when two lighting conditions (730 and 930) are evaluated simultaneously from outside the cubicles. Table 75 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects’ perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 76. There was no significant difference regarding to the main effects of culture group (American and Korean) and color rendering index (75 CRI and 95 CRI) for subject’s perception of lighting as being visually warm or visually cool. Therefore, the Hypotheses 30a and 30b were not rejected. No significant difference resulted on a two-way interaction of culture by CRI. Thus, the Hypothesis 30c was not rejected.

Table 75

A Comparison of the Mean and Standard Deviation Scores for Subjects' Perception of Lighting as Being Visually Warm or Visually Cool[1] When 730 and 930 lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	98	2.91	1.29	
Korean	98	3.09	1.21	
Color Rendering Index				N.S.
75 CRI	98	3.11	1.23	
95 CRI	98	2.89	1.27	
Culture by CRI				N.S.
American x 75 CRI	49	2.96	1.21	
American x 95 CRI	49	2.86	1.37	
Korean x 75 CRI	49	3.27	1.24	
Korean x 95 CRI	49	2.92	1.17	

[1]. 7 point Likert-type scale: 1 = visually warm and 7= visually cool
Note. N.S = not significant at $p < .05$ (see ANOVA result in next table).

Table 76

Analysis of Variance for Subjects' Perception of Lighting as Being Visually Warm or Visually Cool When 730 and 930 lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	1.65	1.65	0.88	0.352
Between Error	96	181.35	1.89		
CRI	1	2.47	2.47	2.01	0.159
Culture x CRI	1	0.73	0.73	0.60	0.441
Within Error	96	117.80	1.23		

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

Hypothesis 31. When two lighting conditions (730 and 930) are evaluated simultaneously, there is no difference in the subjects' perception of lighting as a factor in visual clarity with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Responses using two bipolar adjectives, “bright/dim and clear/unclear,” on a seven-point Likert-type scale were used to assess subjects' perception of lighting when two lighting conditions (730 and 930) are evaluated simultaneously from outside the cubicles. Table 77 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 78. Color rendering index (CRI) as a main effect was statistically very significant with an $F(1, 96) = 45.03$, $p = .000$. All respondents estimated the lower color rendering index of 75 CRI ($M = 6.86$) as brighter and clearer than the higher color rendering index of 95 CRI ($M = 8.84$) at the color temperature of 3000 K regardless of culture group differences. Therefore, the Hypothesis 31b was rejected.

Culture group (American and Korean) as a main effect was not significant for subjects' perception of lighting as being bright/dim and clear/unclear. Thus, the Hypothesis 31a was not rejected. Also, culture by CRI as a two-way interaction was not significant for subject's perception of lighting as being clear or unclear. Thus, the Hypothesis 31c was not rejected.

Table 77

A Comparison of the Mean and Standard Deviation Scores for Subjects' Perception of Lighting as a Factor in Visual Clarity[1] When 730 and 930 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S
American	98	7.45	2.89	
Korean	98	8.25	2.74	
Color Rendering Index				0.000
75 CRI	98	6.86	2.66	
95 CRI	98	8.84	2.67	
Culture by CRI				N.S
American x 75 CRI	49	6.55	2.77	
American x 95 CRI	49	8.35	2.76	
Korean x 75 CRI	49	7.16	2.54	
Korean x 95 CRI	49	9.33	2.50	

[1]. Index score created for perception of visual clarity: 2 = the score that indicates the highest or best perception of visual clarity and 14 = the score that indicates the least or poorest perception of visual clarity
Note. N.S. = not significant at $p < .05$ (see ANOVA result in next table).

Table 78

Analysis of Variance for Subjects' Perception of Lighting as a Factor in Visual Clarity When 730 and 930 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	31.04	31.04	3.19	0.077
Between Error	96	935.37	9.74		
CRI	1	192.02	192.02	45.03	0.000***
Culture x CRI	1	1.65	1.65	0.39	0.535
Within Error	96	409.33	4.26		

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

Hypothesis 32. When two lighting conditions (730 and 930) are evaluated simultaneously, there is no difference in the subjects' perception of lighting for room attractiveness with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Responses using the two bipolar adjectives, "attractive/not attractive and inviting/not inviting," on a seven-point Likert-type scale were used to assess subjects' perception of room attractiveness when two lighting conditions (730 and 930) are evaluated simultaneously from outside the cubicles. Table 79 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 80. Regarding color rendering index (CRI) as a main effect, there was statistical significance at p = .000 with an F ratio of 14.45. All respondents estimated the lower color rendering index of 75 CRI (M = 6.42) as more attractive and inviting than the higher color rendering index of 95 CRI (M = 7.80) at the color temperature of 3000 K. Therefore, the Hypothesis 32b was rejected.

Culture group (American and Korean) as a main effect was not significant for subjects' perception of room attractiveness when two lighting conditions (730 and 930) are evaluated simultaneously from outside the cubicles. Thus, the Hypothesis 32a was not rejected. Also, culture by CRI as a two-way interaction was not significant. Thus, the Hypothesis 32c was not rejected.

Table 79

A Comparison of the Mean and Standard Deviation Scores for Subjects' Perception of Lighting for Room Attractiveness[1] When 730 and 930 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S
American	98	6.71	3.07	
Korean	98	7.50	2.92	
Color Rendering Index				0.000
75 CRI	98	6.42	2.76	
95 CRI	98	7.80	3.11	
Culture by CRI				N.S
American x 75 CRI	49	6.16	2.86	
American x 95 CRI	49	7.27	3.21	
Korean x 75 CRI	49	6.67	2.66	
Korean x 95 CRI	49	8.33	2.95	

[1]. Index score created for perception of room attractiveness: 2 = the score that indicates the highest or best perception of room attractiveness and 14 = the score that indicates the least or poorest perception of room attractiveness
Note. N.S = not significant at $p < .05$ (see ANOVA result in next table).

Table 80

Analysis of Variance for Subjects' Perception of Lighting for Room Attractiveness When 730 and 930 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	30.25	30.25	2.83	0.096
Between Error	96	1026.00	10.69		
CRI	1	92.98	92.98	14.45	0.000***
Culture x CRI	1	3.72	3.72	0.58	0.449
Within Error	96	617.80	6.44		

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

Hypothesis 33. When two lighting conditions (730 and 930) are evaluated simultaneously, there is no difference in the subjects' perception of lighting for approach-avoidance intention with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Responses using the bipolar adjectives, "approach or avoid," on a seven-point Likert-type scale were used to assess subjects' perception of lighting when two lighting conditions (730 and 930) are evaluated simultaneously from outside the cubicles. Table 81 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 82. Both culture groups and color rendering index as a main effect were statistically significant. Culture group was significant at $p = .028$ with an F ratio of 4.98. American subjects ($M = 3.21$) responded to the room as more approach than Korean subjects ($M = 3.72$) regardless of lighting conditions. Thus, the Hypothesis 33a was rejected.

Color rendering index was significant at $p = .001$ with an F ratio of 10.78. All respondents estimated the room as more approach under the lower color index of 75 CRI ($M = 3.17$) than under the higher color rendering index of 95 CRI ($M = 3.77$). Thus, the Hypothesis 33b was rejected. For this measure, Culture by CRI as a two-way interaction was not significant at the $p = .05$ level. Therefore, the Hypothesis 33c was not rejected.

Table 81

A Comparison of the Mean and Standard Deviation Scores for Subjects' Perception of Lighting for Approach-avoidance Intention[1] When 730 and 930 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				0.028
American	98	3.21	1.49	
Korean	98	3.72	1.43	
Color Rendering Index				0.001
75 CRI	98	3.17	1.38	
95 CRI	98	3.77	1.53	
Culture by CRI				N.S.
American x 75 CRI	49	2.92	1.37	
American x 95 CRI	49	3.51	1.57	
Korean x 75 CRI	49	3.43	1.37	
Korean x 95 CRI	49	4.02	1.45	

[1]. 7 point Likert-type scale: 1 = approach and 7 = avoid
Note. N.S = not significant at $p < .05$ (see ANOVA result in next table).

Table 82

Analysis of Variance for Subjects' Perception of Lighting for Approach-avoidance Intention When 730 and 930 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	12.76	12.76	4.98	0.028*
Between Error	96	246.06	2.56		
CRI	1	17.16	17.16	10.78	0.001***
Culture x CRI	1	0.00	0.00	0.00	1.000
Within Error	96	152.84	1.59		

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

Hypothesis 34. When two lighting conditions (730 and 930) are evaluated simultaneously, there is no difference in the subjects' overall lighting preference with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Responses using the bipolar adjectives, "like or dislike," on a seven-point Likert-type scale were used to assess subjects' overall lighting preference when two lighting conditions (730 and 930) are evaluated simultaneously from outside the cubicles. Table 83 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 84. Color rendering index (CRI) as a main effect was significant with an F (1, 96) = 11.27, p = .001. All respondents regardless culture group preferred the lower color rendering index of 75 CRI (M = 3.15) better than the higher color rendering index of 95 CRI (M = 3.76) at the color temperature of 3000 K. Thus, the Hypothesis 34b was rejected.

Culture group (American and Korean) as a main effect was not significant for subjects' overall lighting preference when two lighting conditions (730 and 930) are evaluated simultaneously from outside the cubicles. Thus, the Hypothesis 40a was not rejected. Also, culture by CRI as a two-way interaction was not significant. Thus, the Hypothesis 34c was not rejected.

Table 83

A Comparison of the Mean and Standard Deviation Scores for Subjects' Overall Lighting Preference[1] When 730 and 930 lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	N	Mean	SD	p
Culture group				N.S.
American	98	3.26	1.48	
Korean	98	3.65	1.42	
Color Rendering Index				0.001
75 CRI	98	3.15	1.30	
95 CRI	98	3.76	1.56	
Culture by CRI				N.S.
American x 75 CRI	49	3.04	1.29	
American x 95 CRI	49	3.47	1.63	
Korean x 75 CRI	49	3.27	1.30	
Korean x 95 CRI	49	4.04	1.44	

[1]. 7 point Likert-type scale: 1 = like and 7 = dislike
Note. N.S = not significant at $p < .05$ (see ANOVA result in next table).

Table 84

Analysis of Variance for Subjects' Overall Lighting Preference When 730 and 930 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	7.76	7.76	3.13	0.080
Between Error	96	238.33	2.48		
CRI	1	17.76	17.76	11.27	0.001***
Culture x CRI	1	1.47	1.47	0.94	0.336
Within Error	96	151.27	1.58		

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

Hypothesis 35. When two lighting conditions (730 and 930) are evaluated simultaneously, there is no difference in the subjects' impression of the light color with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)

To investigate the color impression of the lighting according to the important variables of culture group and color rendering index, the hypothesis 35 was tested. The subjects were asked to evaluate the color of the light from the outside of the cubicles associating with six names of color such as reddish, orangish, yellowish, greenish, bluish, and whitish. For this test, chi-square analysis was conducted.

The results of the analysis for this measure are shown in Table 85. There were no statistical significant for culture group on subjects' impression of the color of the light. Both the American and Korean subjects perceived the color of the lighting as being orangish and yellowish for the comparison of 730 and 930 lighting conditions. Therefore, the Hypothesis 35a was not rejected.

The color rendering index (75 CRI and 95 CRI) was statistically significant at $\chi^2 = 17.45$, $p = 0.0037$. The graph of the response for subjects' impression of the color of the light on color rendering index illustrates on Figure 24. As shown in Figure 24, the subjects' impression for the color of the light had strong effect on color rendering index variation under same color temperature of 3000 K.

Although most of the respondents described their impression of the color of the light as being orangish and yellowish, a greater proportion of difference showed between 75 CRI and 95 CRI for the subject's impression of the color of the light. Under the higher color rendering index of 95 CRI, thirty (15.3%) of98 respondents perceived the color of the light as orangish, while 17 (8.7%) of98 respondents perceived the color of the light as orangish under 75 CRI. Under the higher color rendering index of 95 CRI, thirty-three (16.8%) of98 respondents perceived the color of the light as yellowish, while 46 (23.5%) of98 respondents perceived the color of the light as yellowish under 75 CRI. Thus, the Hypothesis 35b was rejected.

Table 85

Chi-square Analysis of Subjects' Impression of the Light Color When 730 and 930 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Possible color choices of the light	Culture group				Color Rendering Index			
	American		Korean		75 CRI		95 CRI	
	n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
Reddish	14	(7.1)	13	(6.6)	11	(5.6)	16	(8.2)
Orangish	20	(10.2)	27	(13.8)	17	(8.7)	30	(15.3)
Yellowish	38	(19.4)	41	(20.9)	46	(23.5)	33	(16.8)
Greenish	9	(4.6)	3	(1.5)	2	(1.0)	10	(5.1)
Bluish	5	(2.6)	5	(2.6)	7	(3.6)	3	(1.5)
Whitish	12	(6.1)	9	(4.6)	15	(7.7)	6	(3.1)
Total Subject [b]	98		98		98		98	
χ^2	4.62				17.45			
p	0.4637				0.0037**			

[a] % based on 98 observations for each main effect.
[b] Total subjects: 49 in American group and 49 in Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.
* $p < .05$. ** $p < .01$. *** $p < .001$.

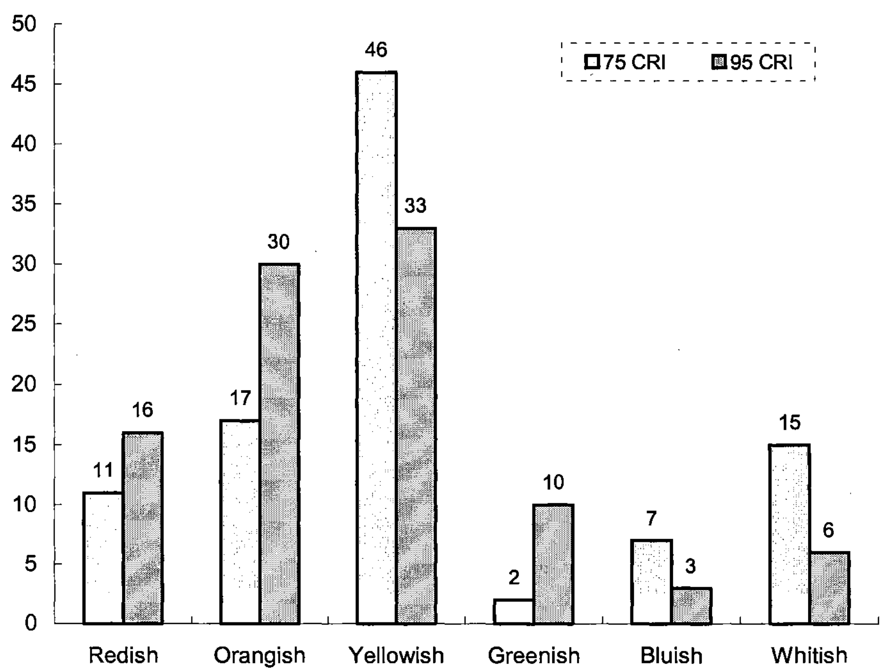


Figure 24. A Graph of the Response for Subjects' Impression of the Light Color on Color Rendering Index When 730 and 930 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Hypothesis 36. When two lighting conditions (730 and 930) are evaluated simultaneously, there is no difference in the subjects' preference of the light color with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Responses using the bipolar adjectives, "like or dislike," on a seven-point Likert-type scale were used to assess subjects' preference of the color of the light when two lighting conditions (730 and 930) are evaluated simultaneously from outside the cubicles. Table 86 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 87. Color rendering index (CRI) as a main effect was significant with an F (1,96) = 13.07, p = .001. All respondents regardless culture group preferred the lower color rendering index of 75 CRI (M = 3.15) better than the higher color rendering index of 95 CRI (M = 3.85) at the color temperature of 3000 K. Thus, the Hypothesis 36b was rejected.

Culture group (American and Korean) as a main effect was not significant for subjects' preference of the color of the light when two lighting conditions (730 and 930) are evaluated simultaneously from outside the cubicles. Thus, the Hypothesis 36a was not rejected. Also, culture by CRI as a two-way interaction was not significant. Thus, the Hypothesis 36c was not rejected.

Table 86

A Comparison of the Mean and Standard Deviation Scores for Subjects' Preference of the Light Color[1] When 730 and 930 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	98	3.30	1.51	
Korean	98	3.70	1.52	
Color Rendering Index				0.001
75 CRI	98	3.15	1.42	
95 CRI	98	3.85	1.56	
Culture by CRI				N.S.
American x 75 CRI	49	2.92	1.35	
American x 95 CRI	49	3.67	1.59	
Korean x 75 CRI	49	3.39	1.47	
Korean x 95 CRI	49	4.02	1.52	

[1]. 7 point Likert-type scale: 1 = like and 7 = dislike
Note. N.S = not significant at $p < .05$ (see ANOVA result in next table).

Table 87

Analysis of Variance for Subjects' Preference of the Light Color When 730 and 930 lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	8.16	8.16	3.14	0.080
Between Error	96	249.84	2.60		
CRI	1	23.59	23.59	13.07	0.001***
Culture x CRI	1	0.18	0.18	0.10	0.750
Within Error	96	173.22	1.80		

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

Hypothesis 37. When two lighting conditions (730 and 930) are evaluated simultaneously, there is no difference in the subjects' perception of fruit color as being natural or unnatural with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Responses using the bipolar adjectives, "natural or not natural," on a seven-point Likert-type scale were used to assess subjects' perception of fruit color appearance when two lighting conditions (730 and 930) are evaluated simultaneously from outside the cubicles. Table 88 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 89. Culture group as a main effect was statistically significant with an F (1, 96) = 7.01, p = .010. American subjects (M = 2.96) perceived the fruit color as more natural than Korean subjects (M = 3.62) regardless of the lighting conditions. Therefore, the Hypothesis 37a was rejected.

Color rendering index (75 CRI and 95 CRI) as a main effect was not significant for subjects' perception of fruit color appearance when two lighting conditions (730 and 930) are evaluated simultaneously from outside the cubicles. Thus, the Hypothesis 37b was not rejected. Also, culture by CRI as a two-way interaction was not significant. Thus, the Hypothesis 37c was not rejected.

Table 88

A Comparison of the Mean and Standard Deviation Scores for Subjects' Perception of Fruit Color[1] When 730 and 930 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				0.001
American	98	2.96	1.65	
Korean	98	3.62	1.32	
Color Rendering Index				N.S.
75 CRI	98	3.28	1.55	
95 CRI	98	3.31	1.52	
Culture by CRI				N.S.
American x 75 CRI	49	2.92	1.64	
American x 95 CRI	49	3.00	1.67	
Korean x 75 CRI	49	3.63	1.36	
Korean x 95 CRI	49	3.61	1.29	

[1]. 7 point Likert-type scale: 1 = natural and 7 = not natural
Note. N.S = not significant at $p < .05$ (see ANOVA result in next table).

Table 89

Analysis of Variance for Subjects' Perception of Fruit Color When 730 and 930 lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	21.56	21.56	7.01	0.010*
Between Error	96	295.37	3.08		
CRI	1	0.05	0.05	0.03	0.858
Culture x CRI	1	0.13	0.13	0.09	0.766
Within Error	96	137.33	1.43		

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

Hypothesis 38. When two lighting conditions (730 and 930) are evaluated simultaneously, there is no difference in the subjects' perception for five different kinds of fruit with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)

To identify the subjects' color perception of natural objects under the two different lighting conditions by comparing them simultaneously from outside the cubicles, the colors of five different kinds fruits in a bowl was tested. The five different kinds of fruit were apple, orange, banana, lemon, and grape. For this measure, chi-square analysis was conducted.

The results of the analysis are shown in Table 90. There was no statistical significant for the variable of culture group on subjects' perception of the color of five fruits as being distorted or not distorted under the two different lighting conditions. The percentage of the subjects' perception of five fruits shows very little differences between the American subjects and Korean subjects. More than two thirds of the respondents in both groups perceived the all fruit colors as being not distorted from their natural color under the two different lighting conditions.

The variable of color rendering index (75 CRI and 95 CRI) was statistically significant for the only banana color perception ($\chi^2 = 10.10$, $\underline{p} = 0.0015$). Although most of the respondents described the banana color as being not distorted from its natural color, a greater proportion of difference showed between the 75 CRI and 95 CRI for the banana color perception. Thirty-three of196 subjects in both groups responded to the banana color as being distorted under 75 CRI, while only 14 subjects perceived the banana color as being distorted under 95 CRI.

Table 90

Chi-square Analysis of Subjects' Perception of Fruit Color as Being Distorted or Not Distorted under the Lighting When 730 and 930 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Variable		Culture group				Color Rendering Index			
		American		Korean		75 CRI		95 CRI	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
Apple	Distorted	17	(8.7)	18	(9.2)	15	(7.7)	20	(10.2)
	Not Distorted	81	(41.3)	80	(40.8)	83	(42.4)	78	(39.8)
	χ^2	0.03				0.87			
	p	0.8521				0.3511			
Orange	Distorted	14	(7.1)	10	(5.1)	10	(5.1)	14	(7.1)
	Not Distorted	84	(42.9)	88	(44.9)	88	(44.9)	84	(42.9)
	χ^2	0.76				0.76			
	p	0.3834				0.3834			
Banana	Distorted	27	(13.8)	20	(10.2)	33	(16.8)	14	(7.1)
	Not Distorted	71	(36.2)	78	(39.8)	65	(33.2)	84	(42.9)
	χ^2	1.37				10.10			
	p	0.2416				0.0015**			
Lemon	Distorted	25	(12.8)	24	(12.2)	20	(10.2)	29	(14.8)
	Not Distorted	73	(37.2)	74	(37.8)	78	(39.8)	69	(35.2)
	χ^2	0.03				2.20			
	p	0.8690				0.1376			
Grape	Distorted	20	(10.2)	24	(12.2)	19	(9.7)	25	(12.8)
	Not Distorted	78	(39.8)	74	(37.8)	79	(40.3)	73	(37.2)
	χ^2	0.47				1.06			
	p	0.4935				0.3044			
Total Subject[b]		98		98		98		98	

[a] % based on 98 observations for each main effect.
[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Hypothesis 39. When two lighting conditions (730 and 930) are evaluated simultaneously, there is no difference in the subjects' ability to match and designate colors with regard to culture and color rendering index for T-shirts dyed

a) red
b) yellow
c) blue
d) purple blue

To investigate the difference in the ability to match color when two lighting conditions (730 and 930) were observed simultaneously from outside the lighted environment, the four hues from the Munsell' color system were tested using four different colored T-shirts. The four Munsell hues of the T-shirts were 5R 4/14 for the red shirt, 5Y 8.5/14 for the yellow shirt, 5B 5/10 for the blue shirt, and 5PB 5/10 for the purple blue shirt. To measure this hypothesis, the subjects were asked to match the color of the shirts using color cards. Four color cards were designed by the researcher based on the New Munsell Student Color Set by adding more Munsell color chips from the Munsell Book of Color in order to provide various color choices. Therefore, each of four color cards has fourteen color chips in relation to hue, value and chroma. Chi-square analysis was conducted to test color match of individuals with different culture groups under two different color rendering indices (75 CRI and 95 CRI) at color temperature of 3000 K.

The results of the analysis for the red shirt (Munsell Hue 5R 4/14) are shown in Table 91. Culture group for the designation of the red shirt was not significant. Although the differences are not significant, a greater proportion of both the American and Korean subjects designated the red shirt as 6/14 (7.5R 5/16) and 7/14 (7.5R 5/14). Only 3 of196 observations in both groups described the red shirt as its original color by comparing two lighting conditions.

Color rendering indices (75 CRI and 95 CRI) were statistically significant (χ^2 = 30.20, p = 0.0001) on subjects' color matching of the red shirt (Munsell 5R 4/14). The results of the red shirt designation indicate the significant differences between 75 CRI and 95 CRI for 5/14 (5R 5/14), 6/14 (7.5R 5/16), 7/12 (2.5R 6/12), and 7/14 (7.5R 5/14). Under the lower color rendering index (75 CRI), a greater proportion of the subjects in both groups designated the red shirt as 5/14 (5R 5/14) and 7/12 (2.5R 6/12). However, under the higher color temperature (95 CRI), a greater proportion of the subjects in both groups designated the red shirt as 6/14 (7.5R 5/16) and 7/14

(7.5R 5/14). Theses results indicate that under 75 CRI, the pure hue of red (5R) appeared as 2.5 red, the color on a counterclockwise direction of the Munsell color wheel, while under 95 CRI, it appeared to have the hue of 7.5R, the color on a clockwise direction of the color wheel.

Table 91

Chi-square Analysis for the Color Designation of the Red Shirt When 730 and 930 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Original Research Color Chip Designation in Card A	Munsell Designation for All Possible Red Choices	Culture				Color Rendering Index			
		American		Korean		75 CRI		95 CRI	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
3/12	2.5R 5/10	0	(0)	0	(0)	0	(0)	0	(0)
3/14	2.5R 4/14	2	(1.0)	2	(1.0)	3	(1.5)	1	(0.5)
4/10	5R 4/10	0	(0)	0	(0)	0	(0)	0	(0)
4/12	5R 4/12	0	(0)	0	(0)	0	(0)	0	(0)
4/14	5R 4/14	0	(0)	3	(1.5)	1	(0.5)	2	(1.0)
5/10	5R 5/10	0	(0)	0	(0)	0	(0)	0	(0)
5/12	5R 5/12	1	(0.5)	3	(1.5)	4	(2.0)	0	(0.0)
5/14	5R 5/14	8	(4.1)	8	(4.1)	12	(6.1)	4	(2.0)
6/10	5R 6/10	0	(0)	0	(0)	0	(0)	0	(0)
6/12	5R 6/12	3	(1.5)	1	(0.5)	3	(1.5)	1	(0.5)
6/14	7.5R 5/16	31	(15.8)	35	(17.9)	25	(12.8)	41	(20.9)
7/10	5R 7/10	0	(0)	0	(0)	0	(0)	0	(0)
7/12	2.5R 6/12	5	(2.6)	9	(4.6)	14	(7.1)	0	(0)
7/14	7.5R 5/14	48	(24.5)	37	(18.9)	36	(18.4)	49	(25.0)
Total Subject[b]		98		98		98		98	
χ^2		7.81				30.20			
p		0.3498				0.0001***			

Note. Underlined Munsell Designation, "___", indicates the "true" color match for the shirt under natural light, thus, no color distortion of the shirt.
[a] % based on 98 observations for each main effect.
[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.
* $p < .05$. ** $p < .01$. *** $p < .001$.

The results of chi-square analysis for the color matching and designation to the blue shirt (5/10, Munsell 5B 5/10) are shown in Table 92. All two variables have a significant impact on perception of the blue shirt. Culture group (American and Korean) was statistically significant (χ^2 = 21.82, p = 0.0161). Only 15 of196 observations in both groups described the blue shirt as its original hue in comparison of the two lighting conditions.

There was a significant difference between the American and Korean subjects for the color chips of 4/10 (2.5B 5/10), 5/8 (5B 5/8), 5/10 (5B 5/10), 6/6 (5B 6/6), 6/8 (5B 6/8), and 6/10 (Munsell 5B 6/10). More American subjects than Korean subjects described the blue shirt as 6/6 (5B 6/6) and 6/10 (Munsell 5B 6/10), while more Korean subjects than American subjects described the blue shirt as 4/10 (2.5B 5/10), 5/8 (5B 5/8), 5/10 (5B 5/10), and 6/8 (5B 6/8).

Color rendering index was also significant for the blue shirt (χ^2 = 53.55, p = 0.0001). There was a significant difference between 75 CRI and 95 CRI for the color chips of 5/10 (5B 5/10), 6/6 (5B 6/6), 6/8 (5B 6/8), 6/10 (5B 6/10), 7/8 (5B 7/8), 7/10 (7.5B 7/8), and 8/8 (10BG 7/8). Under 75 CRI, a greater proportion of the subjects described the blue shirt as 6/6 (5B 6/6), 6/8 (5B 6/8) 7/8 (5B 7/8), and 7/10 (7.5B 7/8). Under 95 CRI, a greater proportion of the subjects described the blue shirt as 5/10 (5B 5/10), 6/10 (5B 6/10), and 8/8 (10BG 7/8).

These results indicate under 75 CRI, the pure hue of blue (5B) appeared as the hue of 7.5B, the color on a clockwise direction of the color wheel or having the same hue with a lighter value and weaker chroma than its original blue. However, under 95 CRI, it appeared as its original color of blue, as the same hue with a little lighter value (5B 6/10), and as the hue of 10BG, the color on a counterclockwise direction of the color wheel.

Table 92

Chi-square Analysis for the Color Designation of the Blue Shirt When 730 and 930 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Original Research Color Chip Designation in Card B	Munsell Designation for All Possible Blue Choices	Culture				Color Rendering Index			
		American		Korean		75 CRI		95 CRI	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
4/6	5B 4/6	0	(0)	0	(0)	0	(0)	0	(0)
4/8	10BG 5/10	0	(0)	3	(1.5)	0	(0)	3	(1.5)
4/10	2.5B 5/10	0	(0)	7	(3.6)	3	(1.5)	4	(2.0)
5/6	5B 5/6	0	(0)	0	(0)	0	(0)	0	(0)
5/8	5B 5/8	0	(0)	6	(3.1)	3	(1.5)	3	(1.5)
5/10	5B 5/10	7	(3.6)	8	(4.1)	5	(2.6)	10	(5.1)
6/6	5B 6/6	10	(5.1)	4	(2.0)	12	(6.1)	2	(1.0)
6/8	5B 6/8	13	(6.6)	17	(8.7)	20	(10.2)	10	(5.1)
6/10	5B 6/10	34	(17.4)	27	(13.8)	19	(9.7)	42	(21.4)
7/6	5B 7/6	2	(1.0)	1	(0.5)	3	(1.5)	0	(0)
7/8	5B 7/8	7	(3.6)	5	(2.6)	10	(5.1)	2	(1.0)
7/10	7.5B 7/8	16	(8.2)	15	(7.7)	23	(11.7)	8	(4.1)
8/6	10BG 7/6	0	(0)	0	(0)	0	(0)	0	(0)
8/8	10BG 7/8	9	(4.6)	5	(2.6)	0	(0)	14	(7.1)
Total Subject [b]		98		98		98		98	
χ^2		21.82				53.55			
p		0.0161*				0.0001***			

Note. Underlined Munsell Designation, "___", indicates the "true" color match for the shirt under natural light, thus, no color distortion of the shirt.

[a] % based on 98 observations for each main effect.

[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.

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

The results of chi-square analysis for the color matching and designation of the yellow shirt (6/14, Munsell 5Y 8.5/14) are shown in Table 93. All two variables have a significant impact on the perception of the yellow shirt. Culture group (American and Korean) was statistically significant (χ^2 = 13.30, p = 0.0386). There was a significant difference between the American and Korean subjects for the color chips of 5/12 (2.5Y 8.5/12), 6/10 (2.5Y 8.5/12), 6/12 (2.5Y 8/12), and 6/14 (5Y 8.5/14). More American subjects than Korean subjects described the blue shirt as 5/12 (2.5Y 8.5/12) and 6/10 (2.5Y 8.5/12), while more Korean subjects than American subjects described the blue shirt as 6/12 (2.5Y 8/12) and 6/14 (5Y 8.5/14).

Color rendering index was significant for the yellow shirt (χ^2 = 84.23, p = 0.0001). There was a significant difference between 75 CRI and 95 CRI for the color chips of 5/12 (2.5Y 8.5/12), 6/10 (2.5Y 8.5/12), 6/12 (2.5Y 8/12), 6/14 (5Y 8.5/14), 7/12 (7.5Y 8.5/12), 7/14 (5Y 8.5/12), and 8.14 (7.5Y 8.5 /8). Under 75 CRI, a greater proportion of the subjects described the yellow shirt as 5/12 (2.5Y 8.5/12), 6/10 (2.5Y 8.5/12), 6/12 (2.5Y 8/12), and 6/14 (5Y 8.5/14). Under 95 CRI, a greater proportion of the subjects described the yellow shirt as 7/12 (7.5Y 8.5/12), 7/14 (5Y 8.5/12), and 8.14 (7.5Y 8.5 /8).

These results indicate that the pure hue of yellow (5Y) appeared as the hue of 7.5Y, the color on a clockwise direction of the color wheel and as having the same hue with a lighter value or weaker chroma under 75 CRI. However, under 95 CRI, the pure hue of yellow (5Y) appeared as its original color or the hue of 2.5Y, the color on a counterclockwise direction of the color wheel.

Table 93

Chi-square Analysis for the Color Designation of the Yellow Shirt When 730 and 930 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Original Research Color Chip Designation in Card C	Munsell Designation for All Possible Yellow Choices	Culture				Color Rendering Index			
		American		Korean		75 CRI		95 CRI	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
5/10	2.5Y 8.5/8	0	(0)	0	(0)	0	(0)	0	(0)
5/12	2.5Y 8.5/12	17	(8.7)	12	(6.1)	0	(0)	29	(14.8)
5/14	5Y 8/14	0	(0)	0	(0)	0	(0)	0	(0)
6/10	2.5Y 8.5/12	15	(7.7)	7	(3.6)	8	(4.1)	14	(7.1)
6/12	2.5Y 8/12	3	(1.5)	14	(7.1)	3	(1.5)	14	(7.1)
6/14	5Y 8.5/14	17	(8.7)	22	(11.2)	13	(6.6)	26	(13.3)
7/8	5Y 7/8	0	(0)	0	(0)	0	(0)	0	(0)
7/10	5Y 7/10	2	(1.0)	0	(0)	2	(1.0)	0	(0)
7/12	7.5Y 8.5/12	12	(6.1)	14	(7.1)	23	(11.7)	3	(1.5)
7/14	5Y 8.5/12	25	(12.8)	24	(12.2)	37	(18.9)	12	(6.1)
8/8	5Y 8/8	0	(0)	0	(0)	0	(0)	0	(0)
8/10	5Y 8/10	0	(0)	0	(0)	0	(0)	0	(0)
8/12	5Y 8/12	0	(0)	0	(0)	0	(0)	0	(0)
8/14	7.5Y 8.5/8	7	(3.6)	5	(2.6)	12	(6.1)	0	(0)
Total Subject[b]		98		98		98		98	
χ^2		13.30				84.23			
p		0.0386*				0.0001***			

Note. Underlined Munsell Designation, "___", indicates the "true" color match for the shirt under natural light, thus, no color distortion of the shirt.

[a] % based on 98 observations for each main effect.

[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.

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

The results of chi-square analysis for the color matching and designation to the purple blue shirt (Munsell 5PB 5/10) are shown in Table 94. Culture group was not significant for the designation of the purple blue shirt (Munsell 5PB). Although the differences are not significant, a greater proportion of both the American and Korean subjects designated the purple blue shirt as 5/8 (Munsell 5PB 5/8) and 6/8 (Munsell 5PB 6/8). Only eight observations in both groups described the purple blue shirt as its original color by comparison of the two lighting conditions. Theses results indicate that all subjects perceived the purple blue shirt as a lighter value and lower chroma than its original blue of the shirt.

Color rendering indices (75 CRI and 95 CRI) were statistically significant ($\chi^2 = 46.55$, $\underline{p} = 0.0001$) on subjects' color matching of the purple blue shirt (Munsell 5PB 5/10). There was a significant difference between 75 CRI and 95 CRI for the color chips of 5/8 (5PB 5/8). 5/10 (5PB 5/10), 6/6 (5PB 6/6), 6/8 (5PB 6/8), 6/12 (2.5PB 6/10), and 7/8 (5PB 7/8). Under 75 CRI, a greater proportion of the subjects described the purple blue shirt as 5/8 (5PB 5/8). 5/10 (5PB 5/10), and 6/8 (5PB 6/8). Under 95 CRI, a greater proportion of the subjects described the purple blue shirt as 6/8 (5PB 6/8), 6/12 (2.5PB 6/10), and 7/8 (5PB 7/8).

These results indicate that the pure hue of purple blue (5PB) appeared as its original color, as having the same hue with a lighter value, and as a weaker chroma under 75 CRI. However, under 95 CRI, the pure hue of purple blue (5PB) appeared as the hue of 2.5PB, the color on a counterclockwise direction of the color wheel or a lighter value and weaker chroma than its original color.

Table 94

Chi-square Analysis for the Color Designation of the Purple Blue Shirt When 730 and 930 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Original Research Color Chip Designation in Card D	Munsell Designation for All Possible Purple Blue Choices	Culture				Color Rendering Index			
		American		Korean		75 CRI		95 CRI	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
4/8	5PB 4/8	0	(0)	0	(0)	0	(0)	0	(0)
4/10	5PB 4/10	0	(0)	0	(0)	0	(0)	0	(0)
4/12	2.5PB 5/12	1	(0.5)	2	(1.0)	0	(0)	3	(1.5)
5/8	5PB 5/8	12	(6.1)	20	(10.3)	26	(13.3)	6	(3.1)
<u>5/10</u>	<u>5PB 5/10</u>	3	(1.5)	5	(2.6)	8	(4.1)	0	(0)
5/12	10B 6/10	4	(2.0)	3	(1.5)	2	(1.0)	5	(2.6)
6/6	5PB 6/6	11	(5.6)	5	(2.6)	2	(1.0)	14	(7.1)
6/8	5PB 6/8	36	(18.4)	27	(11.3)	37	(18.9)	26	(13.3)
6/10	5PB 6/10	14	(7.1)	16	(8.2)	14	(7.1)	16	(8.2)
6/12	2.5PB 6/10	6	(3.1)	11	(5.6)	4	(2.0)	13	(6.6)
7/6	5PB 7/6	2	(1.0)	3	(1.5)	1	(0.5)	4	(2.0)
7/8	5PB 7/8	9	(4.6)	6	(3.1)	4	(2.0)	11	(5.6)
7/10	7.5PB 7/6	0	(0)	0	(0)	0	(0)	0	(0)
7/12	7.5PB 7/8	0	(0)	0	(0)	0	(0)	0	(0)
Total Subject[b]		98		98		98		98	
χ^2		10.20				46.55			
p		0.5121				0.0001***			

Note. Underlined Munsell Designation, "___", indicates the "true" color match for the shirt under natural light, thus, no color distortion of the shirt.

[a] % based on 98 observations for each main effect.

[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.

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

Set 2: 750 lamps (75 CRI, 5000 K) vs. 950 lamps (95 CRI, 5000 K)

The comparison of 750 and 950 lighting conditions: two color rendering indices of 75 CRI and 95 CRI are compared when the color temperature of 5000 K is being held constant.

Hypothesis 40. When two lighting conditions (750 and 950) are evaluated simultaneously, there is no difference in the subjects' perception of lighting as being visually warm or visually cool with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Responses using the bipolar adjectives, "visually warm or visually cool," on a seven-point Likert-type scale were used to assess subjects' perception of lighting when two lighting conditions (750 and 950) are evaluated simultaneously from outside the cubicles. Table 95 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 96. There was no significant difference regarding to the main effects of culture group (American and Korean) and color rendering index (75 CRI and 95 CRI) for subject's perception of lighting as being visually warm or visually cool. Therefore, the Hypotheses 40a and 40b were not rejected. No significant difference resulted on a two-way interaction of culture by CRI. Thus, the Hypothesis 40c was not rejected.

Table 95

A Comparison of the Mean and Standard Deviation Scores for Subjects' Perception of Lighting as Being Visually Warm or Visually Cool[1] When 750 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	98	4.76	1.48	
Korean	98	4.51	1.29	
Color Rendering Index				N.S.
75 CRI	98	4.73	1.33	
95 CRI	98	4.53	1.44	
Culture by CRI				N.S.
American x 75 CRI	49	4.80	1.40	
American x 95 CRI	49	4.71	1.57	
Korean x 75 CRI	49	4.67	1.26	
Korean x 95 CRI	49	4.35	1.30	

[1]. 7 point Likert-type scale: 1 = visually warm and 7= visually cool
Note. N.S = not significant at $p < .05$ (see ANOVA result in next table).

Table 96

Analysis of Variance for Subjects' Perception of Lighting as Being Warm or Cool When 750 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	2.94	2.94	1.16	0.284
Between Error	96	242.61	2.53		
CRI	1	2.04	2.04	1.54	0.218
Culture x CRI	1	0.73	0.73	0.55	0.458
Within Error	96	127.22	1.33		

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

Hypothesis 41. When two lighting conditions (750 and 950) are evaluated simultaneously, there is no difference in the subjects' perception of lighting as a factor in visual clarity with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Responses using two bipolar adjectives, "bright/dim and clear/unclear," on a seven-point Likert-type scale were used to assess subjects' perception of lighting when two lighting conditions (750 and 950) are evaluated simultaneously from outside the cubicles. Table 97 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 98. There was no significant difference regarding to the main effects of culture group (American and Korean) and color rendering index (75 CRI and 95 CRI) for subject's perception of lighting as a factor in visual clarity. Therefore, the Hypotheses 41a and 41b were not rejected. No culture by CRI interaction of statistical significance was indicated for subject's perception of lighting as being clear or unclear. Therefore, the Hypothesis 41c was not rejected.

Table 97

A Comparison of the Mean and Standard Deviation Scores for Subjects' Perception of Lighting as a Factor in Visual Clarity[1] When 750 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S
American	98	5.99	2.60	
Korean	98	6.57	2.54	
Color Rendering Index				N.S
75 CRI	98	6.55	2.71	
95 CRI	98	6.01	2.43	
Culture by CRI				N.S
American x 75 CRI	49	6.35	2.75	
American x 95 CRI	49	5.63	2.42	
Korean x 75 CRI	49	6.76	2.68	
Korean x 95 CRI	49	6.39	2.41	

[1]. Index score created for perception of visual clarity: 2 = the score that indicates the highest or best perception of visual clarity and 14 = the score that indicates the least or poorest perception of visual clarity
Note. N.S. = not significant at $p < .05$ (see ANOVA result in next table).

Table 98

Analysis of Variance for Subjects' Perception of Lighting as a Factor in Visual Clarity When 750 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	16.58	16.58	1.96	0.165
Between Error	96	812.50	8.46		
CRI	1	14.33	14.33	3.03	0.085
Culture x CRI	1	1.47	1.47	0.31	0.578
Within Error	96	454.69	4.74		

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

Hypothesis 42. When two lighting conditions (750 and 950) are evaluated simultaneously, there is no difference in the subjects' perception of room attractiveness with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Responses using the two bipolar adjectives, "attractive/not attractive and inviting/not inviting," on a seven-point Likert-type scale were used to assess subjects' perception of room attractiveness when two lighting conditions (750 and 950) are evaluated simultaneously from outside the cubicles. Table 99 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 100. Culture group (American and Korean) and color rendering index (75 CRI and 95 CRI) as a main effect were not significant for subjects' perception of room attractiveness when two lighting conditions (750 and 950) are evaluated simultaneously from outside the cubicles. Thus, the Hypotheses 42a and 42b were not rejected. Also, culture by CRI as a two-way interaction was not significant. Thus, the Hypothesis 42c was not rejected.

Table 99

A Comparison of the Mean and Standard Deviation Scores for Subjects' Perception of Lighting for Room Attractiveness[1] When 750 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	98	6.87	3.02	
Korean	98	7.08	2.60	
Color Rendering Index				N.S.
75 CRI	98	7.10	2.85	
95 CRI	98	6.85	2.78	
Culture by CRI				N.S.
American x 75 CRI	49	6.92	3.00	
American x 95 CRI	49	6.82	3.08	
Korean x 75 CRI	49	7.29	2.72	
Korean x 95 CRI	49	6.88	2.48	

[1]. Index score created for perception of room attractiveness: 2 = the score that indicates the highest or best perception of room attractiveness and 14 = the score that indicates the least or poorest perception of room attractiveness
Note. N.S = not significant at $p < .05$ (see ANOVA result in next table).

Table 100

Analysis of Variance for Subjects' Perception of Lighting for Room Attractiveness When 750 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	2.25	2.25	0.20	0.653
Between Error	96	1060.12	11.04		
CRI	1	3.19	3.19	0.64	0.425
Culture x CRI	1	1.15	1.15	0.23	0.632
Within Error	96	476.16	4.96		

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

Hypothesis 43. When two lighting conditions (750 and 950) are evaluated simultaneously, there is no difference in the subjects' perception of lighting for approach-avoidance intention with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Responses using the bipolar adjectives, "approach or avoid," on a seven-point Likert-type scale were used to assess subjects' perception of lighting when two lighting conditions (750 and 950) are evaluated simultaneously from outside the cubicles. Table 101 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 102. Culture group (American and Korean) and color rendering index (75 CRI and 95 CRI) as a main effect were not significant for subjects' perception of lighting as being approach or avoid when two lighting conditions (750 and 950) are evaluated simultaneously from outside the cubicles. Thus, the Hypotheses 43a and 43b were not rejected. Also, culture by CRI as a two-way interaction was not significant. Thus, the Hypothesis 43c was not rejected.

Table 101

A Comparison of the Mean and Standard Deviation Scores for Subjects' Perception of Lighting for Approach-avoid Intention[1] When 750 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	98	3.33	1.56	
Korean	98	3.38	1.23	
Color Rendering Index				N.S.
75 CRI	98	3.47	1.44	
95 CRI	98	3.23	1.36	
Culture by CRI				N.S.
American x 75 CRI	49	3.39	1.57	
American x 95 CRI	49	3.27	1.58	
Korean x 75 CRI	49	3.55	1.32	
Korean x 95 CRI	49	3.20	1.12	

[1]. 7 point Likert-type scale: 1 = approach and 7= avoid
Note. N.S = not significant at $p < .05$ (see ANOVA result in next table).

Table 102

Analysis of Variance for Subjects' Perception of Lighting for Approach-avoidance Intention When 750 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	0.13	0.13	0.05	0.828
Between Error	96	258.08	2.69		
CRI	1	2.70	2.70	2.10	0.150
Culture x CRI	1	0.62	0.62	0.48	0.490
Within Error	96	123.18	1.28		

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

Hypothesis 44. When two lighting conditions (750 and 950) are evaluated simultaneously, there is no difference in the subjects' overall lighting preference with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Responses using the bipolar adjectives, "like or dislike," on a seven-point Likert-type scale were used to assess subjects' overall lighting preference when two lighting conditions (750 and 950) are evaluated simultaneously from outside the cubicles. Table 103 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 104. Culture group (American and Korean) and color rendering index (75 CRI and 95 CRI) as a main effect were not significant for subjects' overall lighting preference when two lighting conditions (750 and 950) are evaluated simultaneously from outside the cubicles. Thus, the Hypotheses 44a and 44b were not rejected. Also, culture by CRI as a two-way interaction was not significant. Thus, the Hypothesis 44c was not rejected.

Table 103

A Comparison Mean and Standard Deviation Scores for Subjects' Overall Lighting Preference[1] When 750 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	98	3.43	1.59	
Korean	98	3.51	1.30	
Color Rendering Index				N.S.
75 CRI	98	3.60	1.50	
95 CRI	98	3.34	1.40	
Culture by CRI				N.S.
American x 75 CRI	49	3.43	1.67	
American x 95 CRI	49	3.43	1.53	
Korean x 75 CRI	49	3.78	1.30	
Korean x 95 CRI	49	3.24	1.27	

[1]. 7 point Likert-type scale: 1 = like and 7= dislike
Note. N.S = not significant at $p < .05$ (see ANOVA result in next table).

Table 104

Analysis of Variance for Subjects' Overall Lighting Preference When 750 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	0.33	0.33	0.11	0.745
Between Error	96	294.49	3.07		
CRI	1	3.45	3.45	3.03	0.085
Culture x CRI	1	3.45	3.45	3.03	0.085
Within Error	96	109.10	1.14		

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

Hypothesis 45. When two lighting conditions (750 and 950) are evaluated simultaneously, there is no difference in the subjects' impression of the light color with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)

To investigate the impression of the light color according to the important variables of culture and color rendering index, the hypothesis 45 was tested. The subjects were asked to evaluate the color of the two light conditions (750 vs. 950) by comparing from outside the cubicles associating with six names of color such as reddish, orangish, yellowish, greenish, bluish, and whitish. For this test, chi-square analysis was conducted.

The results of the analysis for this measure are shown in Table 105. There was no statistical significance for culture group on subjects' impression of the color of the light. However, a greater proportion of both the American and Korean subjects perceived the color of the lighting as being bluish and whitish for the comparison of 750 and 950 lighting conditions (same 5000 K with different CRI of 75 and 95). For the color rendering index (75 CRI and 95 CRI), there was no statistical significance. However, most of the subjects described the color of the light as being bluish and whitish for the comparison of two different color rendering indices at the color temperature of 5000 K. Therefore, the Hypotheses 45a and 45b were not rejected.

Table 105

Chi-square Analysis of Subjects' Impression of the Light Color When 750 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Possible color choices of the light	Culture group				Color Rendering Index			
	American		Korean		75 CRI		95 CRI	
	n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
Reddish	4	(2.0)	3	(1.5)	4	(2.0)	3	(1.5)
Orangish	3	(1.5)	5	(2.6)	2	(1.0)	6	(3.1)
Yellowish	7	(3.6)	12	(6.1)	11	(5.6)	8	(4.1)
Greenish	6	(3.1)	3	(1.5)	2	(1.0)	7	(3.6)
Bluish	29	(14.8)	18	(9.2)	22	(11.2)	25	(12.8)
Whitish	49	(25.0)	57	(29.1)	57	(29.1)	49	(25.0)
Total subject [b]	98		98		98		98	
χ^2	6.14				6.19			
p	0.2931				0.2882			

[a] % based on 98 observations for each main effect.
[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Hypothesis 46. When two lighting conditions (750 and 950) are evaluated simultaneously, there is no difference in the subjects' preference of the light color with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Responses using the bipolar adjectives, "like or dislike," on a seven-point Likert-type scale were used to assess subjects' preference of the light color when two lighting conditions (750 and 950) are evaluated simultaneously from outside the cubicles. Table 106 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 107. Culture group (American and Korean) and color rendering index (75 CRI and 95 CRI) as a main effect were not significant for subjects' preference of the color of the light when two lighting conditions (750 and 950) are evaluated simultaneously from outside the cubicles. Thus, the Hypotheses 46a and 46b were not rejected. Also, culture by CRI as a two-way interaction was not significant. Thus, the Hypothesis 46c was not rejected.

Table 106

A Comparison of the Mean and Standard Deviation Scores for Subjects' Preference of the Light Color[1] When 750 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	98	3.68	1.67	
Korean	98	3.42	1.33	
Color Rendering Index				N.S.
75 CRI	98	3.58	1.54	
95 CRI	98	3.52	1.49	
Culture by CRI				N.S.
American x 75 CRI	49	3.57	1.71	
American x 95 CRI	49	3.80	1.65	
Korean x 75 CRI	49	3.59	1.37	
Korean x 95 CRI	49	3.24	1.28	

[1]. 7 point Likert-type scale: 1 = like and 7= dislike

Note. N.S = not significant at $p < .05$ (see ANOVA result in next table).

Table 107

Analysis of Variance for Subjects' Preference of the Light Color When 750 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	3.45	3.45	1.07	0.303
Between Error	96	309.04	3.22		
CRI	1	0.18	0.18	0.14	0.713
Culture x CRI	1	4.00	4.00	2.96	0.089
Within Error	96	129.82	1.35		

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

Hypothesis 47. When two lighting conditions (750 and 950) are evaluated simultaneously, there is no difference in the subjects' perception of fruit color as being natural or unnatural with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)
c) two-way interaction of culture by CRI

Responses using the bipolar adjectives, "natural or not natural," on a seven-point Likert-type scale were used to assess subjects' perception of fruit color appearance when two lighting conditions (750 and 950) are evaluated simultaneously from outside the cubicles. Table 108 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 109. Culture group (American and Korean) and color rendering index (75 CRI and 95 CRI) as a main effect were not significant for subjects' perception of fruit color appearance when two lighting conditions (750 and 950) are evaluated simultaneously from outside the cubicles. Thus, the Hypotheses 54a and 54b were not rejected. Also, culture by CRI as a two-way interaction was not significant. Thus, the Hypothesis 47c was not rejected.

Table 108

A Comparison of the Mean and Standard Deviation Scores for Subjects' Perception of Fruit Color[1] When 750 and 950 lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	98	3.06	1.68	
Korean	98	3.42	1.21	
Color Rendering Index				N.S.
75 CRI	98	3.34	1.48	
95 CRI	98	3.14	1.46	
Culture by CRI				N.S.
American x 75 CRI	49	3.18	1.64	
American x 95 CRI	49	2.94	1.72	
Korean x 75 CRI	49	3.49	1.29	
Korean x 95 CRI	49	3.35	1.13	

[1]. 7 point Likert-type scale: 1 = natural and 7= not natural
Note. N.S = not significant at $p < .05$ (see ANOVA result in next table).

Table 109

Analysis of Variance for Subjects' Perception of Fruit Color When 750 and 950 lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	6.25	6.25	1.94	0.167
Between Error	96	309.98	3.23		
CRI	1	1.84	1.84	1.71	0.194
Culture x CRI	1	0.13	0.13	0.12	0.732
Within Error	96	103.53	1.08		

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

Hypothesis 48. When two lighting conditions (750 and 950) are evaluated simultaneously, there is no difference in the subjects' perception for five different kinds of fruit with regard to

a) culture (American and Korean)
b) color rendering index of fluorescent light (75 CRI and 95 CRI)

To identify the subjects' color perception of natural objects under the two different lighting conditions, the colors of five different kinds fruit in a bowl were tested by comparing the two lighting conditions from outside the cubicles. The five fruits were apple, orange, banana, lemon, and grape as test in Part 2. For this measure, chi-square analysis was conducted. The results of the analysis are shown in Table 110.

The variable of culture group (American and Korean) was statistically significant for the only orange color perception ($\chi^2 = 8.62$, $p = 0.0033$). Although most of the respondents described all fruit colors as being not distorted from their natural color, a greater proportion of difference showed between the American and Korean subjects for the orange color perception. Twenty-three (11.7%) of98 American subjects responded to the orange color as being distorted, while only eight Korean subjects (4.1%) perceived the orange color as being distorted.

The variable of color rendering index (75 CRI and 95 CRI) was statistically significant for the only lemon color perception ($\chi^2 = 8.48$, $p = 0.0036$). Although most of the respondents described all fruit colors as being not distorted from their natural color, a greater proportion of difference showed between 75 CRI and 95 CRI at the same color temperature of 5000 K for the lemon color perception. Thirty-five subjects of98 responded to the lemon color as being distorted under the lower color rendering index of 75 CRI, while 17 subjects perceived the lemon color as being distorted under the higher color rendering index of 95 CRI.

Table 110

Chi-square Analysis of Subjects' Perception of Fruit Color as Being Distorted or Not Distorted under the Lighting When 750 and 950 lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Variable		Culture group				Color Rendering Index			
		American		Korean		75 CRI		95 CRI	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
Apple	Distorted	16	(8.2)	21	(10.7)	17	(8.7)	20	(10.2)
	Not Distorted	82	(41.8)	77	(39.3)	81	(41.3)	78	(39.8)
	χ^2	0.83				0.87			
	p	0.3614				0.3511			
Orange	Distorted	23	(11.7)	8	(4.1)	20	(10.2)	11	(5.6)
	Not Distorted	75	(38.3)	90	(45.9)	78	(39.8)	87	(44.4)
	χ^2	8.62				3.10			
	p	0.0033**				0.0781			
Banana	Distorted	17	(8.7)	19	(9.7)	14	(7.1)	22	(11.2)
	Not Distorted	81	(41.3)	79	(40.3)	84	(42.9)	76	(38.8)
	χ^2	0.14				2.18			
	p	0.7122				0.1400			
Lemon	Distorted	30	(15.3)	22	(11.2)	35	(17.9)	17	(8.7)
	Not Distorted	68	(34.7)	76	(38.8)	63	(32.1)	81	(41.3)
	χ^2	1.68				8.48			
	p	0.1956				0.0036**			
Grape	Distorted	19	(9.7)	28	(14.3)	23	(11.7)	24	(12.2)
	Not Distorted	79	(40.3)	70	(35.7)	75	(38.3)	74	(37.8)
	χ^2	2.27				0.03			
	p	0.1322				0.8671			
Total subject[b]		98		98		98		98	

[a] % based on 98 observations for each main effect.
[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.
* p < .05. ** p < .01. *** p < .001.

Hypothesis 49. When two lighting conditions (750 and 950) are evaluated simultaneously, there is no difference in the subjects' ability to match and designate colors with regard to culture and color rendering index for T-shirts dyed

a) red
b) yellow
c) blue
d) purple blue

To investigate the difference in the ability to match color when the two lighting conditions (750 and 950) were observed simultaneously from outside the lighted environment, the four hues from the Munsell color system were tested using the four different color T-shirts. The four Munsell hues of the T-shirts were 5R 4/14 for the red shirt, 5Y 8.5/14 for the yellow shirt, 5B 5/10 for the blue shirt, and 5PB 5/10 for the purple blue shirt.

To measure this hypothesis, the subjects were asked to match the color of the shirts using four color cards. Four color cards were designed by the researcher based on the New Munsell Student Color Set by adding more Munsell color chips from the Munsell Book of Color in order to provide various color choices. Therefore, each of the four color cards has fourteen color chips in relation to hue, value and chroma. Chi-square analysis was conducted to test color match of individuals with different culture groups under two different color rendering indices (75 CRI and 95 CRI) at color temperature of 5000 K.

Table 111 shows the results of the analysis for the red shirt (Munsell 5R 4/14) by comparing two lighting conditions (750 and 950) simultaneously from outside the cubicles. Culture group was not significant for the color designation of the red shirt (Munsell Hue 5R 4/14). Although the differences are not significant, a greater proportion of both the American and Korean subjects designated the red shirt as 5/14 (5R 5/14), 6/14 (7.5R 5/16), and 7/14 (7.5R 5/14). Only 4 of196 observations in both culture groups described red shirt as its original color by comparing the two lighting conditions.

Color rendering indices (75 CRI and 95 CRI) were statistically significant ($\chi^2 = 68.71$, $\underline{p} = 0.0001$) on subjects' color matching of the red shirt (Munsell 5R 4/14). The results of the red shirt designation indicate significant differences between 75 CRI and 95 CRI for 5/14 (5R 5/14), 6/14 (7.5R 5/16), 7/12 (2.5R 6/12), and 7/14 (7.5R 5/14). Under the lower color rendering index (75

CRI), a greater proportion of subjects in both groups designated the red shirt as 5/14 (5R 5/14), 6/14 (7.5R 5/16), and 7/12 (2.5R 6/12). However, under the higher color index (95 CRI), a greater proportion of subjects in both groups designated the red shirt as 7/14 (7.5R 5/14).

Theses results indicate that under 75 CRI, the pure hue of red (5R) appeared as the hue of 2.5R, the color on a counterclockwise direction of the color wheel and as the same hue with a lighter value. However, under 95 CRI, it appeared as the hue of 7.5R, the color on a clockwise direction of the color wheel.

The results of chi-square analysis for the color matching and designation to the blue shirt (5/10, Munsell 5B 5/10) are shown in Table 112. Culture group was not significant for the color designation of the blue shirt (Munsell 5B 5/10). Although the differences are not significant, a greater proportion of both the American and Korean subjects designated the blue shirt as 5/10 (5B 5/10), 6/10 (Munsell 5B 6/10), and 7/10 (7.5B 7/8). Twenty-eight of196 observations in both groups described blue shirt as its original color by comparing the two color rendering indices of lighting at the color temperature of 5000K.

Color rendering index was also significant for the blue shirt ($\chi^2 = 23.38$, $\underline{p} = 0.0015$). There was a significant difference between 75 CRI and 95 CRI for the color chips of 4/10 (2.5B 5/10), 5/10 (5B 5/10), 6/8 (5B 6/8), 6/10 (5B 6/10), and 7/8 (5B 7/8). Under 75 CRI, a greater proportion of the subjects described the blue shirt as 4/10 (2.5B 5/10), 6/8 (5B 6/8), and 7/8 (5B 7/8). Under 95 CRI, a greater proportion of the subjects described the blue shirt as 5/10 (5B 5/10) and 6/10 (5B 6/10).

These results indicate under 75 CRI, the pure hue of blue (5B) appeared as the hue of 2.5B, the color on a counterclockwise direction of the color wheel and as having the same hue with a lighter value and a weaker chroma than its original blue. However, under 95 CRI, it appeared as its original blue and as having the same hue with a little lighter value (5B 6/10).

Table 111

Chi-square Analysis for the Color Designation of the Red Shirt When 750 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Original Research Color Chip Designation in Card A	Munsell Designation for All Possible Red Choices	Culture				Color Rendering Index			
		American		Korean		75 CRI		95 CRI	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
3/12	2.5R 5/10	0	(0)	0	(0)	0	(0)	0	(0)
3/14	2.5R 4/14	0	(0)	2	(1.0)	2	(1.0)	0	(0)
4/10	5R 4/10	0	(0)	0	(0)	0	(0)	0	(0)
4/12	5R 4/12	1	(0.5)	1	(0.5)	1	(0.5)	1	(0.5)
4/14	5R 4/14	2	(1.0)	2	(1.0)	3	(1.5)	1	(0.5)
5/10	5R 5/10	0	(0)	2	(1.0)	1	(0.5)	1	(0.5)
5/12	5R 5/12	3	(1.5)	3	(1.5)	5	(2.6)	1	(0.5)
5/14	5R 5/14	19	(9.7)	15	(7.7)	27	(13.8)	7	(3.6)
6/10	5R 6/10	0	(0)	0	(0)	0	(0)	0	(0)
6/12	5R 6/12	1	(0.5)	0	(0)	1	(0.5)	0	(0)
6/14	7.5R 5/16	15	(7.7)	25	(12.8)	30	(15.3)	10	(5.1)
7/10	5R 7/10	0	(0)	0	(0)	0	(0)	0	(0)
7/12	2.5R 6/12	6	(3.1)	8	(4.1)	11	(5.6)	3	(1.5)
7/14	7.5R 5/14	51	(26.0)	40	(20.4)	17	(8.7)	74	(37.8)
Total Subject [b]		98		98		98		98	
χ^2		9.59				68.71			
p		0.3850				0.0001***			

Note. Underlined Munsell Designation, "___", indicates the "true" color match for the shirt under natural light, thus, no color distortion of the shirt.
[a] % based on 98 observations for each main effect.
[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.
* p < .05. ** p < .01. *** p < .001.

Table 112

Chi-square Analysis for the Color Designation of the Blue Shirt When 750 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Original Research Color Chip Designation in Card B	Munsell Designation for All Possible Blue Choices	Culture				Color Rendering Index			
		American		Korean		75 CRI		95 CRI	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
4/6	5B 4/6	0	(0)	0	(0)	0	(0)	0	(0)
4/8	10BG 5/10	0	(0)	0	(0)	0	(0)	0	(0)
4/10	2.5B 5/10	5	(2.6)	3	(1.5)	8	(4.1)	0	(0)
5/6	5B 5/6	0	(0)	0	(0)	0	(0)	0	(0)
5/8	5B 5/8	0	(0)	0	(0)	0	(0)	0	(0)
5/10	5B 5/10	15	(7.7)	13	(6.6)	9	(4.6)	19	(9.7)
6/6	5B 6/6	0	(0)	3	(1.5)	2	(1.0)	1	(0.5)
6/8	5B 6/8	6	(3.1)	10	(5.1)	10	(5.1)	6	(3.1)
6/10	5B 6/10	17	(8.7)	22	(11.2)	13	(6.6)	26	(13.3)
7/6	5B 7/6	2	(1.0)	2	(1.0)	4	(2.0)	0	(0)
7/8	5B 7/8	12	(6.1)	11	(5.6)	15	(7.7)	8	(4.1)
7/10	7.5B 7/8	41	(20.9)	34	(17.4)	37	(18.9)	38	(19.4)
8/6	10BG 7/6	0	(0)	0	(0)	0	(0)	0	(0)
8/8	10BG 7/8	0	(0)	0	(0)	0	(0)	0	(0)
Total Subject[b]		98		98		98		98	
χ^2		5.98				23.38			
p		0.5420				0.0015**			

Note. Underlined Munsell Designation, "___", indicates the "true" color match for the shirt under natural light, thus, no color distortion of the shirt.
[a] % based on 98 observations for each main effect.
[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.
* $p < .05$. ** $p < .01$. *** $p < .001$.

The results of chi-square analysis for the color matching and designation to the yellow shirt (6/14, Munsell 5Y 8.5/14) are shown in Table 113. Culture group was not significant for the yellow shirt (Munsell 5Y 8.5/14). Although the differences are not significant, a greater proportion of both the American and Korean subjects designated the yellow shirt as 7/12 (7.5Y 8.5/12) and 7/14 (5Y 8.5Y/12). Twenty-five of196 observations in both culture groups described the yellow shirt as its original color by comparing the two color rendering indices of lighting at the color temperature of 5000K.

Color rendering index was also significant for the blue shirt (χ^2 = 109.52, p = 0.0001). There was a significant difference between 75 CRI and 95 CRI for the color chips of 5/12 (2.5Y 8.5/12), 6/10 (2.5Y 8.5/12), 6/12 (2.5Y 8/12), 6/14 (5Y 8.5/14), 7/12 (7.5Y 8.5/12), 7/14 (5Y 8.5/12), and 8/14 (7.5Y 8.5 /8). Under 75 CRI, a greater proportion of the subjects described the yellow shirt as 5/12 (2.5Y 8.5/12), 6/10 (2.5Y 8.5/12), 6/12 (2.5Y 8/12), and 6/14 (5Y 8.5/14). Under 95 CRI, a greater proportion of the subjects described the yellow shirt as 7/12 (7.5Y 8.5/12), 7/14 (5Y 8.5/12), and 8.14 (7.5Y 8.5 /8).

These results indicate that the pure hue of yellow (5Y) appeared as the hue of 7.5Y, the color on a clockwise direction of the color wheel and as a lighter value, and as a weaker chroma under 75 CRI with 5000 K. However, under 95 CRI with 5000 K, the pure hue of yellow (5Y) appeared as its original color or the hue of 2.5Y, the color on a counterclockwise direction of the color wheel.

Table 113

Chi-square Analysis for the Color Designation of the Yellow Shirt When 750 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Original Research Color Chip Designation in Card C	Munsell Designation for All Possible Yellow Choices	Culture				Color Rendering Index			
		American		Korean		75 CRI		95 CRI	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
5/10	2.5Y 8.5/8	0	(0)	0	(0)	0	(0)	0	(0)
5/12	2.5Y 8.5/12	10	(5.1)	5	(2.6)	0	(0)	15	(7.7)
5/14	5Y 8/14	0	(0)	1	(0.5)	0	(0)	1	(0.5)
6/10	2.5Y 8.5/12	10	(5.1)	14	(7.1)	0	(0)	24	(12.2)
6/12	2.5Y 8/12	9	(4.6)	11	(5.6)	0	(0)	20	(10.2)
<u>6/14</u>	<u>5Y 8.5/14</u>	10	(5.1)	15	(7.7)	9	(4.6)	16	(8.2)
7/8	5Y 7/8	0	(0)	0	(0)	0	(0)	0	(0)
7/10	5Y 7/10	3	(1.5)	0	(0)	2	(1.0)	1	(0.5)
7/12	7.5Y 8.5/12	17	(8.7)	16	(8.2)	24	(12.2)	9	(4.6)
7/14	5Y 8.5/12	27	(13.8)	27	(13.8)	44	(22.5)	10	(5.1)
8/8	5Y 8/8	0	(0)	0	(0)	0	(0)	0	(0)
8/10	5Y 8/10	2	(1.0)	0	(0)	1	(0.5)	1	(0.5)
8/12	5Y 8/12	0	(0)	1	(0.5)	0	(0)	1	(0.5)
8/14	7.5Y 8.5/8	10	(5.1)	8	(4.1)	18	(9.2)	0	(0)
Total Subject[b]		98		98		98		98	
χ^2		10.79				109.52			
p		0.3744				0.0001***			

Note. Underlined Munsell Designation, "___", indicates the "true" color match for the shirt under natural light, thus, no color distortion of the shirt.

[a] % based on 98 observations for each main effect.

[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.

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

The results of chi-square analysis for the color matching and designation to the purple blue shirt (Munsell 5PB 5/10) are shown in Table 114. Culture group was not significant for the purple blue shirt (Munsell 5PB). Although the differences are not significant, a greater proportion of both American and Korean subjects designated the purple blue shirt as 6/10 (Munsell 5PB 6/10) and 6/12 (Munsell 2.5PB 6/10). Only 12 observations in both groups described the purple blue shirt as its original color by comparing the two lighting conditions (75 and 95 CRI at 5000 K).

Color rendering indices (75 CRI and 95 CRI) were statistically significant ($\chi^2 = 32.45$, $\underline{p} = 0.0003$) on subjects' color matching of the purple blue shirt (Munsell 5PB 5/10). There was a significant difference between 75 CRI and 95 CRI for the color chips of 5/8 (5PB 5/8). 5/10 (5PB 5/10), 5/12 (10B 6/10), 6/10 (5PB 6/10) and 6/12 (2.5PB 6/10). Under 75 CRI, a greater proportion of the subjects described the purple blue shirt as 5/8 (5PB 5/8). 5/10 (5PB 5/10), and 6/10 (Munsell 5PB 6/10). Under 95 CRI, a greater proportion of the subjects described the purple blue shirt as 5/12 (10B 6/10) and 6/12 (2.5PB 6/10).

These results indicate the pure hue of purple blue (5PB) appeared as its original color, as a lighter value, and as a weaker chroma under 75 CRI. However, under 95 CRI, the pure hue of purple blue (5PB) appeared as the hues of 2.5PB and 10B, the colors on a counterclockwise direction of the color wheel.

Table 114

Chi-square Analysis for the Color Designation of the Purple Blue Shirt When 750 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Original Research Color Chip Designation in Card D	Munsell Designation for All Possible Purple Blue Choices	Culture				Color Rendering Index			
		American		Korean		75 CRI		95 CRI	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
4/8	5PB 4/8	0	(0)	0	(0)	0	(0)	0	(0)
4/10	5PB 4/10	0	(0)	0	(0)	0	(0)	0	(0)
4/12	2.5PB 5/12	1	(0.5)	3	(1.5)	2	(1.0)	2	(1.0)
5/8	5PB 5/8	15	(7.7)	11	(5.6)	20	(10.2)	6	(3.1)
<u>5/10</u>	<u>5PB 5/10</u>	5	(2.6)	7	(3.6)	9	(4.6)	3	(1.5)
5/12	10B 6/10	10	(5.1)	16	(8.2)	7	(3.6)	19	(9.7)
6/6	5PB 6/6	0	(0)	1	(0.5)	1	(0.5)	0	(0)
6/8	5PB 6/8	19	(9.7)	9	(4.6)	14	(7.1)	14	(7.2)
6/10	5PB 6/10	22	(11.2)	20	(10.2)	28	(14.3)	14	(7.1)
6/12	2.5PB 6/10	20	(10.2)	25	(12.8)	13	(6.6)	32	(16.3)
7/6	5PB 7/6	3	(1.5)	0	(0)	1	(0.5)	2	(1.0)
7/8	5PB 7/8	3	(1.5)	6	(3.1)	3	(1.5)	6	(3.1)
7/10	7.5PB 7/6	0	(0)	0	(0)	0	(0)	0	(0)
7/12	7.5PB 7/8	0	(0)	0	(0)	0	(0)	0	(0)
Total Subject[b]		98		98		98		98	
χ^2		12.73				32.45			
p		0.2393				0.0003***			

Note. Underlined Munsell Designation, "___", indicates the "true" color match for the shirt under natural light, thus, no color distortion of the shirt.
[a] % based on 98 observations for each main effect.
[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Set 3: 730 lamps (75 CRI, 3000 K) vs. 750 lamps (75 CRI, 5000 K)

The comparison of 730 and 750 lighting conditions: two color temperature of 3000 K and 5000 K are compared when the color rendering index of 75 CRI is being held constant

Hypothesis 50. When two lighting conditions (730 and 750) are evaluated simultaneously, there is no difference in the subjects' perception of lighting as being visually warm or visually cool with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Responses using the bipolar adjectives, "visually warm or visually cool," on a seven-point Likert-type scale were used to assess subjects' perception of lighting when two lighting conditions (730 and 750) are evaluated simultaneously from outside the cubicles. Table 115 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 116. There was a main effect of color temperature, F = 222.61, p = .000. Thus, the Hypothesis 50b was rejected. Although the main effect of color temperature reached statistical significance, it was of little interest because a significant two-way interaction (culture x CT) was obtained, F (1, 96) = 4.76, p = .032. Therefore, the Hypotheses 50c was rejected.

To assess the significance of such a finding, analysis of the simple effects was conducted. The outcomes are presented in Figure 25 and Table 117. As can be seen in Fig.25, American subjects perceived the lower color temperature of 3000 K (M = 2.37) as being visually warm, while they perceived the higher color temperature of 5000 K (M = 5.41) as being visually cool with the color rendering index of 75 CRI. Also, Korean subjects perceived the lower color temperature of 3000 K (M = 2.61) as being visually warm, while they perceived the higher color temperature of 5000 K (M = 4.88) as being visually cool with the color rendering index of 75 CRI.

There were no differences in perception of lighting as being warm or cool between American and Korean subjects under the lower color temperature of 3000 K. However, American subjects (M = 5.41) perceived the higher color temperature of 5000 K as cooler than Korean subjects (M = 4.88) did. There was no significant difference regarding to the main effects of culture group (American and Korean) for subject's perception of lighting as being visually warm or visually cool. Therefore, the Hypothesis 50a was not rejected.

Table 115

A Comparison of the Mean and Standard Deviation Scores for Subjects' Perception of Lighting as Being Warm or Cool[1] When 730 and 750 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	98	3.89	1.80	
Korean	98	3.74	1.56	
Color Temperature				0.000
3000 K	98	2.49	0.96	
5000 K	98	5.14	1.11	
Culture by CT				0.032
American x 3000 K	49	2.37	0.83	
American x 5000 K	49	5.41	1.08	
Korean x 3000 K	49	2.61	1.06	
Korean x 5000 K	49	4.88	1.09	

[1] 7 point Likert-type scale: 1 = visually warm and 7 = visually cool

Table 116

Analysis of Variance for Subjects' Perception of Lighting as Being Visually Warm or Visually Cool When 730 and 750 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	1.00	1.00	1.87	0.175
Between Error	96	51.39	0.54		
CT	1	344.90	344.90	222.61	0.000***
Culture x CT	1	7.37	7.37	4.76	0.032*
Within Error	96	148.73	1.55		

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

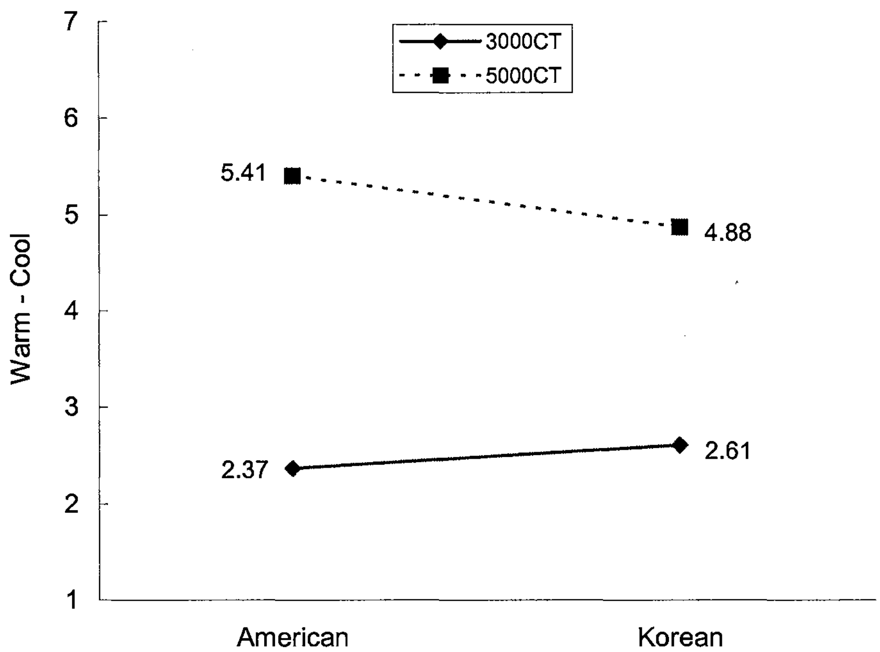


Figure 25. Two-Way Interaction of Culture by Color Temperature for Subjects' Perception of Lighting as Being Visually Warm or Visually Cool When 730 and 750 lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Table 117

Analysis of Simple Effects (Culture x CT) for Subjects' Perception of Lighting as Being Warm or Cool When 730 and 750 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

	1 [American x 3000 K]	2 [American x 5000 K]	3 [Korean x 3000 K]	4 [Korean x 5000 K]
1				
2	-12.09*** (0.0001)			
3	-0.97 (0.3326)	11.12*** (0.0001)		
4	-9.98*** (0.0001)	2.11* (0.0375)	-9.01*** (0.0001)	

Note. Numeric value in parenthesis "( )" indicates p-value
*p < .05. **p < .01. ***p < .001

Hypothesis 51. When two lighting conditions (730 and 750) are evaluated simultaneously, there is no difference in the subjects' perception of lighting as a factor in visual clarity with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Responses using two bipolar adjectives, "bright/dim and clear/unclear," on a seven-point Likert-type scale were used to assess subjects' perception of lighting when two lighting conditions (730 and 750) are evaluated simultaneously from outside the cubicles. Table 118 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 119. Color temperature (CT) as a main effect was statistically very significant with an $F (1, 96) = 17.06$, $p = .000$. All respondents perceived the higher color temperature of 5000 K ($M = 6.43$) as brighter and clearer than the lower color temperature of 3000 K ($M = 8.24$) with the color rendering index of 75 CRI. Therefore, the Hypothesis 51b was rejected.

There was no significant difference regarding to the main effect of culture group (American and Korean) for subject's perception of lighting as a factor in visual clarity. Therefore, the Hypothesis 51a was not rejected. No statistical significance for culture by CRI interaction was indicated for subject's perception of lighting as being clear or unclear when two lighting conditions (730 and 750) are evaluated simultaneously from outside the lighted environment. Therefore, the Hypothesis 51c was not rejected.

Table 118

A Comparison of the Mean and Standard Deviation Scores for Subjects' Perception of Lighting as a Factor in Visual Clarity[1] When 730 and 750 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S
American	98	7.10	2.90	
Korean	98	7.56	2.70	
Color Temperature				0.000
3000 K	98	8.24	2.71	
5000 K	98	6.43	2.61	
Culture by CT				N.S
American x 3000 K	49	7.98	2.88	
American x 5000 K	49	6.22	2.66	
Korean x 3000 K	49	8.49	2.52	
Korean x 5000 K	49	6.64	2.58	

[1]. Index score created for perception of visual clarity: 2 = the score that indicates the highest or best perception of visual clarity and 14 = the score that indicates the least or poorest perception of visual clarity
Note. N.S. = not significant at $p < .05$ (see ANOVA result in next table).

Table 119

Analysis of Variance for Subjects' Perception of Lighting as a Factor in Visual Clarity When 730 and 750 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	10.33	10.33	2.15	0.146
Between Error	96	461.61	4.81		
CT	1	159.84	159.84	17.06	0.000***
Culture x CT	1	0.13	0.13	0.01	0.907
Within Error	96	899.53	9.37		

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

Hypothesis 52. When two lighting conditions (730 and 750) are evaluated simultaneously, there is no difference in the subjects' perception of lighting for room attractiveness with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Responses using the two bipolar adjectives, "attractive/not attractive and inviting/not inviting," on a seven-point Likert-type scale were used to assess subjects' perception of room attractiveness when two lighting conditions (730 and 750) are evaluated simultaneously from outside the cubicles. Table 120 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 121. Culture group (American and Korean) and color temperature (3000 K and 5000 K) as a main effect were not significant for subjects' perception of room attractiveness when two lighting conditions (730 and 750) are evaluated simultaneously from outside the cubicles. Thus, the Hypotheses 52a and 52b were not rejected. Also, culture by CRI as a two-way interaction was not significant. Thus, the Hypothesis 52c was not rejected.

Table 120

A Comparison of the Mean and Standard Deviation Scores for Subjects' Perception of Lighting for Room Attractiveness[1] When 730 and 750 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	98	7.33	3.01	
Korean	98	7.77	2.91	
Color Temperature				N.S.
3000 K	98	7.19	2.96	
5000 K	98	7.90	2.95	
Culture by CT				N.S.
American x 3000 K	49	7.10	2.99	
American x 5000 K	49	7.55	3.05	
Korean x 3000 K	49	7.29	2.94	
Korean x 5000 K	49	8.24	2.83	

[1]. Index score created for perception of room attractiveness: 2 = the score that indicates the highest or best perception of room attractiveness and 14 = the score that indicates the least or poorest perception of room attractiveness

Table 121

Analysis of Variance for Subjects' Perception of Lighting for Room Attractiveness When 730 and 750 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	9.43	9.43	2.20	0.141
Between Error	96	411.65	4.29		
CT	1	24.29	24.29	1.84	0.178
Culture x CT	1	3.19	3.19	0.24	0.624
Within Error	96	1266.02	13.19		

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

Hypothesis 53. When two lighting conditions (730 and 750) are evaluated simultaneously, there is no difference in the subjects' perception of lighting for approach-avoidance intention with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Responses using the bipolar adjectives, "approach or avoid," on a seven-point Likert-type scale were used to assess subjects' perception of lighting when two lighting conditions (730 and 750) are evaluated simultaneously from outside the cubicles. Table 122 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 123. Culture group (American and Korean) and color temperature (3000 K and 5000 K) as a main effect were not significant for subjects' perception of lighting as being approach or avoid when two lighting conditions (730 and 750) are evaluated simultaneously from outside the cubicles. Thus, the Hypotheses 53a and 53b were not rejected. Also, culture by CRI as a two-way interaction was not significant. Thus, the Hypothesis 53c was not rejected.

Table 122

A Comparison of the Mean and Standard Deviation Scores for Subjects' Perception of Lighting for Approach-avoidance Intention[1] When 730 and 750 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	98	3.54	1.56	
Korean	98	3.76	1.42	
Color Temperature				N.S.
3000 K	98	3.63	1.49	
5000 K	98	3.66	1.50	
Culture by CT				N.S.
American x 3000 K	49	3.63	1.58	
American x 5000 K	49	3.45	1.56	
Korean x 3000 K	49	3.63	1.42	
Korean x 5000 K	49	3.88	1.42	

1. 7 point Likert-type scale: 1 = approach and 7 = avoid

Table 123

Analysis of Variance for Subjects' Perception of Lighting for Approach-avoidance Intention When 730 and 750 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	2.25	2.25	2.43	0.123
Between Error	96	88.96	0.93		
CT	1	0.05	0.05	0.01	0.910
Culture x CT	1	2.25	2.25	0.63	0.428
Within Error	96	341.20	3.55		

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

Hypothesis 54. When two lighting conditions (730 and 750) are evaluated simultaneously, there is no difference in the subjects' overall lighting preference with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Responses using the bipolar adjectives, "like or dislike," on a seven-point Likert-type scale were used to assess subjects' overall lighting preference when two lighting conditions (730 and 750) are evaluated simultaneously from outside the cubicles. Table 124 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 125. Culture group (American and Korean) and color temperature (3000 K and 5000 K) as a main effect were not significant for subjects' overall lighting preference when two lighting conditions (730 and 750) are evaluated simultaneously from outside the cubicles. Thus, the Hypotheses 54a and 54b were not rejected. Also, culture by CRI as a two-way interaction was not significant. Thus, the Hypothesis 54c was not rejected.

Table 124

A Comparison of the Mean and Standard Deviation Scores for Subjects' Overall Lighting Preference[1] When 730 and 750 lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	98	3.61	1.48	
Korean	98	3.81	1.43	
Color Temperature				N.S.
3000 K	98	3.68	1.47	
5000 K	98	3.73	1.44	
Culture by CT				N.S.
American x 3000 K	49	3.76	1.53	
American x 5000 K	49	3.47	1.42	
Korean x 3000 K	49	3.61	1.41	
Korean x 5000 K	49	4.00	1.43	

1. 7 point Likert-type scale: 1 = like and 7 = dislike

Table 125

Analysis of Variance for Subjects' Overall Lighting Preference When 730 and 750 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	1.84	1.84	1.75	0.189
Between Error	96	101.08	1.05		
CT	1	0.13	0.13	0.04	0.841
Culture x CT	1	5.56	5.56	1.77	0.187
Within Error	96	301.82	3.14		

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

Hypothesis 55. When two lighting conditions (730 and 750) are evaluated simultaneously, there is no difference in the subjects' impression of the light color with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)

To investigate the color impression of the lighting according to the important variables of culture and color temperature, the hypothesis 55 was tested. The subjects were asked to evaluate the color of the light from outside the cubicles associating six names of color including reddish, orangish, yellowish, greenish, bluish, and whitish. For this test, chi-square analysis was conducted. The results of the analysis for this measure are shown in Table 126.

The color temperature as a main effect (3000 K and 5000 K) was statistically significant at $\chi^2 = 153.83$, $p = 0.0001$. Both the American and Korean subjects described the lower color temperature of 3000 K as being reddish (n = 23, 11.7%), orangish (n = 31, 15.8 %), and yellowish (n = 38, 19.4 %), whereas they described the higher color temperature of 5000 K as being bluish (n = 33, 16.8 %) and whitish (n = 52, 26.5 %). The graph in Figure 26 demonstrates the responses for subjects' impression of the color of the light on color temperature (3000 K and 5000 K). As can be seen in Figure15, the color temperature has a strong effect with the same 75 CRI.

There was no statistical significance for culture group on subjects' impression of the color of the light. However, a greater proportion of both the American and Korean subjects perceived the color of the lighting as being reddish, orangish, yellowish, bluish and whitish for the comparison of 730 and 750 lighting conditions (same 75 CRI with different CT of 3000 K and 5000 K).

Table 126

Chi-square Analysis of Subjects' Impression of the Light Color When 730 and 750 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Possible color choices of the light	Culture group				Color Temperature			
	American		Korean		3000 K		5000 K	
	n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
Reddish	16	(8.2)	7	(3.6)	23	(11.7)	0	(0.0)
Orangish	13	(6.6)	18	(9.2)	31	(15.8)	0	(0.0)
Yellowish	20	(10.2)	24	(12.2)	38	(19.4)	6	(3.1)
Greenish	5	(2.6)	4	(2.0)	2	(1.0)	7	(3.6)
Bluish	18	(9.2)	16	(8.2)	1	(0.5)	33	(16.8)
Whitish	26	(13.3)	29	(14.8)	3	(1.5)	52	(26.5)
Total Subject [b]	98		98		98		98	
χ^2	5.08				153.83			
p	0.4057				0.0001***			

[a] % based on 98 observations for each main effect.
[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.
* $p < .05$. ** $p < .01$. *** $p < .001$.

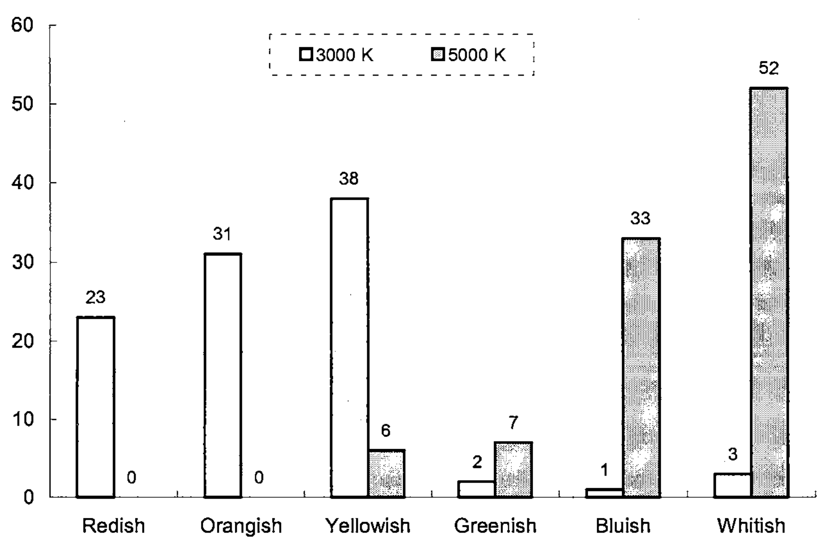


Figure 26. A Graph of the Subjects' Impression of the Light Color on Color Temperature When 730 and 750 lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Hypothesis 56. When two lighting conditions (730 and 750) are evaluated simultaneously, there is no difference in the subjects' preference of the light color with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Responses using the bipolar adjectives, "like or dislike," on a seven-point Likert-type scale were used to assess subjects' preference of the light color when two lighting conditions (730 and 750) are evaluated simultaneously from outside the cubicles. Table 127 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 128. Culture group (American and Korean) and color temperature (3000 K and 5000 K) as a main effect were not significant for subjects' preference of the color of the light when two lighting conditions (730 and 750) are evaluated simultaneously from outside the cubicles. Thus, the Hypotheses 56a and 56b were not rejected. Also, culture by CRI as a two-way interaction was not significant. Thus, the Hypothesis 56c was not rejected.

Table 127

A Comparison of the Mean and Standard Deviation Scores for Subjects' Preference of the Light Color[1] When 730 and 750 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	98	3.62	1.67	
Korean	98	3.88	1.46	
Color Temperature				N.S.
3000 K	98	3.72	1.60	
5000 K	98	3.78	1.54	
Culture by CT				N.S.
American x 3000 K	49	3.73	1.66	
American x 5000 K	49	3.51	1.68	
Korean x 3000 K	49	3.71	1.55	
Korean x 5000 K	49	4.04	1.35	

1. 7 point Likert-type scale: 1 = like and 7 = dislike

Table 128

Analysis of Variance for Subjects' Preference of the Light Color When 730 and 750 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	3.19	3.19	2.76	0.100
Between Error	96	111.06	1.16		
CT	1	0.13	0.13	0.03	0.854
Culture x CT	1	3.72	3.72	0.99	0.322
Within Error	96	360.65	3.76		

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

Hypothesis 57. When two lighting conditions (730 and 750) are evaluated simultaneously, there is no difference in the subjects' perception of fruit color as being natural or unnatural with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Responses using the bipolar adjectives, "natural or not natural," on a seven-point Likert-type scale were used to assess subjects' perception of fruit color appearance when two lighting conditions (730 and 750) are evaluated simultaneously from outside the cubicles. Table 129 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 130. Culture group (American and Korean) and color temperature (3000 K and 5000 K) as a main effect were not significant for subjects' perception of fruit color appearance when two lighting conditions (730 and 750) are evaluated simultaneously from outside the cubicles. Thus, the Hypotheses 57a and 57b were not rejected. Also, culture by CRI as a two-way interaction was not significant. Thus, the Hypothesis 57c was not rejected.

Table 129

A Comparison of the Mean and Standard Deviation Scores for Subjects' Perception of Fruit Color[1] When 730 and 750 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	98	3.39	1.63	
Korean	98	3.66	1.23	
Color Temperature				N.S.
3000 K	98	3.42	1.35	
5000 K	98	3.63	1.54	
Culture by CT				N.S.
American x 3000 K	49	3.39	1.50	
American x 5000 K	49	3.39	1.78	
Korean x 3000 K	49	3.45	1.19	
Korean x 5000 K	49	3.88	1.24	

1. 7 point Likert-type scale: 1 = natural and 7 = not natural

Table 130

Analysis of Variance for Subjects' Perception of Fruit Color When 730 and 750 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	3.72	3.72	2.49	0.118
Between Error	96	143.65	1.50		
CT	1	2.25	2.25	0.84	0.362
Culture x CT	1	2.25	2.25	0.84	0.362
Within Error	96	257.00	2.68		

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

Hypothesis 58. When two lighting conditions (730 and 750) are evaluated simultaneously, there is no difference in the subjects' perception of five different kinds of fruit with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)

To identify the subjects' color perception of natural objects under the two different lighting conditions, the color of five different kinds of fruit in a bowl was tested by comparing the two lighting conditions from outside the cubicles. The five fruits were apple, orange, banana, lemon, and grape. For this measure, chi-square analysis was conducted. The results of the analysis are shown in Table 131.

The variable of culture group (American and Korean) was statistically significant for both the orange ($\chi^2 = 4.90$, $p = 0.0269$) and banana color perception ($\chi^2 = 4.60$, $p = 0.0320$). Although most of the respondents described all fruit colors as being not distorted from their natural color, a greater proportion of difference showed between the Americans and Koreans for the orange color perception. Twenty-four American subjects (12.2%) of98 responded to the orange color as being distorted, while only 12 Korean subjects (6.1%) perceived the orange color as being distorted. For the banana color perception, there is a greater proportion of difference between the American and Korean subjects. Thirty-one (15.8%) of98 American subjects responded to the banana color as being distorted, while only 18 Korean subjects (9.2%) perceived the banana color as being distorted from its natural color.

The variable of color temperature (3000 K and 5000 K) was statistically significant for the only banana color perception ($\chi^2 = 7.86$, $p = 0.0050$). Although most of the respondents described all fruit colors as being not distorted from their natural color, a greater proportion of difference showed between 3000 K and 5000 K with the same 75 CRI for the banana color perception. Thirty-three of98 subjects responded to the banana color as being distorted under the lower color temperature of 3000 K, while only 16 subjects perceived the banana color as being distorted under the higher color temperature of 5000 K.

Table 131

Chi-square Analysis of Subjects' Perception of Fruit Color as Being Distorted or Not Distorted under the Lighting When 730 and 750 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Variable		Culture group				Color Temperature			
		American		Korean		3000K		5000K	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
Apple	Distorted	20	(10.2)	19	(9.7)	16	(8.2)	23	(21.5)
	Not Distorted	78	(39.8)	79	(40.3)	82	(41.8)	75	(38.3)
	χ^2	0.03				1.57			
	p	0.8580				0.2104			
Orange	Distorted	24	(12.2)	12	(6.1)	13	(6.6)	23	(11.7)
	Not Distorted	74	(37.8)	86	(43.9)	85	(43.4)	75	(38.3)
	χ^2	4.90				3.40			
	p	0.0269*				0.0651			
Banana	Distorted	31	(15.8)	18	(9.2)	33	(16.8)	16	(8.2)
	Not Distorted	67	(34.2)	80	(40.8)	65	(33.2)	82	(41.8)
	χ^2	4.60				7.86			
	p	0.0320*				0.0050**			
Lemon	Distorted	26	(13.3)	16	(8.2)	20	(10.2)	22	(11.2)
	Not Distorted	72	(36.7)	82	(41.8)	78	(39.8)	76	(38.8)
	χ^2	3.03				0.12			
	p	0.0817				0.7277			
Grape	Distorted	30	(15.3)	40	(20.4)	35	(17.9)	35	(17.9)
	Not Distorted	68	(34.7)	58	(29.6)	63	(32.1)	63	(32.1)
	χ^2	2.22				0.00			
	p	0.1360				1.0000			
Total subject[b]		98		98		98		98	

[a] % based on 98 observations for each main effect.
[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Hypothesis 59. When two lighting conditions (730 and 750) are evaluated simultaneously, there is no difference in the subjects' ability to match and designate colors with regard to culture and color rendering index for T-shirts dyed

a) red
b) yellow
c) blue
d) purple blue

To investigate the difference in the ability to match color when two lighting conditions (730 and 750) were observed simultaneously from outside the lighted environment, the four hues from the Munsell color system were tested using the four different colored T-shirts. The four Munsell hues of the T-shirts were 5R 4/14 for the red shirt, 5Y 8.5/14 for the yellow shirt, 5B 5/10 for the blue shirt, and 5PB 5/10 for the purple blue shirt. Chi-square analysis was conducted to test color match of individuals with different culture groups under the two different lighting conditions (3000 K and 5000 K with 75 CRI).

Table132 shows the results of the analysis for the red shirt (Munsell 5R 4/14) by comparing two lighting conditions (730 and 750) simultaneously from outside the cubicles. Culture group was not significant for the red shirt (Munsell Hue 5R 4/14). Although the differences are not significant, a greater proportion of both American and Korean subjects designated the red shirt as 5/14 (5R 5/14), 6/14 (7.5R 5/16), and 7/14 (7.5R 5/14). Only four of 196 observations in both groups described the red shirt as its original color by comparing the two lighting conditions.

Color temperature (3000 K and 5000 K) was statistically significant ($\chi^2 = 75.81$, $\underline{p} = 0.0001$) on subjects' color matching of the red shirt (Munsell 5R 4/14). The results of the red shirt designation show significant differences between 3000 K and 5000 K for 5/12 (5R 5/12), 5/14 (5R 5/14), 6/14 (7.5R 5/16), 7/12 (2.5R 6/12), and 7/14 (7.5R 5/14). Under the lower color temperature (3000 K), a greater proportion of subjects in both groups designated the red shirt as 6/14 (7.5R 5/16) and 7/14 (7.5R 5/14). However, under the higher color temperature (5000 K), a greater proportion of subjects in both groups designated the red shirt as 5/12 (5R 5/12), 5/14 (5R 5/14), and 7/12 (2.5R 6/12). Theses results indicate that under 3000 K, the pure hue of red (5R) appeared as the hue of 7.5R, the color on a clockwise direction of the color wheel, while under

5000 K, it appeared as having same hue with a lighter value and weaker chroma than its original red or as the hue of 2.5R, the color on a counterclockwise direction of the color wheel.

Table 132

Chi-square Analysis for the Color Designation of the Red Shirt When 730 and 750 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Original Research Color Chip Designation in Card A	Munsell Designation for All Possible Red Choices	Culture				Color Temperature			
		American		Korean		3000 K		5000 K	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
3/12	2.5R 5/10	1	(0.5)	0	(0)	0	(0)	1	(0.5)
3/14	2.5R 4/14	1	(0.5)	2	(1.0)	0	(0)	3	(1.5)
4/10	5R 4/10	0	(0)	0	(0)	0	(0)	0	(0)
4/12	5R 4/12	0	(0)	1	(0.5)	0	(0)	1	(0.5)
<u>4/14</u>	<u>5R 4/14</u>	0	(0)	4	(2.0)	0	(0.0)	4	(2.0)
5/10	5R 5/10	0	(0)	0	(0)	0	(0)	0	(0)
5/12	5R 5/12	6	(3.1)	4	(2.0)	1	(0.5)	9	(4.6)
5/14	5R 5/14	17	(8.7)	13	(6.6)	1	(0.5)	29	(14.8)
6/10	5R 6/10	1	(0.5)	1	(0.5)	1	(0.5)	1	(0.5)
6/12	5R 6/12	2	(1.0)	2	(1.0)	3	(1.5)	1	(0.5)
6/14	7.5R 5/16	24	(12.2)	26	(13.3)	35	(17.9)	15	(7.7)
7/10	5R 7/10	0	(0)	0	(0)	0	(0)	0	(0)
7/12	2.5R 6/12	7	(3.6)	8	(4.1)	2	(1.0)	13	(6.6)
7/14	7.5R 5/14	39	(19.9)	37	(18.9)	55	(28.1)	21	(10.7)
Total Subject[b]		98		98		98		98	
χ^2		9.47				75.81			
p		0.5790				0.0001***			

Note. Underlined Munsell Designation, "___", indicates the "true" color match for the shirt under natural light, thus, no color distortion of the shirt.
[a] % based on 98 observations for each main effect.
[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.
* $p < .05$. ** $p < .01$. *** $p < .001$.

The results of chi-square analysis for the color matching and designation to the blue shirt (5/10, Munsell 5B 5/10) are shown in Table 133. Culture group (American and Korean) was statistically significant (χ^2 = 28.57, $\underline{p}$ = 0.0046). There was a significant difference between the American and Korean subjects for the color chips of 5/10 (5B 5/10), 6/8 (5B 6/8), 6/10 (5B 6/10), 7/6 (5B 7/6), and 7/10 (7.5B 7/8). More American subjects than Korean subjects described the blue shirt as 6/8 (5B 6/8), 7/6 (5B 7/6), and 7/10 (7.5B 7/8), while more Korean subjects than American subjects described the blue shirt as 5/10 (5B 5/10), and 6/10 (5B 6/10).

Color temperature (3000 K and 5000 K) had a significant impact (χ^2 = 110.57, $\underline{p}$ = 0.0001) on the subjects' color designation of the blue shirt. The results of the blue shirt designation indicate significant differences between 3000 K and 5000 K for 5/10 (5B 5/10), 6/8 (5B 6/8), 6/10 (5B 6/10), 7/6 (5B 7/6), 7/8 (5B 7/8), 7/10 (7.5B 7/8), and 8/8 (10BG 7/8). Under the lower color temperature (3000 K), a greater proportion of subjects in both groups designated the blue shirt as 5/10 (5B 5/10), 6/8 (5B 6/8), 6/10 (5B 6/10), 7/6 (5B 7/6), 7/8 (5B 7/8), and 8/8 (10BG 7/8). However, under the higher color temperature (5000 K), a greater proportion of subjects in both groups designated the blue shirt as 7/10 (7.5B 7/8).

These results indicate that under 3000 K, the pure hue of blue (5B) appeared as the hues of 10BG and 2.5B, the colors on a counterclockwise direction of the color wheel and as having the same hue with a lighter value and weaker chroma, while under5000 K, it appeared as the hue of 7.5B, the color on a clockwise direction of the color wheel.

Table 133

Chi-square Analysis for the Color Designation of the Blue Shirt When 730 and 750 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Original Research Color Chip Designation in Card B	Munsell Designation for All Possible Blue Choices	Culture				Color Temperature			
		American		Korean		3000 K		5000 K	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
4/6	5B 4/6	0	(0)	0	(0)	0	(0)	0	(0)
4/8	10BG 5/10	0	(0)	0	(0)	0	(0)	0	(0)
4/10	2.5B 5/10	0	(0)	2	(1.0)	1	(0.5)	1	(0.5)
5/6	5B 5/6	0	(0)	3	(1.5)	3	(1.5)	0	(0)
5/8	5B 5/8	0	(0)	2	(1.0)	2	(1.0)	0	(0)
5/10	5B 5/10	6	(3.1)	10	(5.1)	10	(5.1)	6	(3.1)
6/6	5B 6/6	3	(1.5)	3	(1.5)	5	(2.6)	1	(0.5)
6/8	5B 6/8	21	(10.7)	10	(5.1)	28	(14.3)	3	(1.5)
6/10	5B 6/10	8	(4.1)	22	(11.2)	23	(11.7)	7	(3.6)
7/6	5B 7/6	7	(3.6)	1	(0.5)	7	(3.6)	1	(0.5)
7/8	5B 7/8	9	(4.6)	8	(4.1)	12	(6.1)	5	(2.6)
7/10	7.5B 7/8	44	(22.5)	34	(17.3)	4	(2.0)	74	(37.8)
8/6	10BG 7/6	0	(0)	1	(0.5)	1	(0.5)	0	(0)
8/8	10BG 7/8	0	(0.0)	2	(1.0)	2	(1.0)	0	(0)
Total Subject[b]		98		98		98		98	
χ^2		28.57				110.57			
p		0.0046**				0.0001***			

Note. Underlined Munsell Designation, "___", indicates the "true" color match for the shirt under natural light, thus, no color distortion of the shirt.
[a] % based on 98 observations for each main effect.
[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.
* p < .05. ** p < .01. *** p < .001.

The results of chi-square analysis for the color matching and designation to the yellow shirt (6/14, Munsell 5Y 8.5/14) are shown in Table 134. Culture group was not significant for the yellow shirt (Munsell 5Y 8.5/14). Although the differences are not significant, a greater proportion of both the American and Korean subjects designated the yellow shirt as 6/14 (5Y 8.5/14), 7/12 (7.5Y 8.5/12), 7/14 (5Y 8.5Y/12), and 8/14 (7.5Y 8.5/8). Thirty-six of196 observations in both groups described the yellow shirt as its original color by comparing the two color temperatures of lighting with 75 CRI.

Color temperatures (3000 K and 5000 K) had a significant impact ($\chi^2 = 98.61$, $\underline{p} = 0.0001$) on the subjects' perception of yellow shirt (5/14, Munsell 5Y 8.5/14). There was a significant difference between 3000 K and 5000 K for the color chips of 5/12 (2.5Y 8.5/12), 6/10 (2.5Y 8.5/12), 6/12 (2.5Y 8/12), 6/14 (5Y 8.5/14), 7/12 (7.5Y 8.5/12), 7/14 (5Y 8.5/12), and 8/14 (7.5Y 8.5 /8). Under 3000 K, a greater proportion of the subjects described the yellow shirt as 5/12 (2.5Y 8.5/12), 6/10 (2.5Y 8.5/12), 6/12 (2.5Y 8/12), 6/14 (5Y 8.5/14), and 7/14 (5Y 8.5/12). Under 5000 K, a greater proportion of the subjects described the yellow shirt as 7/12 (7.5Y 8.5/12) and 8/14 (7.5Y 8.5 /8).

These results indicate that the pure hue of yellow (5Y) appeared as its original color or the hue of 2.5Y, the color on a counterclockwise direction of the color wheel under 3000 K. However, under 5000 K, the pure hue of yellow (5Y) appeared as the hue of 7.5Y, the color on a clockwise direction of the color wheel.

Table 134

Chi-square Analysis for the Color Designation of the Yellow Shirt When 730 and 750 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Original Research Color Chip Designation in Card C	Munsell Designation for All Possible Yellow Choices	Culture				Color Temperature			
		American		Korean		3000 K		5000 K	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
5/10	2.5Y 8.5/8	0	(0)	0	(0)	0	(0)	0	(0)
5/12	2.5Y 8.5/12	3	(1.5)	7	(3.6)	10	(5.1)	0	(0)
5/14	5Y 8/14	0	(0)	2	(1.0)	1	(0.5)	0	(0)
6/10	2.5Y 8.5/12	8	(4.1)	7	(3.6)	13	(6.6)	2	(1.0)
6/12	2.5Y 8/12	4	(2.0)	8	(4.1)	11	(5.6)	1	(0.5)
6/14	5Y 8.5/14	15	(7.7)	21	(10.7)	30	(15.3)	6	(3.1)
7/8	5Y 7/8	0	(0)	0	(0)	0	(0)	0	(0)
7/10	5Y 7/10	2	(1.0)	1	(0.5)	2	(1.0)	1	(0.5)
7/12	7.5Y 8.5/12	26	(13.3)	15	(7.7)	4	(2.0)	37	(18.9)
7/14	5Y 8.5/12	28	(14.3)	22	11.2)	27	(13.8)	23	(11.7)
8/8	5Y 8/8	0	(0)	0	(0)	0	(0)	0	(0)
8/10	5Y 8/10	0	(0)	0	(0)	0	(0)	0	(0)
8/12	5Y 8/12	0	(0)	0	(0)	0	(0)	0	(0)
8/14	7.5Y 8.5/8	12	(6.1)	16	(8.2)	0	(0.0)	28	(14.3)
Total Subject [b]		98		98		98		98	
χ^2		9.58				98.61			
p		0.2961				0.0001***			

Note. Underlined Munsell Designation, "___", indicates the "true" color match for the shirt under natural light, thus, no color distortion of the shirt.
[a] % based on 98 observations for each main effect.
[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.
* $p < .05$. ** $p < .01$. *** $p < .001$.

The results of chi-square analysis for the color matching and designation to the purple blue shirt (Munsell 5PB 5/10) are shown in Table 135. Culture group was not significant for the purple blue shirt (Munsell 5PB 5/10). Although the differences are not significant, a greater proportion of both the American and Korean subjects designated the purple blue shirt as 5/8 (5PB 5/8), 6/8 (5PB 6/8), 6/10 (5PB 6/10), 6/12 (2.5PB 6/10), and 7/8 (5PB 7/8). Only 7 observations in both groups described the purple blue shirt as its original color by comparing the two lighting conditions (3000 K and 5000 K with 75 CRI).

Color temperature (3000 K and 5000 K) had a significant impact ($\chi^2 = 59.52$, $\underline{p} = 0.0001$) on the subjects' perception of the purple blue shirt (Munsell 5PB 5/10). There was a significant difference between for the color chips of 5/8 (5PB 5/8), 6/6 (5PB 6/6), 6/8 (5PB 6/8), 6/10 (5PB 6/10), 6/12 (2.5PB 6/10), and 7/8 (5PB 7/8). Under 3000 K, a greater proportion of the subjects described the purple blue shirt as 5/8 (5PB 5/8). 6/6 (5PB 6/6), and 6/8 (5PB 6/8). Under 95 CRI, a greater proportion of the subjects described the purple blue shirt as 6/10 (5PB 6/10), 6/12 (2.5PB 6/10), and 7/8 (5PB 7/8).

These results indicate that the pure hue of purple blue (5PB) appeared as having the same hue with a lighter value and weaker chroma under 3000 K. However, under 5000 K, the pure hue of purple blue (5PB) appeared as the hue of 2.5PB, the color on a counterclockwise direction of the color wheel.

Table 135

Chi-square Analysis for the Color Designation of the Purple Blue Shirt When 730 and 750 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Original Research Color Chip Designation in Card D	Munsell Designation for All Possible Purple Blue Choices	Culture				Color Temperature			
		American		Korean		3000 K		5000 K	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
4/8	5PB 4/8	0	(0)	0	(0)	0	(0)	0	(0)
4/10	5PB 4/10	0	(0)	0	(0)	0	(0)	0	(0)
4/12	2.5PB 5/12	1	(0.5)	3	(1.5)	1	(0.5)	3	(1.5)
5/8	5PB 5/8	13	(6.6)	13	(6.6)	22	(11.2)	4	(2.0)
<u>5/10</u>	<u>5PB 5/10</u>	2	(1.0)	5	(2.6)	4	(2.0)	3	(1.5)
5/12	10B 6/10	0	(0)	4	(2.0)	1	(0.5)	3	(1.5)
6/6	5PB 6/6	4	(2.0)	1	(0.5)	5	(2.6)	0	(0)
6/8	5PB 6/8	34	(17.4)	29	(14.8)	43	(22.4)	20	(10.2)
6/10	5PB 6/10	22	(11.2)	16	(8.2)	14	(7.1)	24	(12.2)
6/12	2.5PB 6/10	15	(7.7)	15	(7.1)	2	(1.0)	27	(13.8)
7/6	5PB 7/6	0	(0)	1	(0.5)	1	(0.5)	0	(0)
7/8	5PB 7/8	7	(3.6)	11	(6.1)	5	(2.6)	14	(7.1)
7/10	7.5PB 7/6	0	(0)	0	(0)	0	(0)	0	(0)
7/12	7.5PB 7/8	0	(0)	0	(0)	0	(0)	0	(0)
Total Subject[b]		98		98		98		98	
χ^2		19.58				59.52			
p		0.1061				0.0001***			

Note. Underlined Munsell Designation, "___", indicates the "true" color match for the shirt under natural light, thus, no color distortion of the shirt.
[a] % based on 98 observations for each main effect.
[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Set 4: 930 lamps (95 CRI, 3000 K) vs. 950 lamps (95 CRI, 5000 K)

The comparison of 930 and 950 lighting conditions: two color temperature of 3000 K and 5000 K are compared when the color rendering index of 95 CRI is being held constant

Hypothesis 60. When two lighting conditions (930 and 950) are evaluated simultaneously, there is no difference in the subjects' perception of lighting as being visually warm or visually cool with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Responses using the bipolar adjectives, "visually warm or visually cool," on a seven-point Likert-type scale were used to assess subjects' perception of lighting when two lighting conditions (930 and 950) are evaluated simultaneously from outside the cubicles. Table 136 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 137. Color temperature (CT) as a main effect was statistically significant with an F (1, 96) = 139.34, p = .000. All respondents perceived the lower color temperature of 3000 K (M = 2.46) as being visually warm, while they perceived the higher color temperature of 5000 K (M = 4.91) as being visually cool at the same 95 CRI. Thus, the Hypothesis 60b was rejected.

There was no significant difference regarding to the main effects of culture group (American and Korean) for subject's perception of lighting as being visually warm or visually cool. Therefore, the Hypothesis 60a was not rejected. Culture group by CRI as a two-way interaction did not have a significant impact on the subjects' perception of light as being visually warm or visually cool. Therefore, Hypothesis 60c was not rejected.

Table 136

A Comparison of the Mean and Standard Deviation Scores for Subjects' Perception of Lighting as Being Visually Warm or Visually Cool[1] When 930 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	98	3.68	1.89	
Korean	98	3.68	1.57	
Color Temperature				0.000
3000 K	98	2.46	1.10	
5000 K	98	4.91	1.33	
Culture by CT				N.S.
American x 3000 K	49	2.37	1.18	
American x 5000 K	49	5.00	1.50	
Korean x 3000 K	49	2.55	1.02	
Korean x 5000 K	49	4.82	1.15	

1. 7 point Likert-type scale: 1 = visually warm and 7 = visually cool
Note. N.S = not significant at $p < .05$ (see ANOVA result in next table).

Table 137

Analysis of Variance for Subjects' Perception of Lighting as Being Visually Warm or Visually Cool When 930 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	0.00	0.00	0.00	1.000
Between Error	96	86.39	0.90		
CT	1	293.88	293.88	139.34	0.000***
Culture x CT	1	1.65	1.65	0.78	0.378
Within Error	96	202.47	2.11		

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

Hypothesis 61. When two lighting conditions (930 and 950) are evaluated simultaneously, there is no difference in the subjects' perception of lighting as a factor in visual clarity with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Responses using two bipolar adjectives, "bright/dim and clear/unclear," on a seven-point Likert-type scale were used to assess subjects' perception of lighting when two lighting conditions (930 and 950) are evaluated simultaneously from outside the cubicles. Table 138 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 139. Color temperature as a main effect was statistically significant with an $F(1, 96) = 45.26$, $p = .000$. All respondents, regardless of the culture group and color rendering index differences, perceived the higher color temperature of 5000 K (M = 6.14) as brighter and clearer than the lower color temperature of 3000 K (M = 8.95) with the same color rendering index of 95 CRI. Therefore, the Hypothesis 61b was rejected.

Culture group (American and Korean) as a main effect was not significant for subjects' perception of visual clarity when two lighting conditions (930 and 950) are evaluated simultaneously from outside the cubicles. Thus, the Hypothesis 61a was not rejected. No statistical significance for culture by CRI interaction was indicated for subject's perception of lighting as a factor in visual clarity when two lighting conditions (930 and 950) are evaluated simultaneously from outside the lighted environment. Therefore, the Hypothesis 61c was not rejected.

Table 138

A Comparison of the Mean and Standard Deviation Scores for Subjects' Perception of Lighting as a Factor in Visual Clarity[1] When 930 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S
American	98	7.29	2.96	
Korean	98	7.79	2.77	
Color Temperature				0.000
3000 K	98	8.95	2.65	
5000 K	98	6.14	2.35	
Culture by CT				N.S
American x 3000 K	49	6.25	2.58	
American x 5000 K	49	6.35	2.98	
Korean x 3000 K	49	6.04	2.12	
Korean x 5000 K	49	9.55	2.14	

[1]. Index score created for perception of visual clarity: 2 = the score that indicates the highest or best perception of visual clarity and 14 = the score that indicates the least or poorest perception of visual clarity
Note. N.S. = not significant at $p < .05$ (see ANOVA result in next table).

Table 139

Analysis of Variance for Subjects' Perception of Lighting as a Factor in Visual Clarity When 930 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	12.25	12.25	3.23	0.075
Between Error	96	363.84	3.79		
CT	1	385.84	385.84	45.26	0.000***
Culture x CT	1	24.29	24.29	2.85	0.095
Within Error	96	818.37	8.52		

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

Hypothesis 62. When two lighting conditions (930 and 950) are evaluated simultaneously, there is no difference in the subjects' perception of lighting for room attractiveness with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Responses using the two bipolar adjectives, "attractive/not attractive and inviting/not inviting," on a seven-point Likert-type scale were used to assess subjects' perception of lighting for room attractiveness when two lighting conditions (930 and 950) are evaluated simultaneously from outside the cubicles. Table 140 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 140. Regarding culture group as a main effect, there was statistical significance at $p = .033$ with an F ratio of 4.68. American subjects estimated the lighted environment as more attractive than Korean subjects regardless of the color temperature differences. Thus, the Hypothesis 62a was rejected.

Color temperature (3000 K and 5000 K) as a main effect was not significant for subjects' perception of room attractiveness when two lighting conditions (930 and 950) are evaluated simultaneously from outside the cubicles. Thus, the Hypothesis 62b was not rejected. Also, culture by CRI as a two-way interaction was not significant. Thus, the Hypothesis 62c was not rejected.

Table 140

A Comparison of the Mean and Standard Deviation Scores for Subjects' Perception of Lighting for Room Attractiveness[1] When 930 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				0.033
American	98	7.29	3.45	
Korean	98	7.94	2.98	
Color Temperature				N.S.
3000 K	98	8.01	3.41	
5000 K	98	7.21	3.01	
Culture by CT				N.S.
American x 3000 K	49	7.86	3.67	
American x 5000 K	49	6.71	3.15	
Korean x 3000 K	49	8.16	3.16	
Korean x 5000 K	49	7.71	2.81	

[1]. Index score created for perception of room attractiveness: 2 = the score that indicates the highest or best perception of room attractiveness and 14 = the score that indicates the least or poorest perception of room attractiveness
Note. N.S = not significant at $p < .05$ (see ANOVA result in next table).

Table 141

Analysis of Variance for Subjects' Perception of Lighting for Room Attractiveness When 930 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	20.90	20.90	4.68	0.033*
Between Error	96	428.63	4.46		
CT	1	31.04	31.04	1.92	0.169
Culture x CT	1	5.90	5.90	0.36	0.547
Within Error	96	1552.06	16.17		

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

Hypothesis 63. When two lighting conditions (930 and 950) are evaluated simultaneously, there is no difference in the subjects' perception of lighting for approach-avoidance intention with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Responses using the bipolar adjectives, "approach or avoid," on a seven-point Likert-type scale were used to assess subjects' perception of lighting when two lighting conditions (930 and 950) are evaluated simultaneously from outside the cubicles. Table 142 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 143. Regarding culture group as a main effect, there was statistical significance at $p = .044$ with an F ratio of 4.17. American subjects estimated the lighted environment as more approach than Korean subjects regardless of the color temperature differences. Thus, the Hypothesis 63a was rejected.

Color temperature (3000 K and 5000 K) as a main effect was not significant for subjects' for subjects' perception of lighting as being approach or avoid when two lighting conditions (930 and 950) are evaluated simultaneously from outside the cubicles. Thus, the Hypothesis 63b was not rejected. Also, culture by CRI as a two-way interaction was not significant. Thus, the Hypothesis 63c was not rejected.

Table 142

A Comparison of the Mean and Standard Deviation Scores for Subjects' Perception of Lighting for Approach-avoidance Intention[1] When 930 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				0.044
American	98	3.46	1.78	
Korean	98	3.81	1.38	
Color Temperature				N.S.
3000 K	98	3.89	1.65	
5000 K	98	3.38	1.51	
Culture by CT				N.S.
American x 3000 K	49	3.73	1.83	
American x 5000 K	49	3.18	1.69	
Korean x 3000 K	49	4.04	1.44	
Korean x 5000 K	49	3.57	1.29	

1. 7 point Likert-type scale: 1 = approach and 7 = avoid
Note. N.S = not significant at $p < .05$ (see ANOVA result in next table).

Table 143

Analysis of Variance for Subjects' Perception of Lighting for Approach-avoidance Intention When 930 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	5.90	5.90	4.17	0.044*
Between Error	96	135.65	1.41		
CT	1	12.76	12.76	3.57	0.062
Culture x CT	1	0.08	0.08	0.02	0.880
Within Error	96	343.16	3.57		

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

Hypothesis 64. When two lighting conditions (930 and 950) are evaluated simultaneously, there is no difference in the subjects' overall lighting preference with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Responses using the bipolar adjectives, "like or dislike," on a seven-point Likert-type scale were used to assess subjects' overall lighting preference when two lighting conditions (930 and 950) are evaluated simultaneously from outside the cubicles. Table 144 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 145. Regarding the color temperature as a main effect, there was statistical significance with an $F(1, 96) = 4.46$, $p = .035$. All respondents preferred the higher color temperature of 5000 K ($M = 3.42$) better than the lower color temperature of 3000 K ($M = 4.01$) regardless of culture group differences. Thus, the Hypothesis 64b was rejected.

Culture group (American and Korean) as a main effect was not significant for subjects' overall lighting preference when two lighting conditions (930 and 950) are evaluated simultaneously from outside the cubicles. Also, culture by CRI as a two-way interaction was not significant. Thus, the Hypotheses 64a and 64c were not rejected.

Table 144

A Comparison of the Mean and Standard Deviation Scores for Subjects' Overall Lighting Preference[1] When 930 and 950 lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	98	3.63	1.74	
Korean	98	3.80	1.51	
Color Temperature				0.035
3000 K	98	4.01	1.70	
5000 K	98	3.42	1.49	
Culture by CT				N.S.
American x 3000 K	49	4.06	1.84	
American x 5000 K	49	3.20	1.53	
Korean x 3000 K	49	3.96	1.57	
Korean x 5000 K	49	3.63	1.44	

[1] 7 point Likert-type scale: 1 = like and 7 = dislike

Note. N.S = not significant at $p < .05$ (see ANOVA result in next table).

Table 145

Analysis of Variance for Subjects' Overall Lighting Preference When 930 and 950 lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	1.31	1.31	0.94	0.335
Between Error	96	133.69	1.39		
CT	1	17.16	17.16	4.60	0.035*
Culture x CT	1	3.45	3.45	0.92	0.339
Within Error	96	358.39	3.73		

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

Hypothesis 65. When two lighting conditions (930 and 950) are evaluated simultaneously, there is no difference in the subjects' impression of the light color with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)

To investigate the impression of the light color according to the important variables of culture group and color temperature, the hypothesis 65 was tested. The subjects were asked to evaluate the color of the light from outside the cubicles associating with six names of color such as reddish, orangish, yellowish, greenish, bluish, and whitish. For this test, chi-square analysis was conducted. The results of the analysis for this measure are shown in Table 146.

The color temperature (3000 K and 5000 K) as a main effect was statistically significant at $\chi^2 = 155.28$, $p = 0.0001$. A greater proportion of respondents in both groups described the lower color temperature of 3000 K as being reddish (n = 15, 7.7%), orangish (n = 46, 23.5%), and yellowish (n = 31, 15.9%), whereas they described the higher color temperature of 5000 K as being bluish (n = 32, 16.3%) and whitish (n = 57, 29.1%). The graph in Figure 27 demonstrates the responses for the subjects' impression of the color of the light on the two different color temperatures (3000 K and 5000 K). As can be seen in Figure15, the color temperature has a strong effect on the subjects' impression of the light color with the same 95 CRI.

There was no statistical significance for culture group on subjects' impression of the color of the light. However, a greater proportion of both the American and Korean subjects perceived the color of the light as being reddish, orangish, yellowish, bluish and whitish for the comparison of 930 and 950 lighting conditions (same 95 CRI with different CT of 3000 K and 5000 K).

Table 146

Chi-square Analysis of Subjects' Impression of the Light Color When 930 and 950 lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Possible color choices of the light	Culture group				Color Temperature			
	American		Korean		3000 K		5000 K	
	n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
Reddish	7	(3.6)	9	(4.6)	15	(7.7)	1	(0.5)
Orangish	23	(11.7)	23	(11.7)	46	(23.5)	0	(0.0)
Yellowish	19	(9.7)	17	(8.7)	31	(15.8)	5	(2.6)
Greenish	2	(1.0)	3	(1.5)	2	(1.0)	3	(1.5)
Bluish	22	(11.2)	10	(5.1)	0	(0.0)	32	(16.3)
Whitish	25	(12.8)	36	(18.4)	4	(2.0)	57	(29.1)
Total Subject [b]	98		98		98		98	
χ^2	7.04				155.28			
p	0.2173				0.0001***			

[a] % based on 98 observations for each main effect.
[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.
* $p < .05$. ** $p < .01$. *** $p < .001$.

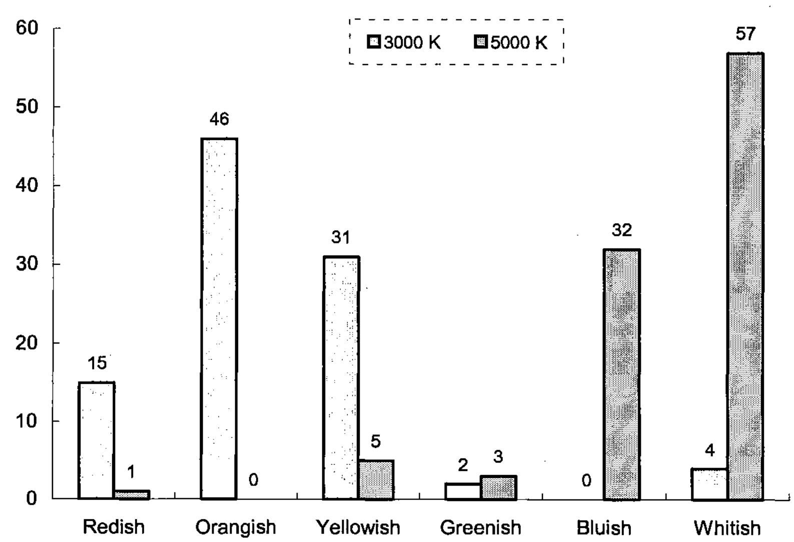


Figure 27. A Graph of the Subjects' Impression of the Light Color on Color Temperature When 930 and 950 lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Hypothesis 66. When two lighting conditions (930 and 950) are evaluated simultaneously, there is no difference in the subjects' preference of the light color with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Responses using the bipolar adjectives, "like or dislike," on a seven-point Likert-type scale were used to assess subjects' preference of the light color when two lighting conditions (930 and 950) are evaluated simultaneously from outside the cubicles. Table 147 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 148. . Regarding the color temperature as a main effect, there was statistical significance with an $F(1, 96) = 5.79$, $p = .018$. All respondents preferred the color of the light under the higher color temperature of 5000 K ($M = 3.40$) than the lower color temperature of 3000 K ($M = 4.10$) regardless of culture group differences. Thus, the Hypothesis 66b was rejected.

Culture group (American and Korean) as a main effect was not significant for subjects' preference of the color of the light when two lighting conditions (930 and 950) are evaluated simultaneously from outside the cubicles. Also, culture by CRI as a two-way interaction was not significant. Thus, the Hypotheses 66a and 66c were not rejected.

Table 147

A Comparison of the Mean and Standard Deviation Scores for Subjects' Preference of the Light Color[1] When 930 and 950 Lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	98	3.68	1.81	
Korean	98	3.82	1.52	
Color Temperature				0.018
3000 K	98	4.10	1.70	
5000 K	98	3.40	1.57	
Culture by CT				N.S.
American x 3000 K	49	4.12	1.87	
American x 5000 K	49	3.24	1.66	
Korean x 3000 K	49	4.08	1.54	
Korean x 5000 K	49	3.55	1.47	

1. 7 point Likert-type scale: 1 = like and 7 = dislike
Note. N.S = not significant at $p < .05$ (see ANOVA result in next table).

Table 148

Analysis of Variance for Subjects' Preference of the Light Color When 930 and 950 lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	0.86	0.86	0.72	0.399
Between Error	96	115.39	1.20		
CT	1	24.29	24.29	5.79	0.018*
Culture x CT	1	1.47	1.47	0.35	0.555
Within Error	96	402.73	4.20		

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

Hypothesis 67. When two lighting conditions (930 and 950) are evaluated simultaneously, there is no difference in the subjects' perception of fruit color as being natural or unnatural with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)
c) two-way interaction of culture by CT

Responses using the bipolar adjectives, "natural or not natural," on a seven-point Likert-type scale were used to assess subjects' perception of fruit color appearance when two lighting conditions (930 and 950) are evaluated simultaneously from outside the cubicles. Table 149 shows the mean and standard deviation scores for main effects and a two-way interaction of subjects' perception of lighting.

The results of the analysis of variance (ANOVA) are summarized in Table 150. Culture group (American and Korean) and color temperature (3000 K and 5000 K) as a main effect were not significant for subjects' perception of fruit color appearance when two lighting conditions (930 and 950) are evaluated simultaneously from outside the cubicles. Thus, the Hypotheses 67a and 67b were not rejected. Also, culture by CRI as a two-way interaction was not significant. Thus, the Hypothesis 67c was not rejected.

Table 149

A Comparison of the Mean and Standard Deviation Scores for Subjects' Perception of Fruit Color[1] When 930 and 950 lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	n	Mean	SD	p
Culture group				N.S.
American	98	3.37	1.64	
Korean	98	3.59	1.34	
Color Temperature				N.S.
3000 K	98	3.55	1.63	
5000 K	98	3.41	1.36	
Culture by CT				N.S.
American x 3000 K	49	3.51	1.80	
American x 5000 K	49	3.22	1.46	
Korean x 3000 K	49	3.59	1.44	
Korean x 5000 K	49	3.59	1.24	

[1] 7 point Likert-type scale: 1 = natural and 7 = not natural
Note. N.S = not significant at $p < .05$ (see ANOVA result in next table).

Table 150

Analysis of Variance for Subjects' Perception of Fruit Color When 930 and 950 lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Source	df	SS	MS	F	p
Culture	1	2.47	2.47	1.65	0.202
Between Error	96	143.45	1.49		
CT	1	1.00	1.00	0.33	0.566
Culture x CT	1	1.00	1.00	0.33	0.566
Within Error	96	289.00	3.01		

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$

Hypothesis 68. When two lighting conditions (930 and 950) are evaluated simultaneously, there is no difference in the subjects' perception for five different kinds of fruit with regard to

a) culture (American and Korean)
b) color temperature of fluorescent light (3000 K and 5000 K)

To identify the subjects' color perception of natural objects under the two different lighting conditions (930 and 950 lighting), the colors of five different kinds fruit in a bowl were tested from outside the cubicles. The five fruits were apple, orange, banana, lemon, and grape. For this measure, chi-square analysis was conducted. The results of the analysis are shown in Table 151.

The variable of culture group (American and Korean) was statistically significant for both the orange (χ^2 = 4.03, p = 0.0447) and banana color perception (χ^2 = 4.03, p = 0.0447). Although most of the respondents described all fruit colors as being not distorted from their natural color, a greater proportion of difference showed between the American and Korean subjects for the orange color perception. Twenty-four (12.2%) of98 American subjects responded to the orange color as being distorted, while only 13 Korean subjects (6.6%) perceived the orange color as being distorted.

For the banana color perception, there is a greater proportion of difference showed between the Americans and Koreans. Twenty-four American subjects (12.2%) of98 responded to the orange color as being distorted, while only 13 Korean subjects (6.6%) perceived the orange color as being distorted from its natural color.

The variable of color temperature (3000 K and 5000 K) was statistically significant for the only lemon color perception (χ^2 = 15.26, p = 0.0001). Although most of the respondents described all fruit colors as being not distorted from its natural color, a greater proportion of difference showed between 3000 K and 5000 K with the same color rendering index of 95 CRI for the lemon color perception. Thirty four (17.4%) of98 subjects in both groups responded to the lemon color as being distorted under 3000 K, while eleven (5.6%) subjects perceived the lemon color as being distorted under 5000 K. Therefore, the Hypotheses 68a and 68b were rejected.

Table 151

Chi-square Analysis of Subjects' Perception of Fruit Color as Being Distorted or Not Distorted under the Lighting When 930 and 950 lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Variable		Culture group				Color Temperature			
		American		Korean		3000K		5000K	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
Apple	Distorted	24	(12.2)	19	(9.7)	20	(10.2)	23	(21.5)
	Not Distorted	74	(37.8)	79	(40.3)	78	(39.8)	75	(38.3)
	χ^2	0.74				0.27			
	p	0.3881				0.6046			
Orange	Distorted	24	(12.2)	13	(6.6)	22	(11.2)	15	(7.7)
	Not Distorted	74	(37.8)	85	(43.4)	76	(38.8)	83	(42.4)
	χ^2	4.03				1.63			
	p	0.0447*				0.2041			
Banana	Distorted	24	(12.2)	13	(6.6)	14	(7.1)	23	(11.7)
	Not Distorted	74	(37.8)	85	(43.4)	84	(42.9)	75	(38.3)
	χ^2	4.03				2.70			
	p	0.0447*				0.1004			
Lemon	Distorted	26	(13.3)	19	(9.7)	34	(17.4)	11	(5.6)
	Not Distorted	72	(36.7)	79	(40.3)	64	(32.7)	87	(44.4)
	χ^2	1.41				15.26			
	p	0.2345				0.0001***			
Grape	Distorted	26	(13.3)	34	(17.4)	32	(16.3)	28	(14.3)
	Not Distorted	72	(36.7)	64	(32.7)	66	(33.7)	70	(35.7)
	χ^2	1.54				0.38			
	p	0.2150				0.5353			
Total subject[b]		98		98		98		98	

[a] % based on 98 observations for each main effect.
[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Hypothesis 69. When two lighting conditions (930 and 950) are evaluated simultaneously, there is no difference in the subjects' ability to match and designate colors with regard to culture and color rendering index for T-shirts dyed

a) red
b) yellow
c) blue
d) purple blue

To investigate the difference in the ability to match color when two lighting conditions (930 and 950) were observed simultaneously from outside the lighted environment, the four hues from the Munsell color system were tested using the four different color T-shirts. The four Munsell hues of the T-shirts were 5R 4/14 for the red shirt, 5Y 8.5/14 for the yellow shirt, 5B 5/10 for the blue shirt, and 5PB 5/10 for the purple blue shirt. Chi-square analysis was conducted to test color match of individuals with different culture groups under the two different lighting conditions (3000 K and 5000 K with 95 CRI).

Table 152 shows the results of the analysis for the red shirt (Munsell 5R 4/14) by comparing the two lighting conditions (930 and 950) simultaneously from outside the cubicles. Culture group was not significant for the color designation of the red shirt (Munsell Hue 5R 4/14). Although the differences are not significant, a greater proportion of both the American and Korean subjects designated the red shirt as 5/14 (5R 5/14), 6/14 (7.5R 5/16), and 7/14 (7.5R 5/14). Only three of196 observations in both groups described the red shirt as its original color by comparing the two lighting conditions.

Color temperature (3000 K and 5000 K) was statistically significant (χ^2 = 49.49, p = 0.0001) on subjects' color matching of the red shirt (Munsell 5R 4/14). The results of the red shirt designation indicate significant differences between 3000 K and 5000 K for 5/14 (5R 5/14), 6/14 (7.5R 5/16), 7/12 (2.5R 6/12), and 7/14 (7.5R 5/14). Under the lower color temperature (3000 K), a greater proportion of subjects in both groups designated the red shirt as 6/14 (7.5R 5/16) and 7/14 (7.5R 5/14). However, under the higher color temperature (5000 K), a greater proportion of subjects in both groups designated the red shirt as 5/14 (5R 5/14) and 7/12 (2.5R 6/12). Theses results indicate that under 3000 K, the pure hue of red (5R) appeared as the hue of 7.5R, the color on a clockwise direction of the color wheel, while under 5000 K, it appeared as having the same hue with a lighter value and weaker chroma than its original red or as the hue of 2.5R, the color on a counterclockwise direction of the color wheel.

Table 152

Chi-square Analysis for the Color Designation of the Red Shirt When 930 and 950 lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Original Research Color Chip Designation in Card A	Munsell Designation for All Possible Red Choices	Culture				Color Temperature			
		American		Korean		3000 K		5000 K	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
3/12	2.5R 5/10	0	(0)	1	(0.5)	0	(0)	1	(0.5)
3/14	2.5R 4/14	0	(0)	1	(0.5)	0	(0)	1	(0.5)
4/10	5R 4/10	0	(0)	0	(0)	0	(0)	0	(0)
4/12	5R 4/12	0	(0)	2	(1.0)	0	(0)	2	(1.0)
<u>4/14</u>	<u>5R 4/14</u>	0	(0)	3	(1.5)	1	(0.5)	2	(1.0)
5/10	5R 5/10	1	(0.5)	1	(0.5)	0	(0)	2	(1.0)
5/12	5R 5/12	3	(1.5)	3	(1.5)	0	(0)	6	(3.1)
5/14	5R 5/14	15	(7.7)	11	(5.6)	6	(3.1)	20	(10.2)
6/10	5R 6/10	1	(0.5)	1	(0.5)	1	(0.5)	1	(0.5)
6/12	5R 6/12	0	(0)	1	(0.5)	0	(0)	1	(0.5)
6/14	7.5R 5/16	25	(12.8)	32	(16.3)	41	(20.9)	16	(8.2)
7/10	5R 7/10	0	(0)	1	(0.5)	0	(0)	1	(0.5)
7/12	2.5R 6/12	12	(6.1)	7	(3.6)	2	(1.0)	17	(8.7)
7/14	7.5R 5/14	41	(20.9)	34	(17.4)	47	(24.0)	28	(14.3)
Total Subject [b]		98		98		98		98	
χ^2		14.44				49.49			
p		0.3433				0.0001***			

Note. Underlined Munsell Designation, "___", indicates the "true" color match for the shirt under natural light, thus, no color distortion of the shirt.
[a] % based on 98 observations for each main effect.
[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.
* $p < .05$. ** $p < .01$. *** $p < .001$.

The results of chi-square analysis for the color matching and designation to the blue shirt (5/10, Munsell 5B 5/10) are shown in Table 153. Culture group was not significant for the blue shirt (Munsell 5B 5/10). Although the differences are not significant, a greater proportion of both the American and Korean subjects designated the blue shirt as 5/10 (5B 5/10), 6/10 (5B 6/10), and 7/10 (7.5B 7/8). Thirty of196 observations in both culture groups described the blue shirt as its original color under both lighting conditions.

Color temperature (3000 K and 5000 K) had a significant impact ($\chi^2 = 82.06$, $\underline{p} = 0.0001$) on the subjects' color perception of the blue shirt. There was a significant difference between 3000 K and 5000 K for the color chips of 5/10 (5B 5/10), 6/8 (5B 6/8), 6/10 (5B 6/10), 7/10 (7.5B 7/8), and 8/8 (10BG 7/8). Under the lower color temperature (3000 K), a greater proportion of the subjects in both groups designated the blue shirt as 6/8 (5B 6/8), 6/10 (5B 6/10), and 8/8 (10BG 7/8). However, under the higher color temperature (5000 K), a greater proportion of the subjects in both groups designated the blue shirt as 5/10 (5B 5/10) and 7/10 (7.5B 7/8).

These results indicate that under 3000 K, the pure hue of blue (5B) appeared as the hue of 10BG, the color on a counterclockwise direction of the color wheel and as having the same hue with a lighter value and weaker chroma, while under 5000 K, it appeared as its original blue or 7.5B, the color on a clockwise direction of the color wheel.

Table 153

Chi-square Analysis for the Color Designation of the Blue Shirt When 930 and 950 lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Original Research Color Chip Designation in Card B	Munsell Designation for All Possible Blue Choices	Culture				Color Temperature			
		American		Korean		3000 K		5000 K	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
4/6	5B 4/6	0	(0)	0	(0)	0	(0)	0	(0)
4/8	10BG 5/10	2	(1.0)	2	(1.0)	4	(2.0)	0	(0)
4/10	2.5B 5/10	1	(0.5)	3	(1.5)	2	(1.0)	2	(1.0)
5/6	5B 5/6	0	(0)	0	(0)	0	(0)	0	(0)
5/8	5B 5/8	0	(0)	1	(0.5)	1	(0.5)	0	(0)
<u>5/10</u>	<u>5B 5/10</u>	15	(7.7)	15	(7.7)	9	(4.6)	21	(10.7)
6/6	5B 6/6	1	(0.5)	5	(2.6)	5	(2.6)	1	(0.5)
6/8	5B 6/8	11	(5.6)	8	(4.1)	16	(8.2)	3	(1.5)
6/10	5B 6/10	29	(14.8)	25	(12.8)	40	(20.4)	14	(7.1)
7/6	5B 7/6	0	(0)	1	(0.5)	1	(0.5)	0	(0)
7/8	5B 7/8	12	(6.1)	7	(3.6)	11	(5.6)	8	(4.1)
7/10	7.5B 7/8	25	(12.8)	27	(13.8)	3	(1.5)	49	(25.0)
8/6	10BG 7/6	0	(0)	0	(0)	0	(0)	0	(0)
8/8	10BG 7/8	2	(1.0)	4	(2.0)	6	(3.1)	0	(0)
Total Subject[b]		98		98		98		98	
χ^2		9.44				82.06			
p		0.5815				0.0001***			

Note. Underlined Munsell Designation, "___", indicates the "true" color match for the shirt under natural light, thus, no color distortion of the shirt.

[a] % based on 98 observations for each main effect.

[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.

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

The results of chi-square analysis for the color matching and designation to the yellow shirt (6/14, Munsell 5Y 8.5/14) are shown in Table 154. Culture group was not significant for the yellow shirt (Munsell 5Y 8.5/14) by comparing two lighting conditions (3000 K and 5000 K with 95 CRI). Although the differences are not significant, a greater proportion of both American and Korean subjects designated the yellow shirt as 5/12 (2.5Y 8.5/12), 6/14 (5Y 8.5/14), 7/12 (7.5Y 8.5/12), and 7/14 (5Y 8.5Y/12). Thirty-three of196 observations in both culture groups described the yellow shirt as its original color by comparing the two color temperatures of lighting with 95 CRI.

Color temperatures (3000 K and 5000 K) had a significant impact ($\chi^2 = 106.77$, p = 0.0001) on the subjects' color perception of the yellow shirt. There was a significant difference between 3000 K and 5000 K for the color chips of 5/12 (2.5Y 8.5/12), 6/10 (2.5Y 8.5/12), 6/12 (2.5Y 8/12), 6/14 (5Y 8.5/14), 7/12 (7.5Y 8.5/12), 7/14 (5Y 8.5/12), and 8/14 (7.5Y 8.5 /8). Under 3000 K, a greater proportion of the subjects described the yellow shirt as 5/12 (2.5Y 8.5/12), 6/10 (2.5Y 8.5/12), 6/12 (2.5Y 8/12), and 6/14 (5Y 8.5/14). Under 5000 K, a greater proportion of the subjects described the yellow shirt as 7/12 (7.5Y 8.5/12), 7/14 (5Y 8.5/12 and 8/14 (7.5Y 8.5 /8).

These results indicate that the pure hue of yellow (5Y) appeared as its original color and the hue of 2.5Y, the color on a counterclockwise direction of the color wheel under 3000 K. However, under 5000 K, the pure hue of yellow (5Y) appeared as the hue of 7.5Y, the color on a clockwise direction of the color wheel.

Table 154

Chi-square Analysis for the Color Designation of the Yellow Shirt When 930 and 950 lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Original Research Color Chip Designation in Card C	Munsell Designation for All Possible Yellow Choices	Culture				Color Temperature			
		American		Korean		3000 K		5000 K	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
5/10	2.5Y 8.5/8	0	(0)	0	(0)	0	(0)	0	(0)
5/12	2.5Y 8.5/12	18	(9.2)	17	(8.7)	35	(17.9)	0	(0)
5/14	5Y 8/14	0	(0)	1	(0.5)	1	(0.5)	0	(0)
6/10	2.5Y 8.5/12	9	(4.6)	6	(3.1)	10	(5.1)	5	(2.6)
6/12	2.5Y 8/12	3	(1.5)	8	(4.1)	7	(3.6)	4	(2.0)
<u>6/14</u>	<u>5Y 8.5/14</u>	17	(8.7)	16	(8.2)	27	(13.8)	6	(3.1)
7/8	5Y 7/8	0	(0)	0	(0)	0	(0)	0	(0)
7/10	5Y 7/10	0	(0)	0	(0)	0	(0)	0	(0)
7/12	7.5Y 8.5/12	24	(12.2)	24	(12.2)	1	(0.5)	47	(24.0)
7/14	5Y 8.5/12	18	(9.2)	20	(10.2)	14	(7.1)	24	(12.2)
8/8	5Y 8/8	0	(0)	0	(0)	0	(0)	0	(0)
8/10	5Y 8/10	0	(0)	0	(0)	0	(0)	0	(0)
8/12	5Y 8/12	0	(0)	1	(0.5)	1	(0.5)	0	(0)
8/14	7.5Y 8.5/8	9	(4.6)	5	(2.6)	2	(1.0)	12	(6.1)
Total Subjects [b]		98		98		98		98	
χ^2		6.18				106.77			
p		0.6271				0.0001***			

Note. Underlined Munsell Designation, "___", indicates the "true" color match for the shirt under natural light, thus, no color distortion of the shirt.
[a] % based on 98 observations for each main effect.
[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.
* $p < .05$. ** $p < .01$. *** $p < .001$.

The results of chi-square analysis for the color matching and designation to the purple blue shirt (Munsell 5PB 5/10) are shown in Table 155. Culture group was not significant for the purple blue shirt (Munsell 5PB 5/10). Although the differences are not significant, a greater proportion of both the American and Korean subjects designated the purple blue shirt as 6/8 (5PB 6/8), 6/10 (5PB 6/10), and 6/12 (2.5PB 6/10). Only 5 observations in both culture groups described the purple blue shirt as its original color by comparing the two lighting conditions (3000 K and 5000 K with 95 CRI).

Color temperature (3000 K and 5000 K) had a significant impact ($\chi^2 = 59.16$, $p = 0.0001$) on the subjects' perception of the purple blue shirt (Munsell 5PB 5/10). There was a significant difference between 3000 K and 5000 K for the color chips of 5/8 (5PB 5/8), 5/12 (10B 6/10), 6/6 (5PB 6/6), 6/8 (5PB 6/8), 6/10 (5PB 6/10), 6/12 (2.5PB 6/10), and 7/8 (5PB 7/8). Under 3000 K, a greater proportion of the subjects described the purple blue shirt as 5/12 (10B 6/10), 5/8 (5PB 5/8). 6/6 (5PB 6/6), and 6/8 (5PB 6/8). Under 95 CRI, a greater proportion of the subjects described the purple blue shirt as 6/10 (5PB 6/10), 6/12 (2.5PB 6/10), and 7/8 (5PB 7/8).

These results indicate that the pure hue of purple blue (5PB) appeared as having the same hue with a lighter value and weaker chroma under 3000 K. However, under 5000 K, the pure hue of purple blue (5PB) appeared as the hues of 2.5PB and 10B, the colors on a counterclockwise direction of the color wheel.

Table 155

Chi-square Analysis for the Color Designation of the Purple Blue Shirt When 930 and 950 lighting Conditions are Observed Simultaneously from Outside the Lighted Environment

Original Research Color Chip Designation in Card D	Munsell Designation for All Possible Purple Blue Choices	Culture				Color Temperature			
		American		Korean		3000 K		5000 K	
		n	(%)[a]	n	(%)[a]	n	(%)[a]	n	(%)[a]
4/8	4/8	0	(0)	0	(0)	0	(0)	0	(0)
4/10	4/10	1	(0.5)	0	(0)	1	(0.5)	0	(0)
4/12	4/12	3	(1.5)	4	(2.0)	2	(1.0)	5	(2.6)
5/8	5/8	5	(2.6)	17	(8.7)	15	(7.7)	7	(3.6)
<u>5/10</u>	<u>5/10</u>	1	(0.5)	4	(2.0)	4	(2.0)	1	(0.5)
5/12	5/12	7	(3.6)	11	(5.6)	2	(1.0)	16	(8.2)
6/6	6/6	6	(3.1)	3	(1.5)	8	(4.1)	1	(0.5)
6/8	6/8	24	(12.3)	17	(8.7)	33	(16.8)	8	(4.1)
6/10	6/10	17	(8.7)	17	(8.7)	15	(7.7)	19	(9.7)
6/12	6/12	27	(13.8)	19	(9.7)	12	(6.1)	34	(17.4)
7/6	7/6	4	(2.0)	1	(0.5)	5	(2.6)	0	(0)
7/8	7/8	3	(1.5)	5	(2.6)	1	(0.5)	7	(3.6)
7/10	7/10	0	(0)	0	(0)	0	(0)	0	(0)
7/12	7/12	0	(0)	0	(0)	0	(0)	0	(0)
Total Subject [b]		98		98		98		98	
χ^2		19.33				59.16			
p		0.0554				0.0001***			

Note. Underlined Munsell Designation, "___", indicates the "true" color match for the shirt under natural light, thus, no color distortion of the shirt.
[a] % based on 98 observations for each main effect.
[b] Total subjects: 49 in the American group and 49 in the Korean group. Repeated measures designs yield four observations per person, thus a total of 196 observations.
* $p < .05$. ** $p < .01$. *** $p < .001$.

CHAPTER V

DISCUSSION AND CONCLUSIONS

Overview

The primary purpose of the study was to understand the impact of different fluorescent color temperatures and color rendering indices on lighting perception and preference, the appearances of complexion and skin color, the impression and preference of the light color, and the color perception and designation of store products according to two different cultures, Caucasian Americans and Koreans. In addition, lighting perception and preference, the impression and preference of the light color, and the color perception and designation of the store products were tested by observing outside the lighted environment, by comparing the responses between inside and outside the lighted environment, and by observing two lighting conditions simultaneously from outside the lighted environment.

In this chapter, the variables and the associated research hypotheses are reviewed with the theories developed in Chapter II and the results generated in Chapter IV. The variables manipulated in the research were cultural group, color rendering index and color temperatures of the fluorescent light and the location of the observers. Of the variables considered in the research, culture and observers' location differences had not been utilized in previous studies. Results of the use of these variables unveiled some interesting findings. The dependent variables included lighting perception in arousal, pleasure, visual clarity, glare, and room attractiveness, lighting preference, impression and preference of the light color, the lighting effects on the appearances of complexion and skin tone, and the color perception and designation of the store products. The future research recommendations and implications of the study are also discussed.

The Effect of Study Variables on Subjects' Perception of Arousal

The results of the study showed that culture group and color temperature had a significant effect on the subjects' perception of lighting as a factor in arousal. American respondents estimated the room light as significantly more arousing than Korean respondents regardless of color rendering indices and color temperatures. The higher color temperature of 5000 K was estimated as more arousing than the lower color temperature of 3000 K regardless of culture group and color rendering index differences. The results supported the proposed study model of this research that it is the color temperature of the light source as an environmental stimulus that affects the perception of arousal influenced or filtered by each person's cultural background.

Previous studies reported that arousal is influenced by lighting (Areni & Kim, 1994; Gifford, 1988; Hebert, 1997). It supported the notion that lighting directly and positively affects one's arousal state, but the only lighting factor manipulated in the previous studies was simply the intensity level of lighting as bright or dim. Therefore, this present study is valuable in lighting research.

The results of the study also showed the effectiveness of Berlyne's (1971) arousal theory and the Meharbian and Russell (1974) environmental psychology model for predicting shopping intentions and consumer behavior. Additionally, this study presented the validity of these theories when applying them in another cultural background.

The Effect of Study Variables on Subjects' Perception of Pleasure

The pleasure of a store lighting environment is significantly affected by changing the color temperature and color rendering index of the light source as viewed by two different culture groups when they observed the lighting conditions in the cubicle. American subjects estimated the higher color rendering index of 95 CRI as more positive than the lower color rendering index of 75 CRI at the lower color temperature of 3000 K. However, Korean subjects estimated the lower color rendering index of 75 CRI as more positive than the higher color rendering index of 95

CRI at the lower color temperature of 3000 K in their perception of pleasure under these lighting conditions.

Also, Korean subjects perceived the lower temperature of 3000 K as more positive than the higher color temperature of 5000 K with the lower color rendering index of 75 CRI. Korean subjects estimated the 730 lighting condition as more positive in perception of pleasure than American subjects. Thus, the results indicate that American subjects estimated the 930 lighting as best in perception of pleasure among the four lighting conditions, while Korean subjects estimated the 730 lighting as best in perception of pleasure among the four lighting conditions. Since significant differences existed between the two culture groups for the pleasure perception, it appears that pleasure of lighting perception has a positive relationship with brightness.

The results of this study suggested that differences in pleasure measures were found for culture and color rendering indices. Unfortunately, the reason cannot be attributed solely to color rendering differences since one's lighting perception of pleasure is also related to one's psychological nature. Cultural differences impact lighting perception of pleasure. The results supported the proposed study model of this research by showing that the color temperature and color rendering index of the light source as environmental stimuli affect perception of pleasure which is also influenced or filtered by each person's cultural background.

The Effect of Study Variables on Subjects' Perception of Visual Clarity

The visual clarity of a store lighting environment was estimated as one of the objectives of the study testing all four sections of the hypotheses. For the test in Section 1 (Inside the Cubicle), the visual clarity is significantly affected by changing the color temperature of its lighting conditions. All respondents estimated the higher color temperature of 5000 K as higher in visual clarity than the lower color temperature of 3000 K regardless of the culture group and color rendering index differences.

For the test in Section 2 (Outside the Cubicle), there were significant differences for the main effects of culture group and color temperature. American respondents estimated the room light as significantly brighter and clearer than Korean respondents regardless of color rendering indices and color temperatures. Like the result in Section 1, all respondents estimated the higher color temperature of 5000 K as significantly brighter and clearer than the lower color temperature of 3000 K regardless of the culture group and color rendering index differences.

For the test in Section 3 (Comparison between Inside and Outside the Lighted Environment), there were significant differences for the main effects of location and color temperature. Regarding location between inside and outside the lighted environment, not surprisingly, all participants perceived the lighting conditions as brighter and clearer when observed inside the lighted environment than when observed outside the lighted environment. Also, the visual clarity is significantly affected by changing the color temperature of its lighting conditions. All participants perceived the 5000 K of the light source as brighter and clearer than the 3000 K.

There was a significant difference in the three-way interaction, namely culture by color temperature by color rendering index. This interaction finding shows that American subjects estimated both 750 and 930 lighting conditions as brighter and clearer than Korean subjects did. Both Americans and Koreans estimated the higher color temperature of 5000 K as brighter and clearer than the lower color temperature of 3000 K with both 75 and 95 CRI. Korean subjects estimated the 930 lighting as the least clear across all lighting conditions.

For the test in Section 4 (Side by Side Evaluation), the visual clarity is significantly affected by changing the color rendering index and color temperature of its lighting conditions. All respondents estimated the 75 CRI as brighter and clearer than the 95 CRI by holding constant the color temperature of 3000 K. There were no differences noted between 75 CRI and 95 CRI when the color temperature of 5000 K was being held constant. Similarly without changing the color rendering index with its lighting conditions, there were significant differences between 3000 K and 5000 K. All respondents estimated the 5000 K as brighter and clearer than the 3000 K with both 75 CRI and 95 CRI.

The results through all four sections show consistent findings of the color temperature. This indicates that the higher color temperature of 5000 K is significantly better for the perception of visual clarity than the lower color temperature of 3000 K. The cultural factor also affected the visual clarity of a lighting environment by showing the Americans' positive attitude toward the 930 lighting condition.

Based on the tests of Sections 1, 2, and 3, the effect of visual clarity under different lighting conditions cannot be predicted by using their CRI values. Besides this, the color rendering effect on visual clarity finding in this study does not support the previous studies which indicated that the good color rendering lamps provide a higher degree of visual clarity (Bellchamber & Godby, 1972; Boyce, 1977; Hegde & Woodson, 1999). Perhaps, the difference between the findings in this study and previous studies can be explained by differences in research methods.

The Effect of Study Variables on Perception of Glare

Perception of glare was estimated only inside the lighted environment (cubicle). The study found that the color temperature of the light source significantly affects the perception of glare. All respondents estimated the lower color temperature of 3000 K as less glaring than the higher color temperature of 5000 K of the light source. This result shows that the perception of glare seems to be correlated directly with the warm/cool dimension. The result of this study does not confirm the study of Park and Farr (2000) which concluded that the lower color rendering index of 75 CRI is less glaring than the higher color rendering index of 85 CRI with 3000 K. However, the result supported the proposed study model of this research by showing the color temperature of the light source as an environmental stimulus affects one's perception of glare.

The Effect of Study Variables on Lighting Preference

Overall lighting preference was tested in all sections of the hypotheses. When observed inside the lighted environment, all participants preferred the lower color temperature of 3000 K more than the higher color temperature of 5000 K regardless of cultural group and color rendering index differences.

By observing from outside the lighted environment, all participants preferred the higher color rendering index of 95 CRI more than the lower color rendering index of 75 CRI regardless of cultural group and color temperature differences. A significant two-way interaction of culture by color temperature was obtained when Korean subjects indicated they preferred the lower color temperature of 3000 K more than American subjects did. And also the Korean subjects preferred the lower color temperature of 3000 K more than the higher color temperature of 5000 K.

By comparing the responses between inside and outside the lighted environment for lighting preference, the American subjects preferred the 930 lighting more than the Korean subjects did. Overall, the American subjects most preferred the 930 lighting condition among the four lighting conditions.

When two lighting conditions were simultaneously compared from outside the lighted environment, both the American and Korean subjects preferred the lower color rendering index (75 CRI) over the higher color rendering index (95 CRI) of the light source at the color temperature of 3000 K. Both the American and Korean subjects preferred the higher color temperature (5000 K) more than the lower color temperature (3000 K) of the light source at 95 CRI. This result indicates that all participants liked the 930 lighting condition the least when two lighting conditions were simultaneously compared from outside the lighted environment.

The Effect of Study Variables on Impression and Preference of the Light Color

The impression and preference of the color of the light in a store lighting environment was investigated as one of the objectives of the study testing all four sections of the hypotheses. For the test in Section 1 (Inside the Cubicle), there was a difference between the 3000 K and 5000 K of the light sources regarding the impression of the color of the light associated with six names of the color of the light: reddish, orangish, yellowish, greenish, bluish, and whitish. Most respondents described the lower color temperature (3000 K) of the light source as warm colors, reddish, orangish, and yellowish, while they described the higher color temperature of 5000 K as cool colors such as bluish and whitish. In using the visually warm/visually cool rating scale, the findings of this question are confirmed. The subjects responded to the variations in light color, and they tended to categorize the presented source colors in a manner that approximated the color temperature scale. There was no difference for the preference of the color of the light regarding the study variables. This result indicates that the subjects do not have special preferences even though they were able to distinguish the color of light differently between two different light sources when observed inside the lighted environment.

For the test in Section 2 (Outside the Cubicle), there were significant differences between the 3000 K and 5000 K regarding the impression of the color of the light. Most of the subjects described the lower color temperature (3000 K) of the light source as warm colors, orangish and yellowish, whereas they described the higher color temperature (5000 K) of the light source as cool colors, bluish and whitish. The findings of this question are confirmed the visually warm/visually cool scale by showing the interaction of CRI by CT. This interaction shows that the 730 lighting was estimated as the warmest color among all four lighting conditions. The finding regarding preference of the color of the light shows that all subjects liked the 95 CRI better than the 75 CRI when observed outside the lighted environment. The subjects clearly recognized the differences in the color rendering indices of the light source when observing from outside the lighted environment.

By comparing the responses between inside and outside the lighted environment, the impression and preferences of the color of the light are significantly affected by changing the color temperature, color rendering index, location of the study variables between the two different cultural groups. The subjects recognized the differences in the color temperature of the light source presented to them. The subjects responded to the variations in light color, and they tended to categorize the presented source colors in a manner that approximated the color temperature scale. However, by different locations, the subjects described the color of the light source differently. From inside the lighted environment, the subjects described the warm color of the light source as yellowish, while they described the warm color of the light source as reddish and orangish from outside the lighted environment. For the cool color of the light source, the subjects described it as bluish from inside the cubicle and they described it as whitish from outside the cubicle. These results indicate that the subjects recognized the light color more clearly from outside the lighted environment as an observer's view than from in the lighted environment.

Culture groups played a role in the impression of the color of the light. For the cool color of the light source, the American subjects described it as greenish and bluish, while the Koreans described it as whitish. For the warm color of the light source, by describing it as reddish, orangish, and yellowish, the Koreans gave higher scores than the American subjects.

The findings of this impression of the light color are confirmed with the visually warm/visually cool scale by showing the two-way interactions of culture by CT and location by CT, and a main effect of CRI. The interaction of culture by CT shows that the American subjects described the 3000 K as warmer than the Korean subjects. All subjects described the 95 CRI as warmer than the 75 CRI. The preferences of the light color show that the American subjects liked the 930 lighting as best among the four lighting conditions, whereas the Korean subjects liked the color of the light under the lower color temperature of 3000 K more than the lighter color temperature of 5000 K with the 75 CRI, and the Koreans also preferred all lighting conditions more from inside than from outside. These findings do not support the "Kruithof effect" that using cool light sources at low illuminances will result in a dim or cold appearance, while using warm light sources at high illuminances results in unnatural color appearances. However, these findings support two other studies (Boyce & Cuttle, 1990; Davis & Ginthner, 1990) that have failed to find a similar tradeoff of color temperature and illuminance.

For the comparison of 730 and 930 lighting conditions, most of the subjects described the higher color rendering index (95 CRI) of the light source as reddish and orangish whereas they described the lower color rendering index (75 CRI) of the light source as yellowish. The preference of the light color is affected by the color rendering index of the light. The subjects preferred the 75 CRI more than the 95 CRI. However this finding is not confirmed by comparison with the visually warm/visually cool scale. For the comparison of 750 and 950 lighting conditions, there was no difference regarding the impression and preference of the light color and the visually warm/visually cool dimension.

For the comparison of 730 and 750 lighting conditions, the subjects described the lower color temperature (3000 K) of the light source as being reddish, orangish, and yellowish whereas they described the higher color temperature (5000 K) of the light source as being bluish and whitish. The findings of this impression of the light color are confirmed by comparison with the visually warm/visually cool scale. The subjects clearly recognized the differences in the color temperature of the light source presented to them. All subjects responded to the variations in light color, and they tended to categorize the presented source colors in a manner that approximated the color temperature scale. All subjects preferred the 5000 K in the comparison of 930 and 950 lighting conditions.

The Effect of Study Variables on Appearance of Complexion and Skin Tone

The results of the study show that both the American and Korean subjects perceived their complexion color as healthier, more attractive, and acceptable under the lower color temperature. For the appearance of skin color under different lighting conditions, American subjects perceived their skin healthier, more attractive, and more acceptable under the lower color temperature of 3000 K, whereas Korean subjects perceived their skin healthier, more attractive, and more acceptable under the higher color temperature of 5000 K.

The results of this study indicate that color temperature is an important factor that influences the appearances of skin tone and complexion color for individuals based on culture. This finding supports Steffy's (1990) statement that skin tones look better under a lower color temperature of the same color rendering index for the American subjects only. Perhaps the difference between the Americans and Koreans can be explained by differences in skin tones. There is no evidence of empirical research being used to study the appearance of skin tones as a function of cultural (demographic) characteristics in Steffy's information.

Furthermore, this finding was consistent with the previous study of Park and Farr (2000) indicating that skin tones look better under the higher color temperature of 4100 K than the lower color temperature of 3000 K without controlling the cultural characteristics. When the choice was either the lower color temperature of 3000 K or the higher color temperature of 4100 K in the previous study (Park & Farr, 2000), the preference was 4100 K. However, when the higher color temperature of 5000 K was compared with the lower color temperature of 3000 K in this study, the preferred color temperature was 3000 K rather than 5000 K. Therefore, the preferred range of color temperature on perception of skin tone could be about 4000 K.

The finding of the appearance of the complexion color supports the Chao & Bennett study (1981) that all subjects of three racial groups scored their facial acceptability as higher under warm white fluorescent light than cool white fluorescent light. However, the researcher assumed that the Korean subjects might prefer to see themselves under cool light since they desire their skin to appear as white according to Koreans' belief and myth. Unfortunately, this study failed to support their belief and myth.

The Effect of Study Variables on Subjects' Perception of Room Attractiveness

Room attractiveness tested from outside the lighted environment is significantly affected by changing the color properties of the light source as reported by the two different culture groups. The American subjects rated the 930 lighting as most attractive among the four lighting conditions, while the Korean subjects estimated the 730 lighting as the most attractive among the four lighting conditions. This indicates that the overall lighting preference and room attractiveness seem to be correlated with each other.

For the simultaneous comparison of two lighting conditions from outside the cubicle, there were the differences for the color rendering index for the comparison of the 730 vs. 930 and for the culture for the comparison of 930 vs. 950. All subjects were attracted to the 75 CRI more than the 95 CRI and the American subjects estimated the lighting conditions as more attractive than the Korean subjects.

The Effect of Study Variables on Approach-avoidance Intentions

The approach-avoidance intention tested from outside the lighted environment is significantly affected by changing the color temperature of the light source between the two different culture groups. When observed outside the lighted environment, the Korean subjects estimated the 5000 K as more approachable than the American subjects. Also, the Korean subjects estimated the 5000 K as more approachable than the 3000 K. These findings do not prove to be consistent in evaluating lighting conditions for the related dependent variables. For example, looking at the two variables of room attractiveness and approach-avoidance intention, the Korean subjects estimated the lower color temperature of 3000 K as more attractive than the higher color temperature of 5000 K, whereas they estimated the 5000 K as more approachable than the 3000 K. However, for the simultaneous comparison of two lighting conditions from outside the cubicle, all subjects proved to be consistent regarding the variables of the color rendering index and culture groups between room attractiveness and approach-avoidance intention. In this study, only one question was asked to find out approach or avoidance intention. Approach-avoidance behavior can include all contexts of display, color, merchandise, and lighting, rather than only lighting. Therefore, future research can be studied by asking all questions more specifically.

The Effect of Study Variables on Color Perception of the Store Products

The color perception of the store products in a store lighting environment was investigated as one of the study objectives by testing all four sections of the hypotheses. The perception of the color of fruit in a store lighting environment is significantly affected by changing the color rendering index of its illumination when observed outside the lighted environment. The respondents estimated the fruit color as more natural under the higher color rendering index of 95 CRI. By comparing the responses made inside and outside the lighted environment, the American subjects estimated the fruit color as more natural than did the Korean subjects. By the simultaneous comparison of the 730 and 930 lighting conditions, the American subjects also estimated the fruit color as more natural than the Korean subjects.

For identification of the subjects' color perception of natural objects under the four different lighting conditions as being distorted or not distorted, the colors of five different kinds of fruit including apple, orange, banana, lemon, and grape were tested. For the investigation of color perception of the apple throughout all four sections, the subjects consistently estimated no color distortion. For the orange color perception, there was a difference between the Korean and American subjects. The American subjects proved to be consistent in evaluating orange color as distorted from its natural color. For the banana color perception, the Korean subjects perceived it as distorted from its natural color when observed in the lighted environment. However, the American subjects perceived the banana color as distorted under conditions of the simultaneous comparison of two color temperatures with both 75 and 95 CRI. For the lemon color perception, all subjects proved to be consistent in evaluating under the 75 CRI and the 3000 K as distorted from its natural color. For the color perception of the grape, all subjects estimated it as more distorted by observing from inside the lighted environment rather than by observing from outside the lighted environment. Although the difference in the findings may be affected by using artificial fruit, the results proved to be consistent in evaluating product color perception.

The Effect of Study Variables on Color Designation of the Merchandise

The results indicate certain trends concerning the impact of light sources on the color matching and designation of the merchandise within particular hues consistent with the hypotheses. The color designation of a red T-shirt in a lighting environment is significantly affected by changing the color rendering index and color temperature of its light source. As indicated by previous research, the lower color temperature of 3000 K enhances the appearance of the red color T-shirts. Conversely, the higher color temperature of 5000 K makes the red color appear to be less vivid. In general, the higher color rendering index of 95 CRI enhances the appearance of the red color T-shirts, while the lower color rendering index of 75 CRI made the appearance of the red color T-shirts look less saturated.

The results show that there was a difference between the American and Korean subjects for the perception of blue and purple blue as cool colors on the Munsell color wheel, while there was no difference between the American and Korean subjects for the perception of red and yellow as warm colors on the Munsell color wheel. Regarding the color perception of blue and purple blue, the Korean subjects designated both colors as their original colors or closer to their original colors regardless of the different lighting conditions. However, the American subjects perceived the blue and purple blue as having lighter value and weaker chroma.

Regarding the study variable of color rendering index, there was no relationship between color rendering index and red color perception when observed from outside the lighted environment. However, there was a significant difference between 75 CRI and 95 CRI for the color perception of yellow, blue, and purple blue shirts. The subjects in both groups designated the blue and yellow shirts as their original colors under the higher color rendering index (95 CRI) whereas they designated the purple blue shirt as its original color under 75 CRI. Two different color rendering indices introduced some distortion of yellow, blue, and purple blue colors. Under 75 CRI, the pure hue of yellow (5Y) appeared as 7.5 yellow, the color on a clockwise direction of the color wheel, while under 95 CRI, it appeared as 2.5 yellow, the color on a counterclockwise direction of the color wheel. Also, under 75 CRI, the chroma of yellow changed from strong intensity (14) to weak intensity (12). For the blue color of the shirt, under 75 CRI, the blue color of 5B 5/10 appeared as 7.5B, the color on a counterclockwise direction of the color wheel or as the same hue of blue with a lighter value (6 or 7) and weaker intensity (6 or 8). However, under 95 CRI, the blue color of 5B 5/10 appeared as 2.5B, the color on a clockwise direction of the color wheel or as same hue and chroma of blue with lighter value. For purple blue color of the shirt, under 75 CRI, the purple blue color of 5PB 5/10 appeared as the same hue with a lighter value or with weaker chroma. However, under 95 CRI, the purple blue appeared as 10 B or 2.5 PB, the colors on a counterclockwise direction of the color wheel.

Regarding the study variable of color temperature, there was a significant difference between 3000 K and 5000 K for the color perception of all four color T-shirts of red, yellow, blue, and purple blue. Under 3000 K, the red shirt appeared as the hue of 7.5R, the color on a clockwise direction of the color wheel with a lighter value and a stronger chroma, while it appeared as the same hue with a lighter value under 5000 K. Under 3000 K, the yellow shirt appeared as its original color or the hue of 2.5Y, the color on a counterclockwise direction of the color wheel, while, under 5000 K, it appeared as the hue of 7.5Y, the color on a clockwise direction of the color wheel. Under 3000 K, the blue shirt appeared as the hues of 10BG and

2.5B, the colors on a counterclockwise direction of the color wheel or the same hue with a lighter value and a weaker chroma, while, under 5000 K, it appeared as its original color or as the hue of 7.5B, the color on a clockwise direction of the color wheel. Under 3000 K, the purple blue shirt appeared as the same hue with a lighter value and a weaker chroma, while, under 5000 K, it appeared to have the hues of 10B and 2.5 PB, the colors on a counterclockwise direction of the color wheel. In other words, the warm color qualities of red and yellow were enhanced under 3000 K, while their color qualities were reduced under 5000 K. The cool color qualities of blue and purple blue were enhanced their color qualities under 5000 K, while their color qualities were reduced under 3000 K.

In summary, the following conclusions were made.

- American subjects estimated all lighting conditions as more arousing than Koreans. The higher color temperature of 5000K is more arousing than 3000K.
- American subjects estimated 95 CRI with 3000 K lighting as giving the most pleasure, while 75 CRI with 3000K lighting is the most pleasant for Koreans.
- Color temperature significantly impacts visual clarity, while CRI was no different for all subjects.
- All subjects clearly recognized the color temperature differences in appearance of the light color.
- Americans perceived their skin tone as healthier and more attractive under 3000K, while Koreans perceived their skin tone better under 5000K.
- All subjects perceived their complexion color as healthier and more attractive under 3000K than 5000K.
- American subjects estimated lighting as more positive than Koreans in perception of arousal, room attractiveness, visual clarity, fruit color perception and intention to approach the simulated store environment.
- In simultaneous comparison, all subjects estimated 95 CRI with 3000K lighting as negative for visual clarity, lighting preference, and preference of the light color.

- American subjects had more positive attitudes to 95 CRI with 3000K lighting than Koreans for visual clarity, room attractiveness, and preference of the light color when observed outside the lighted environment.
- For color perception of store product, all subjects consistently estimated no color distortion for apple color perception, however, Americans consistently perceived the color of orange as distorted from its natural color. The color of grape was perceived as distorted when viewed from inside the cubicle rather than outside. Under 75 CRI, both lemon and banana colors were perceived as distorted from their natural colors.
- For color designation of merchandise, the qualities of the red and yellow colors were enhanced under 3000K, while reduced under 5000K. For the designation of the blue and purple blue shirts, the qualities of color were enhanced under 5000K, while reduced under 3000K. The Korean subjects designated both colors as their original hue or closer to their original hue, while the American subjects perceived them as having lighter value & weaker chroma.

Discussion of the Study Model

The research model in figure 28 shows the relationships of the theoretical frameworks and the associated variables of this study that were examined. This research model summarizes the literature reviews of theoretical perspectives related to lighting quality as store environment stimuli. Based on modified Mehrabian-Russell (M-R) environmental psychology model by Donovan, Rossiter, Marcoolyn, and Nesdale (1994), this study applied the quality of lighting including color temperature and color rendering index as a retail atmospheric factor. Person's cultural background and observer's location were used as filtering variables between environmental stimuli and person's affective and/or cognitive states. The possible responses to the environmental stimuli included arousal, pleasure, perception of glare, appearance of skin tone and complexion, visual clarity, lighting preference, impression and preferences of the color of the light, product color perception, room attractiveness, and color designations of merchandise a in store lighting environments. This model was used to examine the influence of lighting on intended shopping behaviors of consumers from different cultural background, but this study was limited only approach-avoidance intentions.

Location of the person, inside and outside, was included in this study as an additional filtering variable between environmental factor and internal states. The variable of observer's location was added to the study model. Through data analysis and findings, location of the observer is clearly important because people perceived lighting differently depending upon whether they are in the lighted environment or outside the lighted environment. Before a person enters a store, lighting inside the store provides visual stimuli to the person outside the store. Lighting serves as an environmental stimulus influence on a person inside the store and outside the store if the person has a "clear" (unobstructed) view into the store. For example, in a mall, many stores have large openings with nearly unobstructed view of the interior of store. Therefore, lighting inside the store serves as a stimuli to the person outside of the store. And also, after dark or at night, a person coming to the store can clearly see and be affected by lighting inside the store. The findings of this study indicate that the observer's location in relation to lighting has a significant impact on the person's lighting perception and preference.

The model suggested that the lighting conditions of a store environment (stimuli) has a positive influence on affective and/or cognitive variables including pleasure, arousal, visual clarity, room attractiveness, appearance of skin tone and complexion, lighting preference, impression and preference of the light color, color perception and designation of store products.

Implications

The assumption that there are differences by culture in how individuals perceive and feel about four different lighting conditions in store environments is supported by this study. Results provide insight about the specific variables of lighting settings and how those variables are perceived, embraced, and enjoyed by different cultural groups.

Professional designers involved in store display and interior lighting can benefit from the insights this study provides. For example, the results of the study indicate that the 3000K lamps in a fitting room enhances the appearance of complexion regardless of culture differences. Design

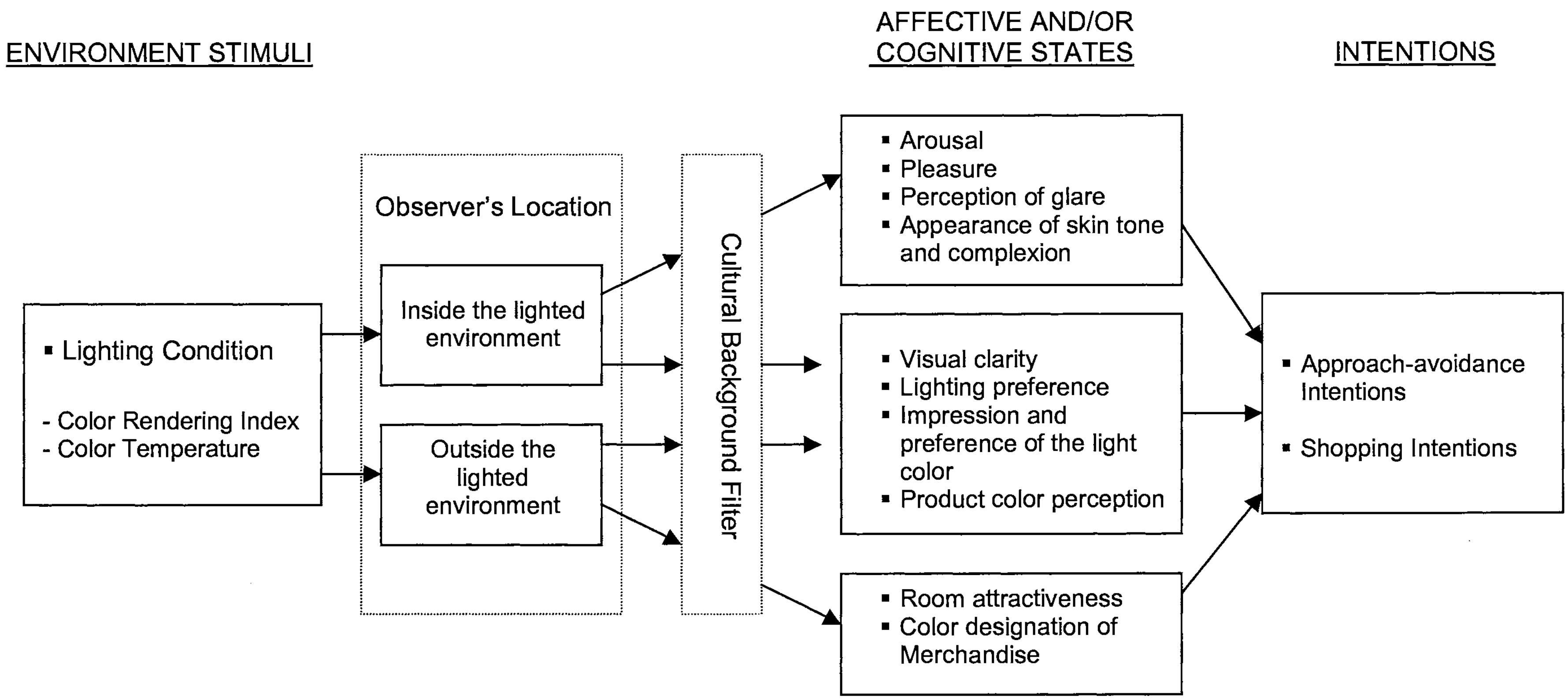


Figure 28. Study Model of Environmental Stimuli and Human Response

practitioners and design educators can constructively utilize the various lighting techniques regarding color temperature, color rendering index and culture information used as independent variables in this study. They are excellent parameters for successfully executing the use of many variations based on the color designations of merchandise, lighting perception and preference, and visual clarity in store environments. Implications from this study can be applied to store lighting techniques to attract consumers from different cultures.

The preference of American subjects for the light color was significant, the findings of the study therefore suggest that the retail store would please American customers by using this preferred lighting with 95 CRI and 3000 K. Findings related to pleasure and overall lighting preference were significant. The 930 lamps were the most pleasure and preference for American subjects. This finding suggests that using lighting with the low color temperature and the higher color rendering index could lead American customers stay longer in a store and by more.

This study can serve as a foundation for the further examination of the effect of lighting on the perception, preference, and shopping intention of consumers from different cultural background in store environment. Based on modified Mehrabian-Russell (M-R) environmental psychology model by Donovan, Rossiter, Marcoolyn, and Nesdale (1994), this study applied the quality of lighting including color temperature and color rendering index as a retail atmospheric factor. In addition, this study examined various responses to the environmental stimuli including arousal, pleasure, perception of glare, appearance of skin tone and complexion, visual clarity, lighting preference, impression and preferences of the color of the light, product color perception, room attractiveness, and color designations of merchandise a in store lighting environments.

This topic of study is worthy of further research since visual stimuli by the lighting environment surrounds humans daily and almost constantly. Areas that could be explored further by a replication of the study include comparison of lighting perceptions and preferences of 1) males to females, 2) culture groups with specified age ranges, 3) a random sampling of subjects in several geographical areas of the country, and 4) a random sampling of subjects in domestic versus international areas.

Another study on this topic could be devised by comparing different sets of lamps related to color rendering index and color temperature, as well as different sets of color samples. It is also suggested that future studies provide for a longer time span between viewing each lighting technique for more accurate comparisons. A master control panel for all the lighting applications would help achieve this. It is recommended that comparisons might be more appropriate if respondents were to evaluate real settings within store environments.

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APPENDIXES

APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVAL

Oklahoma State University
Institutional Review Board

Protocol Expires: 4/16/02

Date: Tuesday, April 17, 2001

IRB Application No HE0155

Proposal Title: INDOOR LIGHTING PERCEPTIONS AND PREFERENCES: A CROSS-CULTURAL COMPARISON

Principal Investigator(s) :

Nam-Kyu Park	Cheryl A. Farr
431 HES	431 HES
Stillwater, OK 74078	Stillwater, OK 74078

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s) : Approved

Signature : [signature]

Carol Olson, Director of University Research Compliance

Tuesday, April 17, 2001

Date

Approvals are valid for one calendar year, after which time a request for continuation must be submitted. Any modifications to the research project approved by the IRB must be submitted for approval with the advisor's signature. The IRB office MUST be notified in writing when a project is complete. Approved projects are subject to monitoring by the IRB. Expedited and exempt projects may be reviewed by the full Institutional Review Board.

APPENDIX B

INFORMED CONSENT FORM

INFORMED CONSENT

I, ______________________________________, hereby agree to participate in the study entitled "Indoor Lighting Perceptions and Preferences" to perform the following procedure.

The purpose of this study is to identify the similarities or differences in lighting perception and preference. The experiment will be conducted within the Lighting and Technology Laboratory (HES 433) in the College of Human Environmental Sciences at Oklahoma State University. The experiment is designed to have all three parts administered in one session. The first part of the experiment will be administered inside one of two lighted spaces called cubicles. Each cubicle is a 5' 9" by 6' 6" space at the east end of the Lighting Laboratory. The space is enclosed three sides and is open to the Lighting Laboratory on one side. The second and third parts will be administered outside the cubicles.

For the first part of the experiment, you will be asked to enter the cubicle; lights will be turned on after you are in the cubicle. After a 60-second lighting adaptation period, you will be instructed to complete the questionnaire for the first lighting condition. As you complete the questionnaire for the first condition, you will be asked to come out and the experimenter will turn off the first lighting condition. You will be seated in a waiting area in the Lighting Laboratory for at least two minutes to rest your eyes before viewing the next lighting condition. You will repeat this procedure between each treatment for the first part of the experiment including entering cubicle, turning on cubicle light, allowing a 60-second adaptation period, completing questionnaire, coming out the cubicle, turning off the cubicle light, and resting the eyes for two minutes.

For the second part, you will be seated at a table thirteen feet from the front edge of the cubicle in order to evaluate each lighting condition. You will view each condition for a one-minute adjustment period plus the time needed to complete the portion of the questionnaire for that treatment, approximately three minutes. All procedures for the rest of three lighting conditions will be repeated in same manner for the second part of the experiment.

For part three, you will assess each lighting condition when evaluated in the presence of another lighting condition in the adjacent cubicle. You will be exposed to both conditions and will assess both lighting conditions separately using the side by side comparison pages of the questionnaire. After you finish your first comparative condition, the experimenter will turn off the light and you will be given at least two minutes to rest your eyes before viewing the next comparative lighting condition. The same procedure will be conducted for the remaining comparative combinations. Following the completion of the last experimental condition, you will be asked not to discuss the experiment. This is to avoid any preconceptions by other potential subjects.

Your opinion of each lighting condition for all three parts of the experiment is important in understanding differences in perception, preference, visual comfort, and color perception. Your honesty in reacting to each lighting condition will help interior designers and store managers make store lighting selections that will provide optimum lighting conditions for consumers.

I understand that, before I participate in the lighting study, I need to take the standard Ishihara Color Vision test, and to put on a white drape in order to avoid the influence of my clothing color on my color perception under the different lighting conditions. In addition, I understand that I need to be available for about 60 minutes to complete all of the lighting evaluations.

I understand that participation is voluntary that there is no penalty for refusal to participate, and that I am free to withdraw from participation in this project at any time without penalty after notifying the project director. I understand that my name will not be associated with the questionnaire after all parts are completed. A subject code number will be used on the questionnaire rather than my name. I will not be identified by name as a subject in this research. I may contact Dr. Cheryl A. Farr at telephone number (405) 744-9526. I may also contact Sharon Bacher, IRB Executive Secretary, Oklahoma State University, 203 Whitehurst, Stillwater, OK 74078. Phone: 405-744-5700.

I have read and fully understand the consent form. I sign it freely and voluntarily. A copy has been given to me.

Date: ______________________ Time: ______________________ (a.m./p.m.)

Signed: ____
Signature of Subject

I certify that I have personally explained all elements of this form to the subject or his/her representative before requesting the subject or his/her representative to sign it.

Signed: ____
Project Director or his/her authorized representative

APPENDIX C

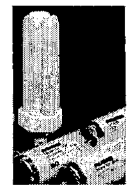
DEMOGRAPHIC AND GENERAL QUESTIONAIRE IN ENGLISH

Subject code #:

INSTRUCTIONS: The following questions are your opinions about the lighting in general. Please answer the questions by circling the number or filling in the blank. Remember, there are no right or wrong answers. We just want your honest opinion.

(Reference)

Incandescent light



Fluorescent light

1. For my house, in general I prefer to have (except natural light):
   1. Incandescent light
   2. Fluorescent light
   3. Other (please specify): ____________________

2. For studying in my office, in general I prefer to have (except natural light)
   1. Incandescent light
   2. Fluorescent light
   3. Other (please specify): ____________________

3. For shopping in a retail store, in general I prefer to have (except natural light):
   1. Incandescent light
   2. Fluorescent light
   3. Other (please specify): ____________________

4. I avoid shopping in some store because of the light: (Circle a number on the scale below)

	always						never
Avoid	1	2	3	4	5	6	7

5. What are your 3 favorite colors? (Please list in order of preference).

1st ________________ 2nd ________________ 3rd ________________

6. Is there any information that you would like to share about LIGHTING that you have not had a chance to share in this questionnaire? Please make your comments here.

Thank you

INSTRUCTIONS: Please answer the following questions about yourself by filling in the blank or circling the number.

A. Are you wearing tinted or colored contacts now?
1. Yes → (If **Yes**) Thank you for your time; however, can we reschedule?
2. No

B. Do you have any visual impairments (such as color blindness) that can not be corrected by your glasses or contact lenses?
1. Yes → (If **Yes**) Thank you for your time; however, your assistance will not be required. You do not need to proceed.
2. No

1. Your gender:
   1. Male
   2. Female

2. Your **year** of birth: 19______

3. Your racial heritage:
   1. Caucasian American
   2. Other (please specify): ___________

4. Are you U.S. citizen?
   1. Yes
   2. No

5. Are you born and raised in the U.S?
   1. Yes
   2. No

6. If yes, have you lived outside the U.S. for an extended period of time?
   1. Yes
   2. No

7. What is the highest degree you have completed?
   1. High school degree
   2. Bachelor's degree
   3. Master's degree
   4. Doctoral degree
   5. Other (please specify): ___________

8. Which term best describes your current status?
   1. Undergraduate student
   2. Graduate student
   3. Other (please specify): ___________

9. Have you taken any lighting courses or worked as a professional to gain knowledge of lighting?
   1. Yes
   2. No

10. Do you usually wear glasses or contacts to correct your vision?
    1. Yes
    2. No

11. If yes, are you wearing them now?
    1. Yes
    2. No

12. Your eye color:
    1. Blue
    2. Brown
    3. Green
    4. Hazel
    5. Other (please specify):___________

13. Your current hair color:
    1. Blonde
    2. Brown
    3. Black
    4. Red
    5. Other (please specify): ___________

14. Are you wearing make up now?
    1. Yes
    2. No

For Researcher Use Only

The Color Vision Test: ____________________ Subject code #: A______________

APPENDIX D

STUDY QUESTIONAIRES FOR PART I, PART II, AND PART III IN ENGLISH

Subject code #:

PART I : INSIDE CUBICLE

INSTRUCTIONS: **Pretend that you have just entered a retail shopping environment.** The following questions are used to identify your opinion about the lighting condition. Please circle the number on the following scales that best describe your feelings about the light setting. Remember, there are no right or wrong answers. We just want your honest opinion.

EXAMPLE: Beautiful 1 (2) 3 4 5 6 7 Ugly

****

1. Please evaluate your perception of the lighting condition on the following scales.

Visually warm	1	2	3	4	5	6	7	Visually cool
Bright	1	2	3	4	5	6	7	Dim
Glare	1	2	3	4	5	6	7	No glare
Visually comfortable	1	2	3	4	5	6	7	Visually uncomfortable
Stimulating	1	2	3	4	5	6	7	Boring
Wide awake	1	2	3	4	5	6	7	Sleepy
Distinct	1	2	3	4	5	6	7	Vague
Clear	1	2	3	4	5	6	7	Unclear
Relaxing	1	2	3	4	5	6	7	Tense
Pleasant	1	2	3	4	5	6	7	Unpleasant

2. In general, how would you describe the color impression of this lighting?

1	2	3	4	5	6
Reddish	Orangish	Yellowish	Greenish	Bluish	Whitish

3. How do you like the ***color*** of the light?

Like 1 2 3 4 5 6 7 Dislike

4. Look at your arms and hands, how does your skin color look under the lighting?

Attractive	1	2	3	4	5	6	7	Not attractive
Healthy	1	2	3	4	5	6	7	Unhealthy
Acceptable	1	2	3	4	5	6	7	Unacceptable

5. Look in mirror, how does your complexion look in this lighting condition?

Attractive	1	2	3	4	5	6	7	Not attractive
Healthy	1	2	3	4	5	6	7	Unhealthy
Acceptable	1	2	3	4	5	6	7	Unacceptable

6. Look at the fruit basket, how does the color of the fruit appear under the lighting condition?

Colors appear *very* natural 1 2 3 4 5 6 7 Colors appear not natural at all

7. From the list below, circle all items with colors that appear to be distorted or not natural under the lighting.

1. Apple 2. Orange 3. Banana 4. Lemon 5. Grape

8. Overall, in this pretend shopping environment, how would you evaluate the lighting?

Like 1 2 3 4 5 6 7 Dislike

Thank you !

Subject code #:

PART II: OUTSIDE CUBICLE

INSTRUCTIONS: **Pretend that you are looking at a retail shopping environment.** The following questions are used to identify your opinion about the lighting condition. Please circle the number on the following scales that best describe your feelings about the light setting. Remember, there are no right or wrong answers. We just want your honest opinion.

****

1. Please circle your impression of the lighting condition on the following scales.

Visually warm	1	2	3	4	5	6	7	Visually cool
Bright	1	2	3	4	5	6	7	Dim
Clear	1	2	3	4	5	6	7	Unclear
Attractive	1	2	3	4	5	6	7	Not attractive
Inviting	1	2	3	4	5	6	7	Not inviting

2. Based on the lighting in this space, would you be likely to;

Approach	1	2	3	4	5	6	7	Avoid

3. In general, how would you describe the color impression of this lighting?

1	2	3	4	5	6
Reddish	Orangish	Yellowish	Greenish	Bluish	Whitish

4. How do you like the ***color*** of the light?

Like	1	2	3	4	5	6	7	Dislike

5. Look at the fruit basket, how does the color of the fruit appear under the lighting condition?

Colors appear *very* natural	1	2	3	4	5	6	7	Colors appear not natural at all

6. From the list below, circle all items with colors that appear to be distorted or not natural.

1. Apple 2. Orange 3. Banana 4. Lemon 5. Grape

7. Please look at the color of shirt **#1**. Using color card **A**, point to the "color chip" that best matches the color of the shirt.

____

8. Please look at the color of shirt **#2**. Using color card **B**, point to the "color chip" that best matches the color of the shirt.

____

9. Please look at the color of shirt **#3**. Using color card **C**, point to the "color chip" that best matches the color of the shirt.

____

10. Please look at the color of shirt **#4**. Using color card **D**, point to the "color chip" that best matches the color of the shirt.

____

11. Overall, in this pretend shopping environment, how would you evaluate the lighting?

Like	1	2	3	4	5	6	7	Dislike

Thank you !

PART III : SIDE BY SIDE COMPARISONS

Subject code #:

INSTRUCTIONS: Pretend that you are looking at a retail shopping environment. By comparing two lighting conditions in the cubicles, please circle the number that best describe your feelings for the light setting. Remember, there are no right or wrong answers. We just want your honest opinion.

****

Left side - Cubicle # 1	**Right side – Cubicle #2**

1. By comparing lighting conditions side by side, please mark your impression of the lighting on the following scales.

Visually warm	1	2	3	4	5	6	7	Visually cool	Visually warm	1	2	3	4	5	6	7	Visually cool
Bright	1	2	3	4	5	6	7	Dim	Bright	1	2	3	4	5	6	7	Dim
Clear	1	2	3	4	5	6	7	Unclear	Clear	1	2	3	4	5	6	7	Unclear
Attractive	1	2	3	4	5	6	7	Not attractive	Attractive	1	2	3	4	5	6	7	Not attractive
Inviting	1	2	3	4	5	6	7	Not inviting	Inviting	1	2	3	4	5	6	7	Not inviting

2. Based on the lighting in this space, would you be likely to;

Approach	1	2	3	4	5	6	7	Avoid	Approach	1	2	3	4	5	6	7	Avoid

3. In general, how would you describe the color impression of this lighting?

1	2	3	4	5	6	1	2	3	4	5	6
Reddish	Orangish	Yellowish	Greenish	Bluish	Whitish	Reddish	Orangish	Yellowish	Greenish	Bluish	Whitish

4. How do you like the ***color*** of the light?

Like	1	2	3	4	5	6	7	Dislike	Like	1	2	3	4	5	6	7	Dislike

Go to next page ⏩⏩

Left side - Cubicle # 1	Right side – Cubicle #2

5. Look at the fruit basket, how does the color of the fruit appear under the lighting condition?

Left side - Cubicle # 1	Right side – Cubicle #2
Colors appear very natural 1 2 3 4 5 6 7 Colors appear not natural at all	Colors appear very natural 1 2 3 4 5 6 7 Colors appear not natural at al

6. From the list below, circle all items with colors that appear to be distorted or not natural.

Left side - Cubicle # 1	Right side – Cubicle #2
1. Apple 2. Orange 3. Banana 4. Lemon 5. Grape	1. Apple 2. Orange 3. Banana 4. Lemon 5. Grape

7. Please look at the color of shirt **#1**. Using <u>color card **A**</u>, point to the "color chip" that best matches the color of the shirt.

(Left cubicle) ____________ (Right cubicle) ____________

8. Please look at the color of shirt **#2**. Using <u>color card **B**</u>, point to the "color chip" that best matches the color of the shirt.

(Left cubicle) ____________ (Right cubicle) ____________

9. Please look at the color of shirt **#3**. Using <u>color card **C**</u>, point to the "color chip" that best matches the color of the shirt.

(Left cubicle) ____________ (Right cubicle) ____________

10. Please look at the color of shirt **#4**. Using <u>color card **D**</u>, point to the "color chip" that best matches the color of the shirt.

(Left cubicle) ____________ (Right cubicle) ____________

11. Overall, in this pretend shopping environment, how would you evaluate the lighting?

Left side - Cubicle # 1	Right side – Cubicle #2
Like 1 2 3 4 5 6 7 Dislike	Like 1 2 3 4 5 6 7 Dislike

Thank you!

APPENDIX E

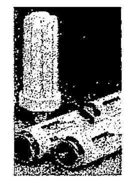
DEMOGRAPHIC AND GENERAL QUESTIONAIRE IN KOREAN

Subject code #:

INSTRUCTIONS: The following questions are your opinions about the lighting environment in general. Please answer the questions by circling the number or filling in the blank. Remember, there are no right or wrong answers. We just want your honest opinion. (다음의 질문들은 일반적인 조명 환경에 대한 귀하의 의견을 알고자 합니다. 아래의 질문들에 대해 알맞은 번호에 O 표를 하거나 빈 칸을 채우십시오. 질문에 옳고 그른 정답은 없으며, 단지 연구자는 귀하의 솔직한 의견을 알고자 합니다)

(참고)

백열등



형광등

1. For my house, in general I prefer to have (except natural light):
(보편적으로 나는 집안에 _____ 조명을 좋아한다. 자연광을 제외한)
    1. Incandescent light (백열등)
    2. Fluorescent light (형광등)
    3. Other (기타): ______________________

2. For studying in my office, in general I prefer to have (except natural light):
(보편적으로 나는 내 오피스에서 공부할때 _____ 조명을 좋아한다. 자연광을 제외한)
    1. Incandescent light (백열등)
    2. Fluorescent light (형광등)
    3. Other (기타): ______________________

3. For shopping in a retail store, in general I prefer to have (except natural light):
(보편적으로 나는 가게에서 쇼핑할때 _____ 조명을 좋아한다. 자연광을 제외한)
    1. Incandescent light (백열등)
    2. Fluorescent light (형광등)
    3. Other (기타): ______________________

4. I avoid shopping in some stores because of the light: (Circle a number on the scale below)
(나는 조명 때문에 어떤 가게에서는 쇼핑하는 것을 피한다. 알맞은 숫자에 O 표를 하십시오)

	Always (항상)					*never* (전혀 피하지 않는다)
Avoid (피한다)	1	2	3	4	5	6	7

5. In general, have you observed any differences in **retail store lighting** between your country and the U.S? (가게의 조명상태에 대해, 일반적으로 귀하께서는 귀하의 나라와 미국과의 차이점을 느낀적이 있습니까?)
    1. Yes (예) ⟶ If yes, explain ("예"라면, 차이점을 설명해 주십시오):
    2. No (아니오)

____

____

6. In general, have you observed any differences in **residential lighting** between your country and the U.S? (집안의 조명상태에 대해, 일반적으로 귀하께서는 귀하의 나라와 미국과의 차이점을 느낀적이 있습니까?)
    1. Yes (예) ⟶ If yes, explain ("예"라면, 차이점을 설명해 주십시오):
    2. No (아니오)

____

____

7. What are your 3 favorite colors? Please list in order of preference. (귀하가 가장 좋아 하는 색깔 3가지를 순서대로 나열해 주십시오):

1st ____________ 2nd ____________ 3rd ____________

8. Is there any information that you would like to share about LIGHTING that you have not had a chance to share in this questionnaire? Please make your comments here. (지금까지의 설문 내용외에 조명에 관해 귀하의 개인적 소견이 있으면 서술해주십시오.)

Thank you

INSTRUCTIONS: **Please answer the following questions about yourself by filling in the blank or circling the number.** (귀하의 신상에 대한 다음 질문들에 대하여 응답하여 주십시오)

A. Are you wearing tinted or colored contacts now? (귀하는 현재 색깔있는 혹은 코팅된 렌즈를 끼고 계십니까?)

1. Yes (예) → (If **Yes**) Thank you for your time; however, can we reschedule? ("예" 라면, 죄송하지만 다시 시간 약속을 하시겠습니까?)
2. No (아니오)

B. Do you have any visual impairments (such as color blindness) that can not be corrected by your glasses or contact lenses? (귀하는 안경과 렌즈의 착용으로도 고쳐질 수 없는 시각 장애 (예를 들면 색맹) 를 가지고 있습니까?)

1. Yes (예) → (If **Yes**) Thank you for your time; however, can we reschedule? ("예" 라면, 죄송하지만 다시 시간 약속을 하시겠습니까?)
2. No (아니오)

1. Your gender (귀하의 성별은?):
   1. Male (남자)
   2. Female (여자)

2. Your **year** of birth (귀하의 태어난 년도):_____년

3. Are you a Korean? (귀하는 한국인입니까?)
   1. Yes (예)
   2. No (아니오)

4. Are you born and raised in Korea? (귀하는 한국에서 태어나고 자랐습니까?)
   1. Yes (예)
   2. No (아니오)

5. If yes, have you lived outside Korea for an extended period of time before coming to the U.S.? ("예"라면, 귀하는 미국에 오기전 다른 나라에서 사신적이 있습니까?)
   1. Yes (예)
   2. No (아니오)

6. How long have you lived in U.S.A? (귀하는 미국에 살고 계신 기간이 얼마나 되십니까?)

   Months or Years:
   (개월수 또는 년수): ______________

7. How long have you lived in Stillwater, Oklahoma? (귀하는 오클라호마 스틸워터에 살고 계신 기간이 얼마나 되십니까?)

   Months or Years:
   (개월수 또는 년수): ______________

8. What is the highest degree you have completed? (귀하의 최종 학력은 무엇입니까?)
   1. High school degree (고졸)
   2. Bachelor's degree (대졸)
   3. Master's degree (석사학위)
   4. Doctoral degree (박사학위)
   5. Other (기타): ______________

9. Which term best describes your current status? (귀하의 현재 신분을 나타낸 알맞은 번호에 O표 하십시오)
   1. Undergraduate student (학부학생)
   2. Graduate student (대학원생)
   3. ELI student (어학연수 학생)
   4. Other (기타): ______________

10. Have you taken any lighting courses or worked as a professional to gain knowledge of lighting? (귀하는 조명 수업을 들었거나 조명지식을 쌓기위해 전문가로서 일한적이 있습니까?)
    1. Yes (예)
    2. No (아니오)

11. Do you usually wear glasses or contacts to correct your vision? (귀하는 평상시 안경이나 렌즈를 쓰십니까?)
    1. Yes (예)
    2. No (아니오)

12. If yes, are you wearing them now? ("예" 라면, 지금 현재 쓰고 계십니까?)
    1. Yes (예)
    2. No (아니오)

13. Your eye color (귀하의 눈동자 색은?):
    1. Black (검은색)
    2. Dark Brown (어두운 갈색)
    3. Light Brown (밝은 갈색)
    4. Other (기타) : ______________

14. Are you wearing make up now? (귀하는 현재 화장을 하셨습니까?)
    1. Yes (예)
    2. No (아니오)

15. Your current hair color (귀하의 현재 머리 색은?):
    1. Black (검은색)
    2. Dark Brown (어두운 갈색)
    3. Light Brown (밝은 갈색)
    4. Other (기타):______________

For Researcher Use Only (연구자 사용란)

The Color Vision Test: ______________ Subject code #: K__________

APPENDIX F

STUDY QUESTIONAIRES FOR PART I, PART II, AND PART III IN KOREAN

Subject code #:

PART I: INSIDE CUBICLE

INSTRUCTIONS: **Pretend that you have just entered a retail shopping environment.** The following questions are used to identify your opinion about the lighting condition. Please circle the number on the following scales that best describe your feelings about the light setting. Remember, there are no right or wrong answers. We just want your honest opinion.
(지시: 귀하는 지금 쇼핑 센터 안에 들어왔다고 가정 하십시오. 다음의 질문들은 조명 상태에 대한 귀하의 의견을 알고자 합니다. 조명 상태에 대한 귀하의 느낌을 가장 잘 나타낸 숫자에 O 표를 하십시오. 질문에 옳고 그른 정답은 없으며, 단지 연구자는 귀하의 솔직한 의견을 알고자 합니다)

EXAMPLE: (보기)	Beautiful (아름답다)	1	(2)	3	4	5	6	7	Ugly (추하다)

****

1. Please evaluate your perception of the lighting condition on the following scales.
(현 조명 상태를 나타내는 다음의 질문들에 대하여 귀하의 느낌을 가장 잘 나타낸 숫자에 O 표를 하십시오)

Visually warm (시각적으로 따뜻하다)	1	2	3	4	5	6	7	Visually cool (시각적으로 차다)
Bright (밝다)	1	2	3	4	5	6	7	Dim (어둡다)
Glare (눈부시다)	1	2	3	4	5	6	7	No glare (눈부시지 않다)
Visually comfortable (시각적으로 편안하다)	1	2	3	4	5	6	7	Visually uncomfortable (시각적으로 불편하다)
Stimulating (흥미를 돋구다)	1	2	3	4	5	6	7	Boring (지루하다)
Wide awake (활기있다)	1	2	3	4	5	6	7	Sleepy (졸립게 하다)
Distinct (선명하다)	1	2	3	4	5	6	7	Vague (희미하다)
Clear (깨끗하다)	1	2	3	4	5	6	7	Unclear (흐릿하다)
Relaxing (휴식적 이다)	1	2	3	4	5	6	7	Tense (긴장되 보인다)
Pleasant (유쾌하다)	1	2	3	4	5	6	7	Unpleasant (불쾌하다)

2. In general, how would you describe the color impression of this lighting?
(현 조명의 색상을 가장 잘 묘사한 숫자에 O 표를 하십시오.)

1	2	3	4	5	6
Reddish (붉은)	Orangish (오렌지)	Yellowish (노란)	Greenish (초록)	Bluish (푸른)	Whitish (흰)

3. How do you like the *color* of the light? (현 조명의 색에 대한 귀하의 선호도를 가장 잘 나타낸 숫자에 O 표를 하십시오)

Like (좋다)	1	2	3	4	5	6	7	Dislike (싫다)

4. Look at your arms and hands, how does your skin color look under the lighting?
(귀하의 손과 팔을 보시고. 현 조명 아래에서 귀하의 피부색에 대해 가장 잘 나타낸 숫자에 O 표를 하십시오.)

Attractive (호감이 간다)	1	2	3	4	5	6	7	Not attractive (호감이 가지않는다)
Healthy (건강해 보인다)	1	2	3	4	5	6	7	Unhealthy (건강해 보이지 않는다)
Acceptable (마음에 든다)	1	2	3	4	5	6	7	Unacceptable (마음에 들지 않는다)

5. Look in mirror, how does your complexion look in this lighting condition?
(거울을 보시고, 현 조명 아래에서 귀하의 얼굴색에 대해 가장 잘 나타낸 숫자에 O 표를 하십시오)

Attractive (호감이 간다)	1	2	3	4	5	6	7	Not attractive (호감이 가지않는다)
Healthy (건강해 보인다)	1	2	3	4	5	6	7	Unhealthy (건강해 보이지 않는다)
Acceptable (마음에 든다)	1	2	3	4	5	6	7	Unacceptable (마음에 들지 않는다)

6. Look at the fruit basket, how does the color of the fruit appear under the lighting condition?
(과일 접시를 보시고. 현 조명 아래에서 과일 색깔에 대해 가장 잘 나타낸 숫자에 O 표를 하십시오)

Colors appear very natural (색깔이 자연색에 가깝다)	1	2	3	4	5	6	7	colors appear not natural at all (색깔이 전혀 자연색에 가깝지 않다)

7. From the list below, circle all items with colors that appear to be distorted or not natural under the lighting.
(현 조명 아래에서 아래 목록의 과일 색깔이 변형되어 보이거나 자연색에 가깝지 않아 보이는 것들에 O 표를 하십시오)

1. Apple (사과) 2. Orange (오렌지) 3. Banana (바나나) 4. Lemon (레몬) 5. Grape (포도)

8. Overall in this pretend shopping environment, how would you evaluate the lighting?
(지금까지 살펴본 이 꾸며진 쇼핑 룸의 전반적인 조명상태에 대해 귀하의 선호도를 가장 잘 나타낸 숫자에 O 표를 하십시오)

Like (좋다)	1	2	3	4	5	6	7	Dislike (싫다)

Thank you!

PART II: OUTSIDE CUBICLE

Subject code #:

INSTRUCTIONS: **Pretend that you are looking at a retail shopping environment.** The following questions are used to identify your opinion about the lighting condition. Please circle the number on the following scales that best describe your feelings about the light setting. Remember, there are no right or wrong answers. We just want your honest opinion.
(지시: 귀하는 지금 쇼핑 룸을 바라보고 있다고 가정 하십시오. 다음의 질문들은 조명 상태에 대한 귀하의 의견을 알고자 합니다. 조명 상태에 대한 귀하의 느낌을 가장 잘 나타낸 숫자에 O 표를 하십시오. 질문에 옳고 그른 정답은 없으며, 단지 연구자는 귀하의 솔직한 의견을 알고자 합니다)

****

1. Please circle your impression of the lighting condition on the following scales.
(현 조명 상태에 대하여 귀하의 느낌을 가장 잘 나타낸 숫자에 O 표를 하십시오)

Visually warm (시각적으로 따뜻하다)	1	2	3	4	5	6	7	Visually cool (시각적으로 차다)
Bright (밝다)	1	2	3	4	5	6	7	Dim (어둡다)
Clear (깨끗하다)	1	2	3	4	5	6	7	Unclear (흐릿하다)
Attractive (마음을 끌다)	1	2	3	4	5	6	7	Not attractive (마음을 끌지않다)
Inviting (반기다)	1	2	3	4	5	6	7	Not inviting (반기지 않다)

2. Based on the lighting in this space, would you be likely to; (현 공간의 조명에 근거하여, 귀하는 ?)

Approach (다가가고 싶다)	1	2	3	4	5	6	7	Avoid (피하고 싶다)

3. In general, how would you describe the color impression of this lighting?
(현 조명의 색상을 가장 잘 묘사한 숫자에 O 표를 하십시오.)

1	2	3	4	5	6
Reddish (붉은)	Orangish (오렌지)	Yellowish (노란)	Greenish (초록)	Bluish (푸른)	Whitish (흰)

4. How do you like the ***color*** of the light? (현 조명의 색에 대한 귀하의 선호도를 가장 잘 나타낸 숫자에 O 표를 하십시오)

Like (좋다)	1	2	3	4	5	6	7	Dislike (싫다)

5. Look at the fruit basket, how does the color of the fruit appear under the lighting condition?
(과일 접시를 보시고. 현 조명 아래에서 과일 색깔에 대해 가장 잘 나타낸 숫자에 O 표를 하십시오)

Colors appear very natural (색깔이 매우 자연색에 가깝다)	1	2	3	4	5	6	7	Colors appear not natural at all (색깔이 전혀 자연색에 가깝지 않다)

6. From the list below, circle all items with colors that appear to be distorted or not natural under the lighting.
(현 조명 아래에서 아래 목록의 과일 색깔이 변형되어 보이거나 자연색에 가깝지 않아 보이는 것들에 O 표를 하십시오)

1. Apple (사과) 2. Orange (오렌지) 3. Banana (바나나) 4. Lemon (레몬) 5. Grape (포도)

7. Please look at the color of shirt **#1**. Using color card **A**, point to the "color chip" that best matches the color of the shirt. (1 번 셔츠의 색깔을 보시고, 색 카드 A 를 사용하여 현 조명 아래에서의 셔츠색과 가장 잘 맞는 "색표"를 지적하십요..)

____

8. Please look at the color of shirt **#2**. Using color card **B**, point to the "color chip" that best matches the color of the shirt. (2 번 셔츠의 색깔을 보시고, 색 카드 B 를 사용하여 현 조명 아래에서의 셔츠색과 가장 잘 맞는 "색표"를 지적하십요..)

____

9. Please look at the color of shirt **#3**. Using color card **C**, point to the "color chip" that best matches the color of the shirt. (3 번 셔츠의 색깔을 보시고, 색 카드 C 를 사용하여 현 조명 아래에서의 셔츠색과 가장 잘 맞는 "색표"를 지적하십요..)

____

10. Please look at the color of shirt **#4**. Using color card **D**, point to the "color chip" that best matches the color of the shirt. (4 번 셔츠의 색깔을 보시고, 색 카드 D 를 사용하여 현 조명 아래에서의 셔츠색과 가장 잘 맞는 "색표"를 지적하십요..)

____

11. Overall in this pretend shopping environment, how would you evaluate the lighting?
(지금까지 살펴본 이 꾸며진 쇼핑 룸의 전반적인 조명상태에 대해 귀하의 선호도를 가장 잘 나타낸 숫자에 O 표를 하십시오)

Like (좋다)	1	2	3	4	5	6	7	Dislike (싫다)

Thank you!

Subject code #:

PART III : SIDE BY SIDE COMPARISONS

INSTRUCTIONS: Pretend that you are looking at a retail shopping environment. By comparing two lighting conditions in the cubicles, please circle the number that best describe your feelings for the light setting. Remember, there are no right or wrong answers. We just want your honest opinion. (지시: 귀하는 지금 쇼핑 룸을 바라보고 있다고 가정 하십시오. 두 룸의 조명를 비교하면서, 조명 상태에 대한 귀하의 느낌을 가장 잘 나타낸 숫자에 O 표를 하십시오. 질문에 대해 옳고 그른 정답은 없으며, 단지 연구자는 귀하의 솔직한 의견을 알고자 합니다)

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Left side (왼쪽) - Cubicle # 1 | **Right side (오른쪽) – Cubicle #2**

1. By comparing lighting conditions side by side, please mark your impression of the lighting on the following scales.
(왼쪽과 오른쪽 룸의 조명 상태를 비교하면서 귀하의 느낌을 가장 잘 나타낸 숫자에 O 표를 하십시오)

Left side - Cubicle # 1

Visually warm (시각적으로 따뜻하다)	1	2	3	4	5	6	7	Visually cool (시각적으로 차다)
Bright (밝다)	1	2	3	4	5	6	7	Dim (어둡다)
Clear (깨끗하다)	1	2	3	4	5	6	7	Unclear (흐릿하다)
Attractive (마음을 끌다)	1	2	3	4	5	6	7	Not attractive (마음을 끌지 않다)
Inviting (반기다)	1	2	3	4	5	6	7	Not inviting (반기지 않다)

Right side - Cubicle #2

Visually warm (시각적으로 따뜻하다)	1	2	3	4	5	6	7	Visually cool (시각적으로 차다)
Bright (밝다)	1	2	3	4	5	6	7	Dim (어둡다)
Clear(깨끗하다)	1	2	3	4	5	6	7	Unclear (흐릿하다)
Attractive (마음을 끌다)	1	2	3	4	5	6	7	Not attractive (마음을 끌지 않다)
Inviting (반기다)	1	2	3	4	5	6	7	Not inviting (반기지 않다)

2. Based on the lighting in this space, would you be likely to (현 공간의 조명에 근거하여 귀하는 ?);

Left: Approach (다가가고 싶다)	1	2	3	4	5	6	7	Avoid (피하고 싶다)
Right: Approach (다가가고 싶다)	1	2	3	4	5	6	7	Avoid (피하고 싶다)

3. In general, how would you describe the color impression of this lighting? (현 조명의 색상을 가장 잘 묘사한 숫자에 O 표를 하십시오.)

	1	2	3	4	5	6
Left	Reddish (붉은)	Orangish (오렌지)	Yellowish (노란)	Greenish (초록)	Bluish (푸른)	Whitish (흰)
Right	Reddish (붉은)	Orangish (오렌지)	Yellowish (노란)	Greenish (초록)	Bluish (푸른)	Whitish (흰)

4. How do you like the *color* of the light? (현 조명의 색에 대한 귀하의 선호도를 가장 잘 나타낸 숫자에 O 표를 하십시오)

Left: Like (좋다)	1	2	3	4	5	6	7	Dislike (싫다)
Right: Like (좋다)	1	2	3	4	5	6	7	Dislike (싫다)

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Left side (왼쪽) - Cubicle # 1 | **Right side (오른쪽) - Cubicle #2**

5. Look at the fruit basket, how does the color of the fruit appear under the lighting condition?
(과일 접시를 보시고. 현 조명 아래에서 과일 색깔에 대해 가장 잘 나타낸 숫자에 O 표를 하십시오)

Cubicle		1	2	3	4	5	6	7	
Left side (Cubicle # 1)	Colors appear very natural (색깔이 자연색에 가깝다)	1	2	3	4	5	6	7	Colors appear not natural at all (색깔이 전혀 자연색에 가깝지 않다)
Right side (Cubicle #2)	Colors appear very natural (색깔이 자연색에 가깝다)	1	2	3	4	5	6	7	Colors appear not natural at all (색깔이 전혀 자연색에 가깝지 않다)

6. From the list below, circle all items with colors that appear to be distorted or not natural under the lighting.
(현 조명 아래에서 아래 목록의 과일 색깔이 변형되어 보이거나 자연색에 가깝지 않아 보이는 것들에 O 표를 하십시오)

Left side (Cubicle # 1)	1. Apple (사과)	2. Orange (오렌지)	3. Banana (바나나)	4. Lemon (레몬)	5. Grape (포도)
Right side (Cubicle #2)	1. Apple (사과)	2. Orange (오렌지)	3. Banana (바나나)	4. Lemon (레몬)	5. Grape (포도)

7. Please look at the color of shirt **#1**. Using color card **A**, point to the "color chip" that best matches the color of the shirt.
(1 번 셔츠의 색깔을 보시고, 색 카드 **A** 를 사용하여 현 조명 아래에서의 셔츠색과 가장 잘 맞는 "색표"를 지적하십시오.)

Left: ____________ | Right: ____________

8. Please look at the color of shirt **#2**. Using color card **B**, point to the "color chip" that best matches the color of the shirt.
(2 번 셔츠의 색깔을 보시고, 색 카드 **B** 를 사용하여 현 조명 아래에서의 셔츠색과 가장 잘 맞는 "색표"를 지적하십시오.)

Left: ____________ | Right: ____________

9. Please look at the color of shirt **#3**. Using color card **C**, point to the "color chip" that best matches the color of the shirt.
(3 번 셔츠의 색깔을 보시고, 색 카드 **C** 를 사용하여 현 조명 아래에서의 셔츠색과 가장 잘 맞는 "색표"를 지적하십시오.)

Left: ____________ | Right: ____________

10. Please look at the color of shirt **#4**. Using color card **D**, point to the "color chip" that best matches the color of the shirt.
(4 번 셔츠의 색깔을 보시고, 색 카드 **D** 를 사용하여 현 조명 아래에서의 셔츠색과 가장 잘 맞는 "색표"를 지적하십시오.)

Left: ____________ | Right: ____________

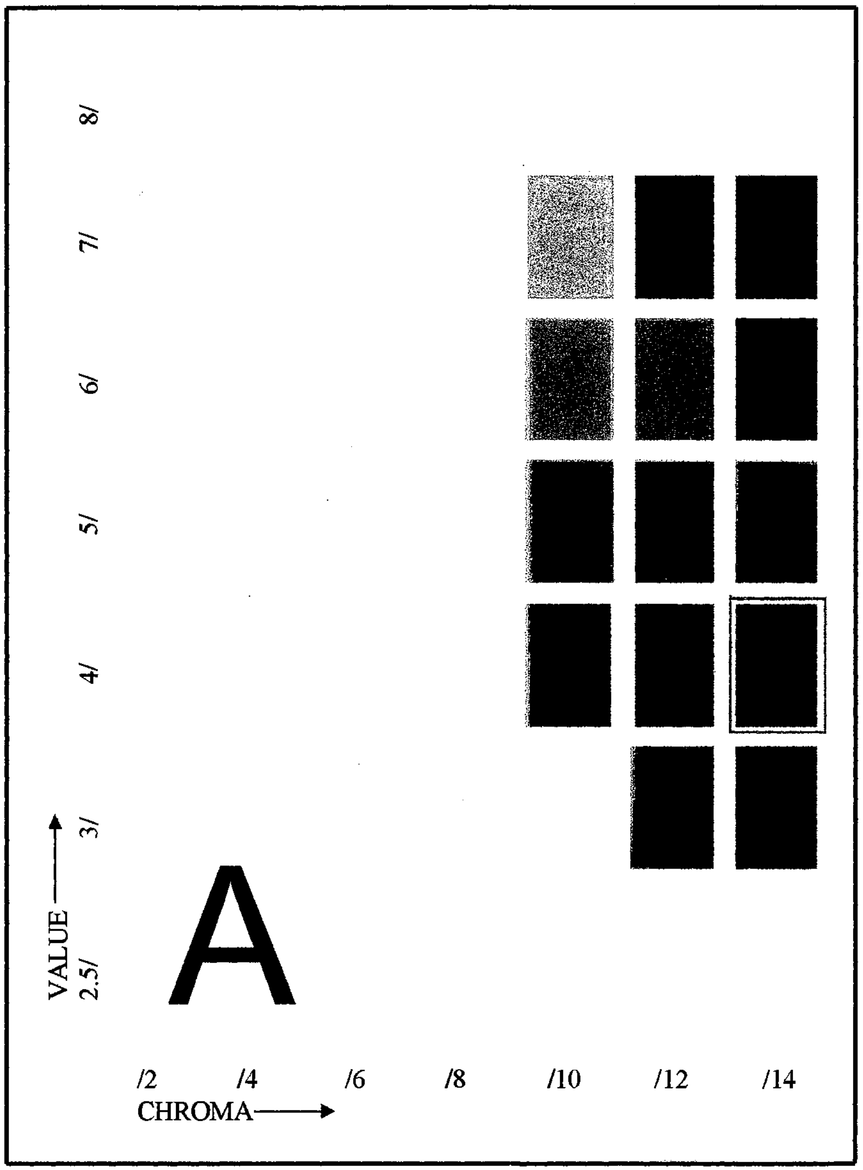
11. Overall in this pretend shopping environment, how would you evaluate the lighting?
(지금까지 살펴본 이 꾸며진 쇼핑 룸의 전반적인 조명상태에 대해 귀하의 선호도를 가장 잘 나타낸 숫자에 O 표를 하십시오)

Cubicle		1	2	3	4	5	6	7	
Left side (Cubicle # 1)	Like (좋다)	1	2	3	4	5	6	7	Dislike (싫다)
Right side (Cubicle #2)	Like (좋다)	1	2	3	4	5	6	7	Dislike (싫다)

Thank you!

APPENDIX G

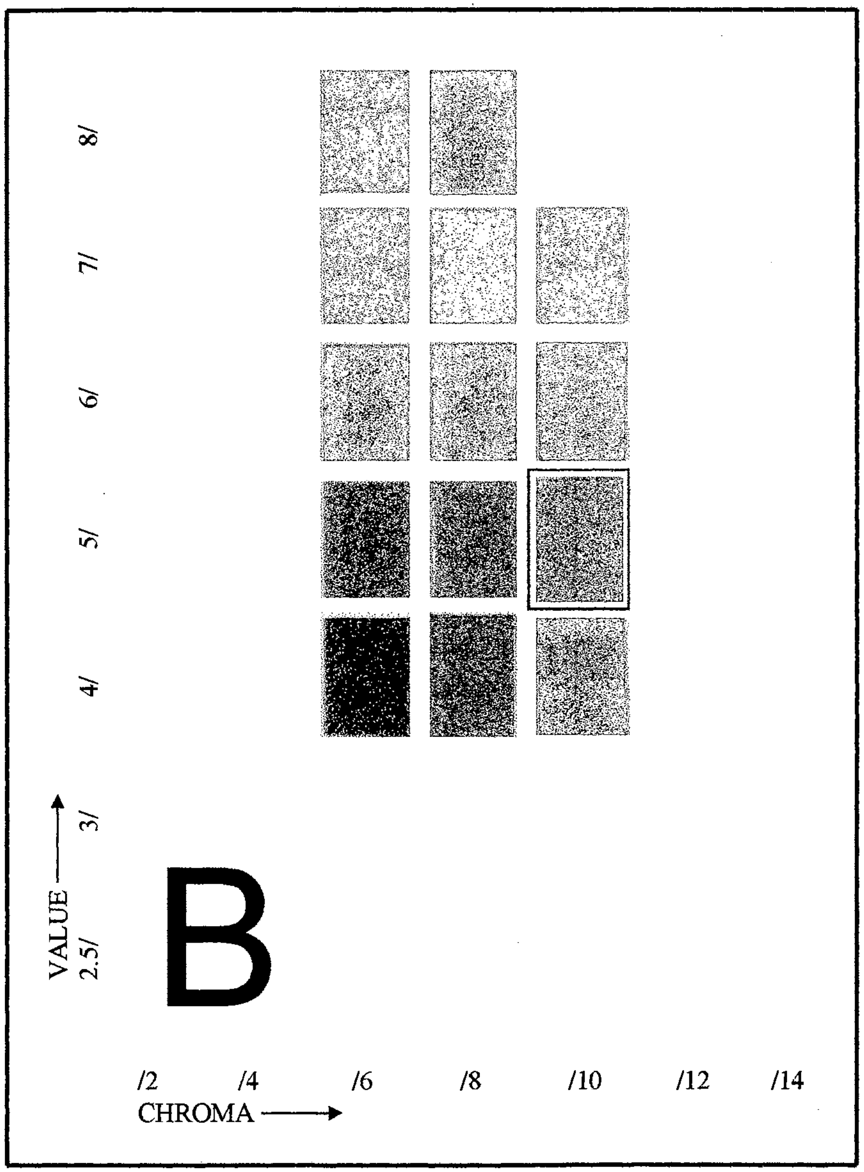
MUNSELL COLOR CHARTS



The Designation of Color Chips for the Red T-Shirt

	Original research color chip designation in card A	Munsell hue designation: all possible choices for red
1	*3/12*	*2.5R 5/10*
2	*3/14*	*2.5R 4/14*
3	4/10	5R 4/10
4	4/12	5R 4/12
5	4/14	5R 4/14
6	5/10	5R 5/10
7	5/12	5R 5/12
8	5/14	5R 5/14
9	6/10	5R 6/10
10	6/12	5R 6/12
11	*6/14*	*7.5R 5/16*
12	7/10	5R 7/10
13	*7/12*	*2.5R 6/12*
14	*7/14*	*7.5R 5/14*

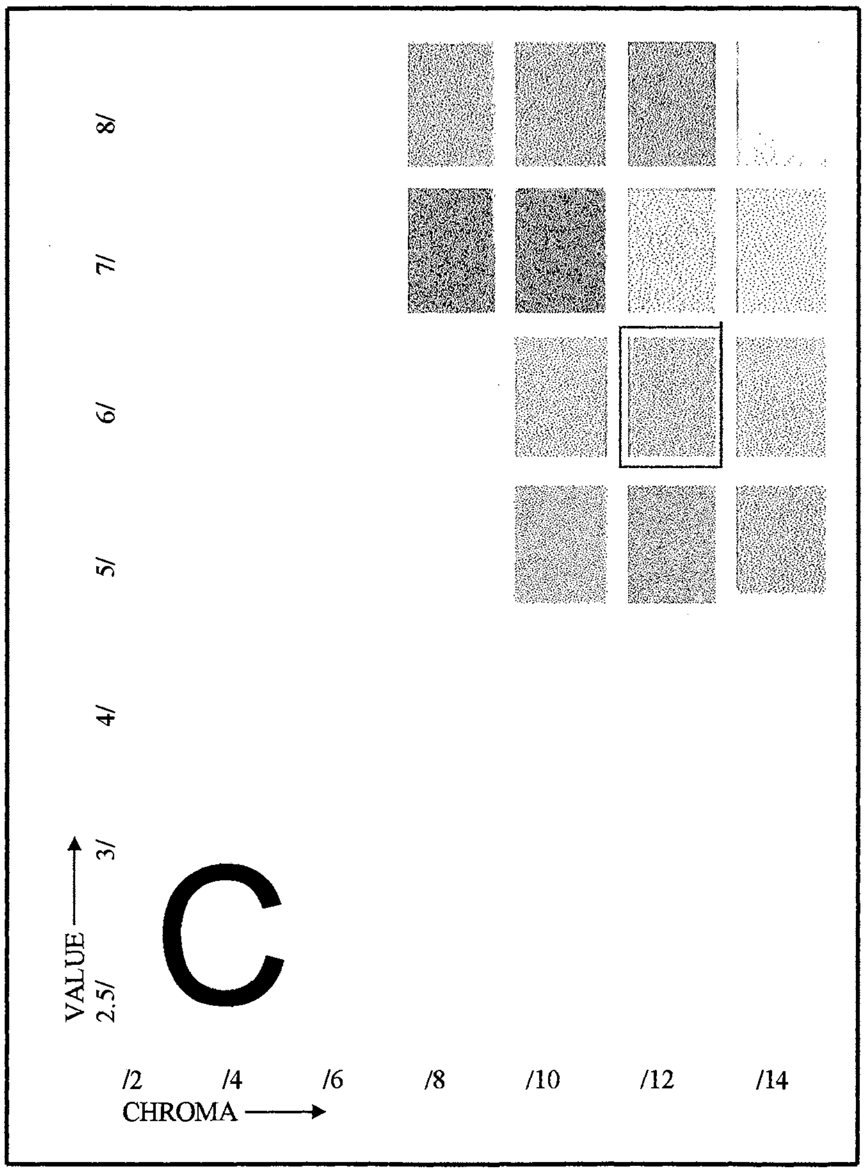
Note. Underlined Designation, "___", indicates the "true" color match for the red T-shirt under natural light. Designations with Italic letters indicate the color chips added to the New Munsell Student Color Set from the Munsell Book of Color



The Designation of Color Chips for the Blue T-Shirt

	Original research color chip designation in card B	Munsell hue designation: all possible choices for blue
1	4/6	5B 4/6
2	*4/8*	*10BG 5/10*
3	*4/10*	*2.5B 5/10*
4	5/6	5B 5/6
5	5/8	5B 5/8
6	*5/10*	*5B 5/10*
7	6/6	5B 6/6
8	6/8	5B 6/8
9	*6/10*	*5B 6/10*
10	7/6	5B 7/6
11	7/8	5B 7/8
12	*7/10*	*7.5B 7/8*
13	*8/6*	*10BG 7/6*
14	*8/8*	*10BG 7/8*

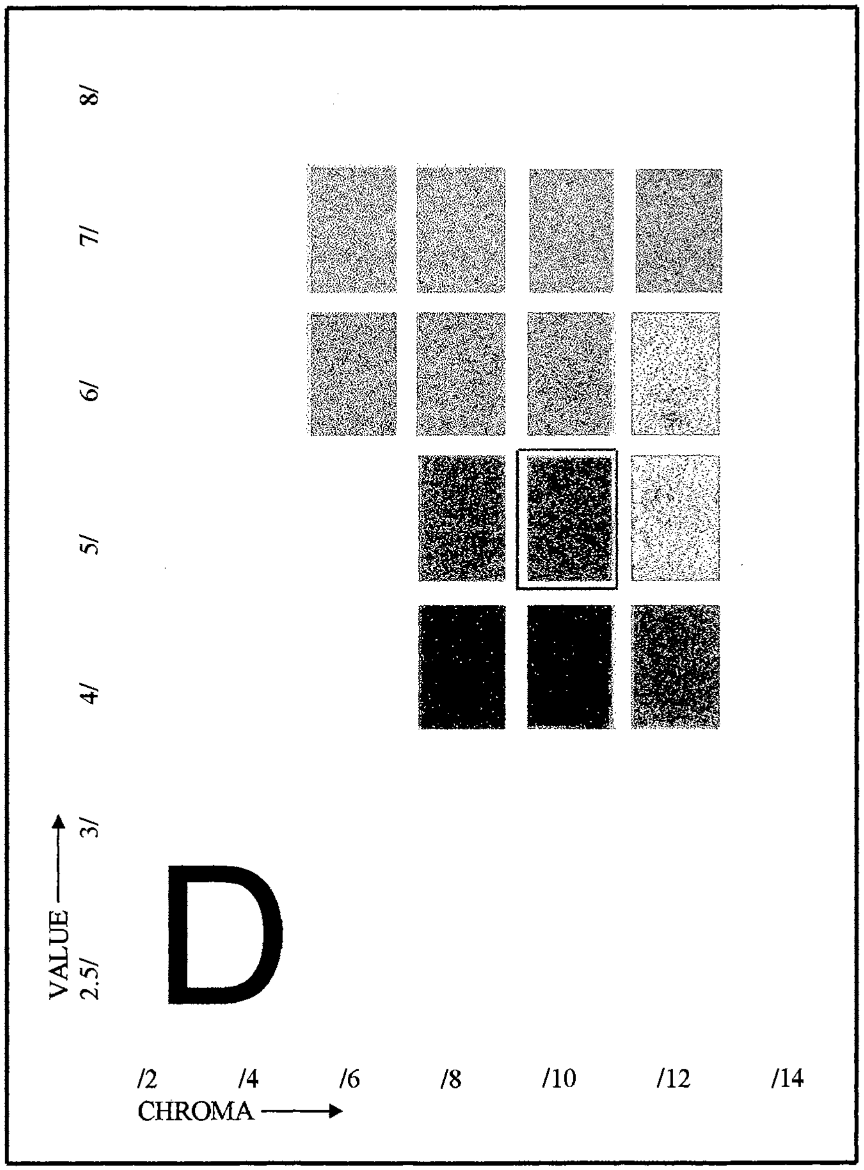
Note. Underlined Designation, "___", indicates the "true" color match for the red T-shirt under natural light. Designations with Italic letters indicate the color chips added to the New Munsell Student Color Set from the Munsell Book of Color



The Designation of Color Chips for the Yellow T-Shirt

	Original research color chip designation in card C	Munsell hue designation: all possible choices for yellow
1	*5/10*	*2.5Y 8.5/8*
2	*5/12*	*2.5Y 8.5/12*
3	*5/14*	*5Y 8/14*
4	*6/10*	*2.5Y 8.5/10*
5	*6/12*	*2.5Y 8/12*
6	*6/14*	*5Y 8.5/14*
7	7/8	5Y 7/8
8	7/10	5Y 7/10
9	*7/12*	*7.5Y 8.5/12*
10	*7/14*	*5Y 8.5/12*
11	8/8	5Y 8/8
12	8/10	5Y 8/10
13	8/12	5Y 8/12
14	*8/14*	*7.5Y 8.5/8*

Note. Underlined Designation, "___", indicates the "true" color match for the red T-shirt under natural light. Designations with Italic letters indicate the color chips added to the New Munsell Student Color Set from the Munsell Book of Color



The Designation of Color Chips for the Purple Blue T-Shirt

	Original research color chip designation in card D	Munsell hue designation: all possible choices for purple blue
1	4/8	5PB 4/8
2	4/10	5PB 4/10
3	*4/12*	*2.5PB 5/12*
4	5/8	5PB 5/8
5	5/10	5PB 5/10
6	*5/12*	*10B 6/10*
7	6/6	5PB 6/6
8	6/8	5PB 6/8
9	6/10	5PB 6/10
10	*6/12*	*2.5PB 6/10*
11	7/6	5PB 7/6
12	7/8	5PB 7/8
13	*7/10*	*7.5PB 7/6*
14	*7/12*	*7.5PB 7/8*

Note. Underlined Designation, "___", indicates the "true" color match for the red T-shirt under natural light. Designations with Italic letters indicate the color chips added to the New Munsell Student Color Set from the Munsell Book of Color

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VITA

Nam-Kyu Park

Candidate for the Degree of

Doctor of Philosophy

Thesis: INDOOR LIGHTING PERCEPTIONS AND PREFERENCES: A CROSS-CULTURAL COMPARISON

Major Field: Human Environmental Sciences

Biographical:

Personal Data: Born in Chung-Ju, Korea in 1967, the daughter of Ro-Sung Park and Sung-Hwa Park (Kim). Married to Byung-Ok Im in 1991.

Education: Graduated from Chung-Ju Women High School, Chung Cheong Buk Province, Korea, in February 1985; received Bachelor of Science degree in Home Economics from Kon-Kuk University, Seoul, Korea, in February 1989; received Master of Science in Interior Design, Department of Design, Housing and Merchandising, Oklahoma State University in May 1999. Completed the requirements for the Doctor of Philosophy degree with a major in Human Environmental Sciences at Oklahoma State University in December 2001.

Professional Experience: Teaching assistant, Department of Home Economics, Kon-Kuk University, Seoul, Korea, 1989-1991; Graduate research assistant, Department of Design, Housing, and Merchandising, Oklahoma State University, 1998 to 1999; Teaching assistant, Department of Design, Housing, and Merchandising, Oklahoma State University, 1999 to 2001.

Professional Affiliations: Environmental Design Research Association (EDRA)
Interior Design Educators Council (IDEC)
Illuminating Engineering Society of North America (IESNA)
International Facility Management Association (IFMA)