



**HAL**  
open science

# Lighting and Perceived Temperature: Energy-Saving Levers to Improve Store

Gwenaëlle Briand Decré, Bernard Pras

► **To cite this version:**

Gwenaëlle Briand Decré, Bernard Pras. Lighting and Perceived Temperature: Energy-Saving Levers to Improve Store. Academy of Marketing, Jul 2009, Leeds (Angleterre), United Kingdom. hal-04430972

**HAL Id: hal-04430972**

**<https://hal.science/hal-04430972>**

Submitted on 1 Feb 2024

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial - NoDerivatives 4.0 International License

# **Lighting and Perceived Temperature: Energy-Saving Levers to Improve Store Evaluations?**

## **Abstract**

Light intensity and thermal conditions have energy savings implications. Based on environmental psychology, ergonomics and in-store environment research, this study analyzes the direct and interaction effects of lighting and perceived temperature on store evaluations. Three evaluative dimensions emerged from the factor analysis: stimulation, upmarket positioning and relaxation. A 2 x 2 x 3 experiment (lighting x perceived temperature x retail outlet) shows that lighting and its interaction with perceived temperature influence stimulation and upmarket positioning. Perceived temperature has a direct impact on stimulation. The type of retail outlet (jeans, books, and furniture) affects stimulation, upmarket positioning and relaxation.

## **Lighting and Perceived Temperature: Energy-Saving Levers to Improve Store Evaluations?**

Do lighting and temperature significantly influence store evaluations? Lighting and temperature are said to have a major impact on energy savings. They also affect individuals' emotions and behavior (Anderson 1989; Lam 1998; Rosenthal et al. 1984) and are considered as essential by retailers and experts in sensometry. However, they are understudied stimuli of store environment despite some research completed on lighting's influence on shopping behavior (Areni and Kim 1994; Summers and Hebert 2001). A systematic and controlled analysis of the effect of lighting on consumers' store evaluations has not yet been done. Furthermore, no academic research has ever been devoted to the influence of temperature on store evaluation.

Scientific interest in lighting has been focused on physical and psychological variables, brightness in particular. Research on temperature has concentrated primarily on physical variables. Psychological variables may also play a role with temperature. Stramler, Kleiss and Howell (1983) have shown that changes in purported temperature significantly influence comfort sensations, even if the actual temperature is maintained constant. This illustrates the importance of perceived temperature despite what the actual temperature is. Both brightness and perceived temperature are therefore thought to affect consumer's store evaluations. These variables are actionable and have energy savings implications. Our research aims at highlighting the direct and interaction effects of bright versus soft light and of perceived temperature on consumers' store evaluations.

Our propositions will be based on research in marketing, environmental and clinical psychology and ergonomics. Environmental psychology applied to a retail context suggests that stimuli (S) influence internal evaluations of the environment (O), which in turn influence the consumer in-store approach or avoidance behavior. While many articles in marketing concentrate on the behavioral responses (R) with stimuli such as color or music (S) (e.g., Yalch and Spangenberg 1990, adapted from Mehrabian and Russell model (1974)), we focus here on lighting and temperature as suggested by Bitner (1992) among others, and their potential influence upon store evaluations. Research findings in psychiatry and clinical psychology have revealed the effects of illuminance levels on individuals. Research in ergonomics indicates the existence of significant relationships between the level of brightness and the perceptions of the environment. A bright light is associated with stimulative and upmarket (spaciousness, comfort) perceptions whereas low lighting is associated with intimacy. Social psychology research reports strong influences of ambient temperature on emotions, and emphasizes the negative impact of getting out of the comfort zone. Moreover, a high perceived temperature within the comfort range is preferred by individuals. Interaction effects between light, temperature and characteristics of the environment are also pointed out.

We conducted a 2 (bright vs. soft lighting) x 2 (warm vs. cool perceived temperature) x 3 (types of retail outlets: jeans, books, furniture) factorial design experiment based upon digitally manipulated pictures in order to create the desired lighting and perceived temperature conditions. The objective of a retail outlet is to enhance positive evaluations. Therefore, we decided to focus on pleasant lighting and temperature conditions. The pleasing impression induced by lighting (Kruithof curve 1941) depends on illuminance levels and correlated color temperature (CCT). The two pleasing conditions are "bright cool lighting" and "soft warm lighting". The pleasing temperatures are those within the thermal comfort range (Rohles 2007). As the comfort level depends on activity level and clothing, we used pictures representing a female teenager standing in front of a display,

with a low activity. On these pictures, we implemented two temperature levels by changing teenager's clothes: light clothing for warm conditions and a coat for cool conditions. A manipulation check over 180 individuals reveals significant differences in perceived temperature changes, going from 4°F (for furniture store) to 6°F (for jeans and bookstore). The average perceived temperatures range from 66°F in cool conditions to 72.5°F in warm conditions. The final sample consisted of 115 French "MS in Management" students in Paris. The experiment was conducted in June under controlled conditions. The subjects were randomly assigned to a set of three combinations (four sets of three combinations in total). Each combination was administered to an equal number of respondents.

For store evaluations, the scale construction was based upon the seven-point "Judgments of Environmental Quality Scale" (Fisher 1974), and also upon Spangenberg et al. (1996) research and experts assessment.

A factor analysis using Varimax rotation was carried out and three store evaluation factors emerged: "stimulation", "upmarket positioning" and "relaxation" dimensions. Each factor is composed of relevant items, considering Russell and Pratt (1980) and Mehrabian and Russell (1974) research. The resulting effects of lighting and temperature support most of our propositions.

MANOVA findings show a systematic positive impact of bright and cool lighting, warm perceived temperature, type of retail outlet, and lighting x perceived temperature upon the "stimulative" dimension of store evaluation. A "soft and warm" light has a significant positive effect on the "upmarket positioning" dimension. There is no significant effect of light illuminance level upon the "relaxation" dimension overall. However, a "soft and warm" light is positively related to the intimacy item. As expected, lighting has a stronger effect upon store evaluations than perceived temperature. The type of retail outlet significantly influences store evaluations on the three dimensions.

This research also demonstrates the relevance of experiments with simulated temperature levels. Perceived temperature becomes an actionable variable. It can be induced by controlled indicators (winter or summer clothes at a given activity level as recommended by Fanger (1970)) or through purported temperature (Stramler et al. 1983), or other clues. This actionable variable influences store perceptions. Moreover, generating a higher perceived temperature than the actual temperature has important energy savings implications.

Three other comments can be made: 1) implementing pleasing modalities for lighting and perceived temperature makes sense since different pleasing modalities significantly influence store evaluations; 2) this initial research on lighting and perceived temperature effects on store evaluations has been done for the first time under controlled conditions; 3) our findings provide strong enough evidence supporting ergonomic and environmental psychology research with actual and purported temperature to pursue further in-store research in real but controlled settings.

## **Lighting and Perceived Temperature: Energy-Saving Levers to Improve Store Evaluations?**

Most marketing research studying store environment has focused on variables, such as music, color or scent (e.g., Crowley 1993; Spangenberg, Crowley, and Henderson 1996; Yalch and Spangenberg 2000). Lighting and temperature are said to have a major impact on energy savings and are important variables in this respect. They also affect the individual's emotions and behaviors (Anderson 1989; Lam 1998; Rosenthal et al. 1984) and are considered as essential by retailers and experts in sensometry (Maille and Siekierski 2006; Petit, Siekierski, and Lageat 2003; Rouillet 2006). Yet they are understudied aspects of store environment. The influence of in-store lighting has never been studied in a controlled environment. A few researchers have studied the effect of display lighting (Areni and Kim 1994; Summers and Hebert 2001) and of additional lighting in a specific shelf (Bakini Driss, Ben Lallouna Hafsia, and Zghal 2008) on shopping behavior and the effect of pleasant or unpleasant lighting on shoppers' affective reactions (Lemoine 2002). However, a systematic and controlled analysis of the effect of in-store lighting on consumers' evaluation has not yet been done. Furthermore, no marketing research specialized in atmospheric factors has ever been conducted on either actual or perceived temperature.

Assessing the impact of lighting and temperature stimuli on consumers' store evaluations therefore sounds extremely useful. Stramler, Kleiss and Howell (1983) have shown a significant effect of purported temperature increase on perceived comfort, even when the actual temperature is not changed. This means that non-physical factors can play a role in the perception of thermal comfort. Implications for energy savings and in-store atmosphere perception are real. Perceived temperature may affect consumer's sensation of comfort while shopping as well as the actual temperature. According to

specialists, an actual 1.8°F decrease, from 68°F (20°C) to 66.2°F (19°C) results in energy savings of 7%. Experts<sup>1</sup> in lighting and temperature also suggest that lighting can enhance a store image while temperature can affect consumer's sensation of comfort while shopping. The aim of our research is to highlight the direct and interaction effects of perceived temperature and lighting on consumers' store evaluations. It focuses on the following questions: To what extent do lighting and perceived temperature affect individuals' evaluations and behavior, considering prior ergonomic or psychological results? To what extent can these results be extended to consumers' perception of store environment and store positioning? Consequently, we introduce some propositions and study the influence of two lighting and two perceived temperature levels in three types of retail outlets (clothing, books, furniture) on the individual's evaluations of store environment and store positioning.

## CONCEPTUAL FRAMEWORK

First of all, this research is based on environmental psychology applied to a retail store context (Donovan and Rossiter 1982; Spangenberg et al. 1996). Stimuli (S) influence the internal evaluations of the environment (O) which in turn influence the consumer in-store behavior. The internal evaluations of the environment can have affective or stimulating dimensions as well as a positioning dimension (for example perceived quality of the goods, upmarket store). The consumer behavioral responses (R) can be approach or avoidance responses. Many articles in marketing have focused on the behavioral responses (R) consecutive to various stimuli such as color or music (S) (Bitner 1992; Yalch and Spangenberg 1990). We study here less or never studied

---

<sup>1</sup> Working group: "Lighting and energy saving", Popai France, Paris, October 2008 and Conference: "Light and health", EDF (Electricité de France) and AFE (Lighting French Association), Paris, January 2009.

relevant stimuli, that are lighting and temperature such as suggested by Bitner (1992), and their potential influence on store evaluation (affective, stimulative or positioning perceptions). The positioning relates to perceptions, and the beliefs one has of a product or a store environment, and of a categorization of the store mentally (Bitner 1992). It should also be mentioned that Spangenberg et al. (1996) or Bitner (1992) propositions are an adaptation of Mehrabian and Russell's model (1974) to the store atmosphere context. Among PAD (Pleasure, Arousal and Dominance) dimensions of Mehrabian and Russell's model, Bitner (1992) as well as Spangenberg et al. (1996) do not retain the dominance dimension, in a store context. This is consistent with Donovan and Rossiter (1982) research findings and Russell and Pratt (1980) recommendations.

Second of all, this research is also grounded in the lighting and temperature literature in environmental and applied psychology, and ergonomics. This leads to some propositions in a store evaluation context, further analyzed through an experiment.

### **Lighting<sup>2</sup>**

Research in different scientific fields has revealed the various effects of light on individuals. Psychiatric and medical research have demonstrated that light illuminance modulates circadian rhythm (and specifically hormonal cycles) leading to a succession of stimulating (arousal and activation) and relaxing (detente and sleepy) periods (Lam 1998; Rosenthal et al. 1984). Clinical psychology has suggested an increasing cardiovascular activity and a stimulation of physiological arousal (Kumari and Venkatramaiah 1974). Research in marketing has also demonstrated an effect of light on in-store behavior. Supplemental lighting or bright light influences the number of items examined and handled and the time spent in stores or display (Areni and Kim

---

<sup>2</sup> Low level of lighting is associated to soft lighting and high level of lighting to bright light. For color temperature, a warm light is associated to red light and cool light is associated to white or blue light.

1994; Summers and Hebert 2001). Therefore, bright light can be expected to positively affect the stimulating dimension of store perception.

**Proposition 1:** Bright light positively influences a stimulative perception of the store environment.

Biological effects of lighting on humans (Lam 1998; Rosenthal et al. 1984) induce psychological responses (cognitive, aesthetic and emotional). According to ergonomic studies, a bright light and a cool light color temperature are more associated with comfort and spaciousness (Manav 2007). In addition, visual order perception is also achieved with bright light in conditions of wall washing (Durak et al. 2007), the wall washing being a diffuse lighting on the wall.

**Proposition 2:** Bright light is associated with upmarket store perception (comfort, spaciousness, order....).

However, brightness by itself does not seem to have an influence on relaxation. Subjects have reported more positive affect (Baron 1990), feelings of relaxation and intimacy (Carr and Dabbs 1974; Durak et al. 2007) in conditions of low lighting. Manav (2007) has pointed out that a warm light (2700 K) leads to the impression of a relaxing atmosphere. But a feeling of relaxation can also be reported in conditions of wall-washing (Manav and Yener 1999), uplighting (Manav and Yener 1999: 43–47) and cove lighting (Durak et al. 2007), whatever the light intensity.

**Proposition 3:** Low lighting is associated with intimacy; relaxation is not associated with light intensity.

Finally, the preferred lighting level has been associated with the social situation and the type of activities (Biner et al. 1989). Moreover, Summers and Hebert (2001) have demonstrated an interaction effect between lighting and display. According to the retail merchandising perspective, it seems to be necessary to match the lighting to the retail objectives and characteristics.



**Proposition 4:** There is an interaction effect of lighting conditions x types of retail outlets upon the evaluations of the stores.

### **Temperature**

A social psychology research has reported an affective impact of temperature on individuals. Aggressive behavior and riots, negative affects and antisocial behavior in a crowded situation (Anderson 1989; Griffitt and Veitch 1971) increase as the temperature increases. The negative affect also grows as temperature dips (< 62°F: Bell and Baron 1977). This suggests that a "range of comfort" exists and that a negative affective state could be attributed to hot or cold temperatures (Baker and Cameron 1996). "Range of comfort" can be assimilated to "thermal comfort" that is the "condition of mind which expresses satisfaction with the thermal environment and is assessed by subjective evaluation" (Rohles 2007, 14). It seems to be impossible to define an optimal temperature level for all individuals, but Fanger (1970) has developed the Predicted Mean Vote (PMV) model with the Predicted Percentage Dissatisfied, used to predict the thermal sensations of a large group of people. The thermal comfort and PMV depend on the activity level and clothing worn by individuals, along with thermal conditions. Indoor thermal comfort perception ranges from 68°F to 74°F, extended to 66°F with warm clothing and 78°F with light clothing, for a low activity level. Stramler et al. (1983) have shown that individuals responded comparably, in terms of perceived comfort shifts, to actual and purported rises of temperature. This is consistent with Rohles and Kerulis' technical report<sup>3</sup> in which subjects had similar distributions of comfort and thermal sensation votes when they were shown a specific temperature reading (74°F), whether the actual temperature was actually 74°F or in a "68°F-72°F" range. The perceived temperature can therefore be manipulated.

---

<sup>3</sup> Technical report, reported by Fanger, Kleiss and Howell (1983, 187)

A research in the United Kingdom (Humphreys and Hancock 2007) has used ASHRAE Scale, based on Fanger research (1970). It has demonstrated that most individuals (for a low activity) preferred to experience a “slightly warm” or “warm” rather than “neutral” or “cool” sensation, whatever the seasonal period<sup>4</sup>. This suggests that for a low level of shopping activity in a store environment, and within the “comfort range”, the store evaluation is positively correlated to a moderately high perceived level of temperature rather than to a moderately low perceived level of temperature.

**Proposition 5:** A high perceived temperature within the comfort range is preferred by consumers and associated to better store evaluations than a relatively low perceived temperature.

Finally, Rohles’ ergonomic research (1980) has suggested that temperature is perceived as warmer in decorated and very furnished room than in an empty space, while both spaces are at the same temperature level.

**Proposition 6:** The perceived temperature will be lower in a relatively empty space than in a more furnished space

**Proposition 7:** There is an interaction effect of perceived temperature x type of retail outlet (more or less furnished) upon store evaluations.

### **Main effects of lighting versus temperature and interaction effects**

Baker and Cameron’s (1996) conceptual framework suggests the possibility to study a wide range of environmental factors (such as temperature and lighting) and their influence on affect and the perception of waiting time. Analyzing main and interaction effects of temperature and lighting does seem necessary to explore and understand a “polysensory person”. Indeed, “perception will give the priority to the “best” sensory modality for the task at hand” (Guttman 2005, 228). Vision takes precedence over

---

<sup>4</sup> ASHRAE Scale measures the subjective thermal sensation, that is to say the subjective point of view about the personal thermal sensation instead of the temperature of the atmosphere.

spatial information (Welch 1999) and most significantly influences the quality of functional and cognitive information (Schifferstein and Desmet 2007). These results suggest that cognitive information and categorization are treated by vision in priority, and it could be inferred that lighting will be perceived in priority.

**Proposition 8:** The positioning evaluation of a store will be more influenced by lighting than by perceived temperature.

**Proposition 9:** There is an interaction effect of “lighting x perceived temperature” upon store evaluations.

## METHOD

We used a 2 (lighting) X 2 (perceived temperature) X 3 (types of retail outlets) factorial design experiment, based on digitally manipulated pictures in order to create the desired lighting and perceived temperature conditions. The lighting conditions (bright vs. soft), the perceived temperature (low vs. high within the comfort range) and the types of retail outlets (jeans, books and furniture) are presented below as well as the experiment.

### Lighting Conditions

Actually, in physics, light is a form of energy known as electromagnetic radiation that may be perceived by the normal unaided human eyes. Light illuminance level (brightness vs. softness) can be associated to a CCT (Correlated Color Temperature that is a cool or a warm color temperature)<sup>5</sup>. CCT describes the ambiance that a lamp provides, i.e. how "warm" or "cool" the light makes a room be perceived<sup>6</sup>. According to

---

<sup>5</sup> Light illuminance is expressed in lux” (Van Erp 2008) and color temperature is measured in Kelvin.

<sup>6</sup> [www.osram.com](http://www.osram.com)

experts and following the famous Kruithof (1941) curve<sup>7</sup>, the preferred combination of illuminance level (Bright vs. soft) and correlated color temperature (CCT: Cool vs. warm) are “bright and cool lighting” on the one hand and the “soft and warm lighting” on the other hand. On the contrary, two combinations are considered to be unpleasant: “Bright and warm lighting” has been claimed to create a colorful and artificial environment, while “Soft and cool lighting” has been considered to create a drab and cold environment. Therefore, from a managerial point of view, this research focuses on pleasing perceptions of lighting that could entail a positive evaluation of an environment and in turn entail an approach behavior: “bright and cool lighting” for bright light and “soft and warm lighting” for soft light.<sup>8</sup>

### **Perceived Temperature and Types of Retail Outlets**

As underlined above, we focus on the range of comfort for light and perceived temperature. The critical point is to present visual clues corresponding to different perceived temperature levels. As already indicated, previous research has shown that actual temperature changes within the range of comfort had an impact upon thermal sensations similar to that of identical purported temperature changes (Stramler et al. 1983). Temperature changes of 4-5°F (2.3°C-3.3°C) represent a substantial change in the comfort-response distribution according to well-established norms.

As the comfort level depends on the activity level and the clothing, we used pictures representing a female teenager standing in front of the display, therefore with a low activity. On these pictures, we implemented two temperature levels by changing teenager’s clothes: light clothing for warm conditions and a coat for cool conditions. A manipulation check over 180 individuals reveals significant differences in perceived

---

<sup>7</sup> Kruithof curve (1941) relates the illuminance and color temperature of visually pleasing light sources.

<sup>8</sup> Ambient fluorescent tubes lighting in retail stores is commonly Bright cool lighting. The Energy Bill (2007) bans the incandescent light bulbs by 2014, which are to be replaced by energy savings bulbs. These bulbs can be used for accent light in retail stores, and can possibly be bright or soft, and warm or cool.

temperature changes, going from 4°F (2.3°C) for furniture store to 6°F (3.3°C) for jeans and bookstore. The average perceived temperatures range from 66°F in the cool conditions to 72.5°F in the warm conditions.

The shopping behavior was perfectly similar in the two lighting conditions (“bright and cool light” and “soft and warm” light) and the three different stores. Pictures got retouched by a professional photographer using Photoshop to create the two lighting conditions. In each store represented on pictures, no brand or no corporate name appeared. Three types of retail outlet were selected according to literature and experts’ advice. Besides, each type of retail outlet is expected to allow a homogeneous store environment from one display to another inside the specific store, as compared to supermarkets which are composed of heterogeneous store environments.

### **Experiment Implementation, Subjects and Questionnaire**

*Experiment and Subjects.* The sample consisted of 115 French “MS in Management” students in Paris, France. The experiment was conducted in June and resulted in 12 combinations of temperature, lighting and store. The same room, with the same temperature level and the same light illuminance level, was used during the whole experiment, and the weather remained constant. We constructed four sets of three combinations with three retail outlets<sup>9</sup> that we replicated in order to have eight sets (twice the same four sets x three combinations). The experiment was administered by the same researcher to groups of eight subjects at a time. In each group, subjects were randomly assigned to one of the eight sets. Each respondent had to figure himself in the shopping situation. For each photograph, that is each retail outlet with a light/temperature combination, we submitted a questionnaire about the store

---

<sup>9</sup> Mixing the modalities and the order (with Jeans (S1), Books (S2), Furniture (S3), Bright light (L1), Soft light (L2), Cool temperature (T1), Warm temperature (T2)), the 4 basic sets were:

Set 1 (S1L1T1/S2L1T2/S3L2T2); Set 2 (S2L2T2/S3L1T1/S1L2T1); Set 3 (S3L2T1/S1L1T2/S2L1T1); Set 4 (S2L2T1/S1L2T2/S3L1T2).

environment evaluation, the store positioning and the product quality perceptions. The final sample was composed of 110 subjects: 63 females and 47 males. 330 questionnaires were validated, which made 27 or 28 subjects for each combination.

*Questionnaire Construction.* The questionnaire construction was based on Fisher's scale (1974) and Spangenberg et al. (1996) research. The first list was supplemented with items suggested by 12 individuals from the same population as the respondents. They were asked to write a list of items describing a store environment to guarantee the semantic saturation. Then, one expert in lighting, one expert in thermal comfort and one expert in marketing were also asked to complete and to validate this list and avoid redundant items. The final list was composed of 21 non-redundant items. Evaluation of store environment was measured using the seven-point "Judgments of Environmental Quality Scale" (Stimulating-boring; motivating-unmotivating; comfortable-uncomfortable; cheerful-depressing; positive-negative; attractive-unattractive; lively-unlively; good-bad; bright-dull; pleasant-unpleasant; relaxed-tense; colorful-drab) (Fisher 1974). Four seven-point items have completed the Fisher's (1974) scale according to their relevance to our stimuli (cold welcome-warm welcome; friendly-unfriendly; unstressful-stressful, intimate-impersonal), following interviews with experts. Evaluation of store positioning was measured using four seven-point scales (Spacious-cramped (Durak et al. 2007; Manav 2007); well ordered-unordered (Expert); upmarket-downmarket (Expert); outdated-modern (Bellizzi, Crowley and Hasty 1983). Product evaluation was assessed using a seven-point scale (Low/High Quality) (Spangenberg et al. 1996).

## **DATA ANALYSIS AND RESULTS**

### **Store Evaluations**

To examine the existence of distinct components within the subject's responses to the stimuli, a principal component analysis using Varimax rotation was conducted (table 1).

**TABLE 1**  
**FACTORS OF STORE EVALUATIONS**  
**(LOADINGS, COMMUNALITY AND ALPHA-VARIMAX ROTATION)**

Items	Stimulation	Upmarket Positioning	Relaxation	Communality
Cheerful	.791	.170	.143	.674
Stimulating	.772	.157	.132	.638
Attractive	.771	.273	.328	.777
Positive	.732	.237	.298	.681
Lively	.714	-.004	.095	.519
Motivating	.698	.183	.119	.535
Colorful*	.661	.026	.225	.488
Upmarket	.257	.805	.063	.718
Modern	.378	.740	-.035	.692
Spaciousness	.190	.708	.175	.568
Well ordered*	-.180	.609	.256	.470
Relaxed	.224	.266	.777	.725
Unstressful	.296	.075	.753	.661
Intimate*	.154	.068	.656	.459
Cronbach's alpha (factor)	$\alpha_1 = .886$	$\alpha_2 = .747$	$\alpha_3 = .659$	
Cronbach's alpha (scale)	$\alpha = .880$			

\* We have decided to keep: colorful, well ordered and intimate (communality > .45) according to their conceptual interest (Rossiter 2002) in reference with previous research (Spangenberg et al. 1996; Carr and Dabbs 1974; Durak et al. 2007). The determination of "low" value of communality is considered to be subjective.

Pleasant, bright, warm welcome, comfortable, good, friendly and high quality merchandise were eliminated because of a low value for these items communality. Three main factors of store evaluation emerged from the analysis: an "activation or stimulative" dimension, in the sense of a lively environment (Russell and Pratt 1980), which combines arousal (stimulating, motivating, lively and colorful) and pleasure (attractive, positive and cheerful) evaluations; an "upmarket positioning" dimension and a "relaxation" dimension (Russell and Pratt 1980) of store evaluation which is composed of relaxed, unstressful and intimate items. The three factors explain 61.5% of the total variance in 14 variables.

### Effects of Light Illuminance, Perceived Temperature and Type of retail outlet

The effects of light, perceived temperature and type of retail outlet on “stimulation”, “upmarket positioning” and “relaxation” are tested (table 2), using MANOVA; the Levene’s test for equality of variances is not significant ( $p > .05$  for each factor).

**TABLE 2**

EFFECTS OF LIGHT AND TEMPERATURE ON STORE EVALUATIONS:  
STIMULATIVE, UPMARKET POSITIONING AND RELAXATION DIMENSIONS

Stimuli	Factors	<i>F</i>	<i>P</i>
Light	Stimulation	48.50	.000
	Upmarket positioning	5.31	.022
	Relaxation	0.78	.379
Temperature	Stimulation	8.06	.005
	Upmarket positioning	0.20	.658
	Relaxation	0.97	.326
Type of retail outlet	Stimulation	20.87	.000
	Upmarket positioning	88.80	.000
	Relaxation	13.55	.000
Temperature * Light	Stimulation	4.86	.028
	Upmarket positioning	7.77	.006
	Relaxation	0.56	.453
Temperature * Type of retail outlet	Stimulation	0.75	.474
	Upmarket positioning	3.75	.025
	Relaxation	2.08	.127
Light * Type of retail outlet	Stimulation	18.23	.000
	Upmarket positioning	2.05	.130
	Relaxation	0.11	.897
Temperature * Light * Type of retail outlet	Stimulation	0.48	.619
	Upmarket positioning	0.459	.632
	Relaxation	0.547	.579

A “bright and cool” light influences the “stimulative” evaluation ( $F = 48.50$ ;  $p < .001$ ) of a store environment. This result strongly supports Proposition 1 and confirms the stimulation dimension of a store environment in conditions of bright light, consistent with Areni and Kim (1994), Kumari and Venkatramaiah (1974), Mehrabian (1976), and Summers and Hebert (2001) suggestions, and with the founding research on internal responses (Mehrabian and Russell 1974). A “soft and warm” light has a significant effect on the “upmarket positioning” dimension ( $F = 5.31$ ;  $p < .05$ ) and seems inconsistent with Proposition 2. Actually, a “soft and warm” light has a

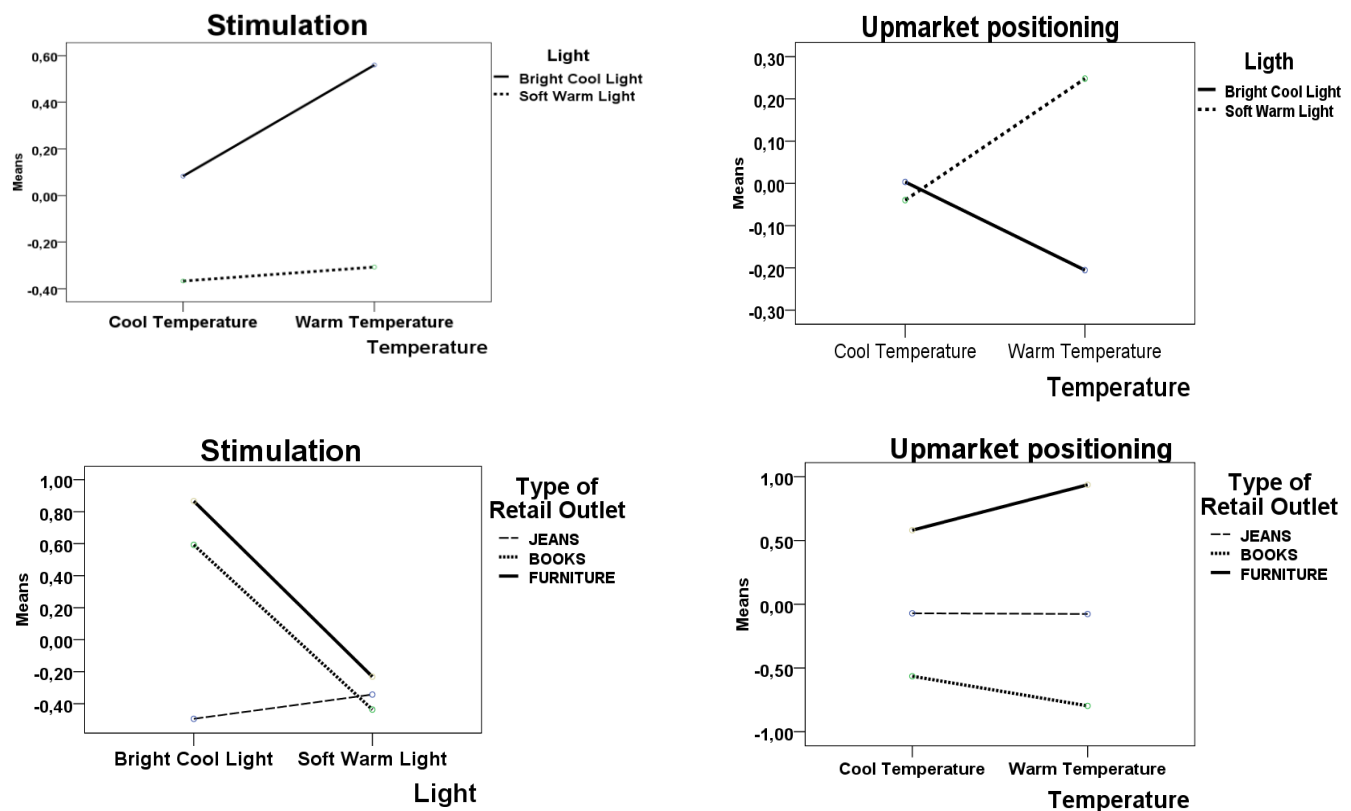


significant positive impact on the upmarket item but no effect on the modern, spacious and well-ordered items. Further research is needed about these sub-dimensions. As expected, there is no significant effect of the light level upon the “relaxation” dimension perceived by subjects and a “soft and warm” light is positively related to the intimacy item. This indicates that Proposition 3 makes sense. There is a significant interaction effect of “lighting x type of retail outlet” on evaluation of the “stimulative” dimension of store environment such as suggested in Proposition 4 (figure 1). A “bright and cool” light in stores with no product physical involvement such as furniture and bookstores enhances a stimulative evaluation of store environment ( $F = 8.06; p < .05$ ). Our research has focused on the range of thermal comfort, such as determined by previous research. A perceived warm temperature within this range has a positive effect on the “stimulation” factor ( $F = 18.23; p < .001$ ), which supports Proposition 5. It has no influence on the “relaxation” dimension but on the intimate item. There is a type of retail outlet effect. The furniture store, which is the most spacious, is perceived as less warm than the others, according to the manipulation check. This result supports Proposition 6. The interaction effect (temperature x type of retail outlet) has a significant impact on the upmarket factor ( $F = 3.75; p < .05$ ), consistently with Proposition 7 (figure 1). We can also point out that lighting has a significant effect on “upmarket positioning” while temperature has not, consistently with Proposition 8 which suggested that cognitive evaluation of a store would be more influenced by lighting than by temperature. And the “temperature x light” interaction has a significant effect on the evaluation of the “stimulative” factor ( $F = 4.86; p < .05$ ) and the upmarket positioning ( $F = 7.77; p < .05$ ) (figure 1). This interaction effect provides evidence supporting Proposition 9. Finally, the type of retail outlet influences the three dimensions ( $p < .001$ ) emerged from the factor analysis. Consumers perceive the store atmosphere as more relaxing and more stimulating in furniture and bookstores (vs

clothing). This could be explained by the “low physical involvement” of furniture and books. Moreover, subjects have considered furniture and clothing stores more upmarket positioned than the bookstore, probably because furniture and clothes are more expensive and show more space than does the bookstore.

**FIGURE 1**

**INTERACTION EFFECTS OF LIGHT, TEMPERATURE AND TYPE OF RETAIL OUTLET ON STIMULATIVE AND UPMARKET POSITIONING DIMENSIONS**



**DISCUSSION AND CONCLUDING REMARKS**

The systematic impact of light intensity, perceived temperature level, type of retail outlet, and lighting x temperature upon the store evaluation on the “stimulative” factor is one of the main results of this exploratory study. In addition, almost all propositions based on ergonomics and environmental psychology prove well-founded in a store evaluation context. Interestingly enough, even if the upmarket positioning results did not match the propositions exactly, it clearly appears that upmarket positioning is

influenced by light intensity, type of retail outlet and temperature x light and temperature x type of retail outlet interactions. As for relaxation, light intensity has an impact upon intimacy perception but not on relaxation. Experiments with wall washing effects would seem useful, following Manav suggestions in ergonomics (2007).

An important element in this exploratory research is the relevance of experiments with simulated temperature levels via pictures, with controlled indicators: winter or summer clothes at a given activity level like recommended by Fanger (1970). Perceived temperature becomes a controllable variable, which has been shown to influence store perceptions. A perceived temperature higher than an actual temperature has high energy savings implications.

Another contribution of this research is the range of modalities studied. Even though previous marketing research has focused on illumination or supplemental lighting, practitioners have pointed out the role of Correlated Color Temperature of lighting on the individual's perception. We therefore focused on pleasing modalities of illuminance level, which had not been done before. We also concentrated on the range of comfort. A warmer perceived temperature within comfort range is preferred by respondents. This is consistent with prior studies. Perceived warmth influences the stimulation dimension and the intimacy item of the relaxation factor.

This is the first research on lighting and perceived temperature effects on evaluations of store environment and positioning conducted under controlled conditions. It provides strong enough evidence supporting ergonomic and environmental psychology research to pursue further research in real and controlled settings. This should be done with actual and purported (or perceived) temperature levels.

## REFERENCES

- Anderson, Craig A. (1989), "Temperature and Aggression: Ubiquitous Effects of Heat on Occurrence of Human Violence," *Psychological Bulletin*, 106 (July), 74-96.
- Areni, Charles S. and David Kim (1994), "The Influence of In-Store Lighting on Consumers' Examination of Merchandise in a Wine Store," *International Journal of Research in Marketing*, 11 (March), 117-25.
- Baker, Julie and Michaelle Cameron (1996), "The Effects of the Service Environment on Affect and Consumer Perception of Waiting Time: An Integrative Review and Research Propositions," *Journal of the Academy of Marketing Science*, 24 (September), 338-49.
- Bakini Driss, Fatma E., Hajer Ben Lallouna Hafsia, and Mustapha Zghal (2008), "L'Impact d'un Eclairage Additionnel dans un Point de Vente sur les Réactions Comportementales des Consommateurs," *La Revue des Sciences de Gestion, Direction et Gestion*, 229 (Janvier-Février), 41-9.
- Baron, Robert A. (1990), "Lighting as a Source of Positive Affect," *Progressive Architecture*, 71 (November), 123-24.
- Bell, Paul A. and Robert A. Baron (1977), "Aggression and Ambient Temperature: The Facilitating and Inhibiting Effects of Hot and Cold Environments," *Bulletin of the Psychonomic Society*, 9 (6), 443-45.
- Bellizzi, Joseph A., Ayn E. Crowley, and Ronald W. Hasty (1983), "The Effects of Color in Store Design," *Journal of Retailing*, 59 (Spring), 23-45.
- Biner, Paul M., Darrell L. Butler, Ann R. Fisher, and Amy J. Westergren (1989), "An Arousal Optimization Model of Lighting Level Preferences: An Interaction of Social Situation and Task Demands," *Environment and Behavior*, 21 (January), 3-16.

- Bitner, Mary Jo (1992), "Servicescapes: The Impact of Physical Surroundings on Customers and Employees", *Journal of Marketing*, 56 (April), 57-71.
- Carr, Suzanne J. and James M. Dabbs Jr. (1974), "The Effects of Lighting, Distance and Intimacy of Topic on Verbal and Visual Behavior," *Sociometry*, 37 (December), 592-600.
- Crowley, Ayn E. (1993), "The Two-Dimensional Impact of Color on Shopping," *Marketing Letters*, 4 (January), 59-69.
- Donovan, Robert J. and John R. Rossiter (1982), "Store Atmosphere: an Environmental Psychology Approach," *Journal of Retailing*, 58 (Spring), 34-57.
- Durak, Ayse, Nilgün C. Olguntürk, Cengiz Yener, Dilek Güvenç, and Yusuf Gürçünar (2007), "Impact of Lighting Arrangements and Illuminances on Different Impressions of a Room," *Building and Environment*, 42 (October), 3476-482.
- Fanger, Ole (1970), *Thermal Comfort Analysis and Applications in Environmental Engineering*, Copenhagen, Danish Technical Press.
- Fisher, Jeffrey D. (1974), "Situation-Specific Variables as Determinants of Perceived Environmental Aesthetic Quality and Perceived Crowdedness," *Journal of Research in Personality*, 8 (August), 177-88.
- Griffitt, William and Russell Veitch (1971), "Hot and Crowded: Influences of Population Density and Temperature on Interpersonal Affective Behaviour," *Journal of Personality and Social Psychology*, 17 (January), 92-8.
- Guttman Sharon E., Lee A. Gilroy, and Randolph Blake (2005), "Hearing What the Eyes See: Auditory Encoding of Visual Temporal Sequences," *Psychological Science*, 16 (March), 228-35.
- Humphreys, Michael A. and Mary Hancock (2007), "Do People Like to Feel 'Neutral'? Exploring the Variation of the Desired Thermal Sensation on the ASHRAE Scale," *Energy and Building*, 39 (July), 867-74.

- Kruithof, Arie A. (1941), "Tubular Luminescence Lamps for General Illumination", *Philips Technical Review*, 6, 65-96.
- Kumari, Bharathi K. and S.R. Venkatramaiah (1974), "Effects of Anxiety on Closure Effect Disappearance Threshold (Brain Blood Shift Gradient)," *Indian Journal of Clinical Psychology*, 1, 114-20.
- Lam, Raymond W. (1998), *Seasonal Affective Disorder and Beyond: Light Treatment for SAD and non SAD Conditions*, Washington D.C, American Psychiatric Press.
- Lemoine, Jean-François (2002), "Perception de l'Atmosphère du Point de Vente et Réactions Comportementales et Emotionnelles du Consommateur," *Actes du 5ème Colloque Etienne Thil, Université de La Rochelle*, CD-ROM.
- Maille, Virginie and Edouard Siekierski (2006), "Comment Gérer les Sensations Tactiles ? ", in *Le Marketing Sensoriel du Point de Vente*, ed. Sophie Rieunier, Paris, Dunod, 169-203.
- Manav, Banu (2007), "An Experimental Study on the Appraisal of the Visual Environment at Offices in Relation to Colour Temperature and Illuminance," *Building and environment*, 42 (February), 979-83.
- Manav, Banu and Cengiz Yener (1999), "Effects of Different Lighting Arrangements on Space Perception," *Architectural Science Review*, 42 (March), 43-8.
- Mehrabian, Albert (1976), *Public Spaces and Private Spaces: The Psychology of Work, Play, and Living Environments*, New York: Basic Books.
- Mehrabian, Albert and James A. Russell (1974), *An Approach to Environmental Psychology*, Cambridge MA: MIT Press.
- Petit, Cécile, Edouard Siekierski, and Thierry Lageat (2003), "Du Confort Thermique à la Caractérisation Sensorielle des Ambiances", *Revue Française du Marketing*, 194, 29-47.

- Rohles, Frederick H. Jr (2007), "Temperature and Temperament: A Psychologist Looks at Comfort," *ASHRAE Journal*, 49 (February), 14-22.
- Rosenthal, Norman E., David A. Sack, J. Christian Gillin, Alfred J. Lewy, Frederick K. Goodwin, Yolande Davenport, Peter S. Mueller, David A. Newsome, and Thomas (1984), "Seasonal Affective Disorder: a Description of the Syndrome and Preliminary Findings with Light Therapy," *Archives of General Psychiatry*, 41 (January), 72-80.
- Rossiter, John R. (2002), "The C-OAR-SE Procedure for Scale Development in Marketing," *International Journal of Research in Marketing*, 19 (December), 305-35.
- Rouillet, Bernard (2006), "Comment Gérer les Couleurs et les Lumières ?," in *Le Marketing Sensoriel du Point de Vente*, ed. Sophie Rieunier, Paris, Dunod, 133-68.
- Russell, James A. and Geraldine Pratt (1980), "A Description of the Affective Quality Attributed to Environments," *Journal of Personality and Social Psychology*, 38 (February), 311-22.
- Schifferstein, Hendrik N.J. and Pieter M.A. Desmet (2007), "The Effects of Sensory Impairments on Product Experience and Personal Well-Being", *Ergonomics*, 50 (December), 2026-48.
- Spangenberg, Eric R., Ayn E. Crowley, and Pamela W. Henderson (1996), "Improving the Store Environment: Do Olfactory Cues Affect Evaluations and Behaviors?," *Journal of Marketing*, 60 (April), 67-80.
- Stramler Carla S., James A. Kleiss, and William C. Howell (1983), "Thermal Sensation Shifts Induced by Physical and Psychological Means", *Journal of Applied Psychology*, 68 (February), 187-93.

- Summers, Teresa A. and Paulette R. Hebert (2001), "Shedding Some Light on Store Atmospherics Influence of Illumination on Consumer Behavior," *Journal of Business Research*, 54 (November), 145-50.
- Van Erp, Thomas A.M. (2008), "The Effects of Lighting Characteristics on Atmosphere Perception", Master Thesis, Eindhoven University of Technology - Department of Technology Management, April.
- Welch, Robert B. (1999), "Meaning, Attention, and the "Unity Assumption" in the Intersensory Bias of Spatial and Temporal Perceptions," in *Cognitive contributions to the perception of spatial and temporal events*, ed. Gisa Aschersleben, Talis Bachmann and Jochen Musseler, Amsterdam: Elsevier, 371-87.
- Yalch, Richard F. and Eric R. Spangenberg (1990), "Effects of Store Music on Shopping Behavior," *Journal of Consumer Marketing*, 7 (2), 55-63.
- \_\_\_\_\_ (2000), "The Effects of Music in a Retail Setting on Real and Perceived Shopping Times," *Journal of Business Research*, 49 (August), 139-47.