



The Society of
Light and Lighting

Impact of lighting design on brand image for fashion retail stores

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This paper analyses the influence of fashion retail store lighting on the brand classification and brand personality. Four different interiors with four specific light scenes were combined to form 16 different scenes. The fashion retail stores include stereotypes for low budget, colour, black box and minimalism, and lighting scenes with general lighting, vertical illumination, accent lighting and projection. The results revealed that the lighting had an impact on the brand classification with regard to the factors of social status and value orientation and on the brand personality with regard to the factors of temperament, competence, attractiveness and naturalness. The economic analysis of price perception in relation to investment or operating costs does not show significant correlations.

1. Introduction

Studies in building history and architecture theory reveal that companies make use of architectural design and symbols to communicate their brand identity.^{1–4} Consistent design concepts for a brand's retail outlets help a company to form a uniform image to convey a clear brand identity to the consumer. The aspect of lighting design as a part of corporate visual guidelines is relatively new in contrast to interior design elements such as colour, material and furniture, which were established within corporate visual guidelines in the 1960s.^{5–7}

In marketing, a brand is regarded as 'a name, term, sign, symbol or design, or a combination of them, intended to identify the goods or services of one seller or group of

sellers and to differentiate them from those of competitors', following the definition of the American Marketing Association.⁸ Therefore, the aim of a brand communication strategy by a company as the sender is to create a brand image in the mind of the customer as the receiver. This study focuses on fashion retail and respective differences in the corporate visual identities within this market segment.

Store design as one aspect to amplify brand image and identity plays a vast role in today's retail environment. In consumer-based cultures, people often try to identify themselves via the products they buy.⁹ Thus, it becomes a challenge for retailers and brands to represent themselves within their own communicable image.¹⁰

The so-called visual identity of a brand¹¹ as well as the actual personality of a brand¹² is a long-known characteristic when it comes to conveying a certain shopping experience and increasing sales. However, there is not much solid research available regarding the link

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between various lighting techniques and different brand image factors.

2. Theoretical background

The lighting is comprehended as the message of a brand, which has an impact on the appearance of architecture and the brand communication. Therefore, the theoretical background includes marketing with brand identity and two models for brand classification as well as retail lighting design. The first two-dimensional model for brand classification originates from sociology, and the second one derives from marketing with four factors for brand personality. These models are applied to different lighting situations to evaluate the impact on brand perception (see Table 1). The lighting as a cause for brand effects is analysed from both a perception and a technical point of view.

To convey a clear brand identity to the consumer,¹³ consistent design concepts for retail outlets help a company to form a

uniform image. The built interior and exterior environment belongs to traditional media that enhances the communication of an identity. So, the space becomes an important element to influence consumer behaviour.^{14,15} For Melewar,¹⁵ visual identity consists of three factors: the strategy of how an organisation wishes to identify with its customers, the management of influencing images and the visuals themselves as effective vehicles. Lighting as part of the technical building infrastructure is not only an element to allow visibility of the environment but is also a form giver for architecture.^{16,17} If lighting could create a distinctive appearance, it could be considered as a potential medium for the visual brand identity. Focusing on the visual dimension of corporate communication, Herbst² points out lighting recommendations for the presentation of companies, for example: interesting facade illumination, attractive lighting for exhibitions, dynamic and unusual lighting for product presentation. These proposals exceed the conventional visibility of buildings and products and involve a

Table 1 Overview of factors and items for experiments with literature

Model	Factor	Item	Literature
Light	Brightness	Bright	Loe <i>et al.</i> ⁶¹
	Uniformity	Dark	Loe <i>et al.</i> ⁶¹
		Non-uniform light	
	Colour temperature	Uniform light	Tiller and Rea ⁶²
Social milieu	Chromaticity	Cold	Tiller and Rea ⁶²
		Warm	
	Price	Coloured	Tiller and Rea ⁶²
		Colourless	
Brand personality	Style	Low budget	Becker and Nowak ²²
		High class	
	Temperament	Traditional	Raffelt ³¹
		Modern	
	Competence	Smart	
		Progressive	
	Attractiveness	Reputable	
		Competent	
	Naturalness	Glamorous	
		Elegant	
		Close to nature	
		Natural	

symbolic usage of lighting for brand communication. Consequently, lighting can be regarded as a part of the architecture within the overall corporate design and corporate identity, respectively. Besides the store design, other factors such as corporate social responsibility, reputation, service level, the salespeople, the products and price perception are important factors to determine the overall personality of a store.¹⁸ Retail lighting also affects atmosphere with factors such as cosiness, liveliness, tenseness and detachment and thereby shifts the emphasis of lighting to mean more than a factor of visibility.¹⁹ To evaluate a possible benefit of lighting for marketing, this study concentrates on classifications for brand communication instead of the atmosphere, mood or on Kaplan's environmental dimensions of complexity, mystery, coherence and legibility.^{20,21}

For brand classification, a two-dimensional milieu study exists, which derives from sociology and focuses on social status and value orientation.²² The model is based on the sinus milieus that were developed by Sinus Sociovision in the 1980s for Germany, which have been adjusted for several countries and used for various market segments.²³ Critics of the social milieu model addressed the issue of inner consistency and the separation effect of the milieu groups.²⁴ Nevertheless, this approach is widely used for research and for economic purposes.^{25–27} Different types of lighting have an effect on the evaluation of social status and value orientation.²⁸ The study by Schielke²⁸ presents a first step to analyse the relation between lighting design and marketing. It used lighting visualisations with eight light scenes for one interior design and included a correlation analysis for the two-dimensional social status and value-orientation model, but did not include a brand personality model. The results revealed that value orientation shows a strong correlation with uniformity and brightness. The study also presented store

situations with and without visible luminaires that have the same lighting effects and led to a similar evaluation. Thereby, the experiment leads to the assumption that the lighting alters the brand perception and that the luminaires as design objects do not have a significant effect in this case. Furthermore, noteworthy cultural differences between regions such as Europe, America and the Middle East were not detected in regard to the light and brand evaluation of the different light scenes.

Next to the broad application of the Sinus milieus from sociology, marketing provides a valuable evaluation model, which focuses on brand personality, and has been applied to products and architecture. The brand personality was discussed intensively by Aaker¹² for the American market. She defines it as the 'set of human characteristics associated with the brand', with five dimensions that include sincerity, excitement, competence, sophistication and ruggedness.¹² Mäder²⁹ adapted Aaker's¹² concept for the German culture, and another research group evaluated Aaker's¹² five dimensions for their applicability to brand shops.³⁰ Due to possible cultural differences between America and Germany regarding the evaluation of brand personality, Raffelt³¹ derived, from literature and through tests, a scale for empirical studies about architectural design for branding in Germany. She developed a psycho-lexical inventory to cover the design dimensions, which determine the architectural expression as well as the relevant brand-related response dimensions. Raffelt³¹ has a marketing-oriented perspective and examines branding literature, whereby she links prototypical design types in architecture to brand impressions. She judged a four-factor solution as the most adequate for capturing the data and explaining more than 80% of the brand personality variances: Temperament, competence, attractiveness and naturalness. These four factors are based on 4–17 variables and are documented with the respective loadings.

In order to analyse the sociological dimension as well as the marketing perspective of different retail lighting situations, both models were considered for the present experiments with their corresponding indexes: (a) price, (b) style, (c) temperament, (d) competence, (e) attractiveness and (f) naturalness.

Conventional parameters such as horizontal illuminance are regarded as insufficient to describe lighting situations, and therefore the assessment of light arriving at the eye has been added.³² For that reason, the study includes not only a technical viewpoint with different light distributions but also the perceived light in relation to the above-mentioned brand indexes. Unfortunately, the lighting literature does not yet provide details of in-depth relationships between subjective response to brightness, contrast, colour temperature and colour and the discussed brand indexes. However, the literature for retail lighting includes various aspects of quantitative and qualitative research as well as guidelines for structuring the space, highlighting objects, creating an attractive atmosphere and ensuring good visual performance.^{19,33–38} Nevertheless, brightness is one of the most researched lighting variables. Flynn³⁹ observed that bright spaces appear significantly clearer and more spacious in comparison to darker situations. Indirect lighting based on wallwashing leads to an intense brightness perception.⁴⁰ A positive relationship between brightness and a high-pleasure impression has been documented in experiments.⁴¹ Customers examine more products under bright versus soft lighting,⁴² which could be linked to attractiveness. But high-brightness levels are also associated with lower price and quality perception.⁴³ Additionally, a very bright environment could imply negative effects such as glare.^{17,44} However, a bright environment could also be regarded as an association with daylight and naturalness in combination with corresponding colour temperature and

colour rendering. The hypothesis is generalised for all parameters:

H1: Higher-perceived brightness leads to a lower value for (a) price and higher values for (b) style, (c) temperament, (d) competence, (e) attractiveness and (f) naturalness.

From the perspective of lighting technology, it would be interesting if a change in the lighting concept from ambient lighting to accent lighting or another type of lighting could achieve a significant change in the brand image. The lighting concept is regarded as a light pattern that could have an effect on brand indexes. Theories from visual perception could additionally provide the explanation as to how visual patterns are interpreted.⁴⁵ Theories on texture, feature integration and perceptual constancy, in particular, offer a basis for analysing the dominance of light or spatial patterns and their interaction.^{46–48} From the semiotics perspective, architectural pattern can also be regarded as a symbol.⁴⁹ The architecture as well as the light pattern would then be used as a message from a company to the customer in the retail outlet. Specific lighting concepts could facilitate an individual brand message. For a description of different types of lighting, a perception-oriented method is applied by Kelly¹⁶ with three categories: focal glow, ambient luminescence and play of brilliants. Accent lighting with a narrow luminous intensity distribution curve could generate a hierarchy in perception. Wide, rotationally symmetrical lighting distributions from downlights (DL) enable the perception of a space in general and could be regarded as ambient luminescence. An alternative option for an ambient luminescence could be vertical illumination. Kelly's third category is not linked to functional aspects and regards light itself as important information. Effects of coloured light or gobo projections provide light patterns for decorative purposes that embed a narrative component in the lighting setting. With regard to colour temperature,

a cool and bright ambient horizontal lighting with DL is linked to low-budget environments.⁵⁰ This study by Briand and Pras⁵⁰ used photos and three independent variables: light settings (bright versus soft light), perceived temperatures (cool versus warm colour temperature) and types of retail outlets (jeans, books or furniture). The limitations of this experiment can be seen in the limited number of variations within the variables and the lack of a real environment. The hypothesis is set as:

H2: Ambient horizontal lighting leads to lower values for (a) price, (b) style, (c) temperament, (d) competence, (e) attractiveness and (f) naturalness when compared to wallwashing, accent lighting and gobo projection.

The question of economics plays a vast role during the design process with regard to managing the investment and operating costs as well as achieving lighting quality.^{51–53} Given that brightness – meaning, in this case, high-energy consumption – might not be an indicator for the actual price perception in a store, the question arises whether this can also be true with regard to the total costs of a lighting concept. As a consequence, the hypothesis is assumed as follows:

H3: The (a) investment and (b) operating costs of a store's lighting do not correlate with the price perception.

3. Method

To examine the hypothesis that changing the lighting concept is sufficient to change the brand image of a space, an empirical investigation was conducted with a mental assessment test.⁴⁴ To obtain an evaluation of four different light settings and four room situations, the test participants were asked to judge light and brand issues. A seven-level Likert scale was used to quantify the visual scene and subjective reactions with 'completely disagree' and 'completely agree' at

the respective ends of the axis and a 'neutral' in the middle of the scale. The Likert scale has been widely used for experiments, and numerous studies exist, which discuss the reliability, validity and the optimum number of points.^{54–57} Studies with more alternative options for answers show a significant increase in reliability and validity up to seven points. More points within the scale do not lead to a significant quality improvement for the measurement.^{58–60} In total, 20 items were measured (see Table 1). The light was evaluated through the four factors of brightness, uniformity, colour temperature and chromaticity via the following eight items: Bright, Dark, Non-uniform light, Uniform light, Cold, Warm, Coloured and Colourless. Brightness could be determined technically with luminance (cd/m^2), but for the subjective evaluation of lighting simulations on a monitor, the terms 'Bright' and 'Dark' were used, as in similar experiments, as the perceived amount of light in a space.⁶¹ 'Non-uniform light' and 'Uniform light' were utilized in preceding experiments for the factor contrast as well as 'Cold', 'Warm', 'Coloured' and 'Colourless' for colour temperature and chromaticity, respectively.^{61,62}

With regard to the brand image, two different models were considered: social milieus and brand personality. For brand classification, a two-dimensional social milieu study exists, which focuses on social status and value orientation.²² For price index as an indicator for social status, 'Low budget' and 'High class' are used as items in accordance with the Sinus social milieu categories of lower, middle and higher. The style as a marker for value orientation consists of the items 'Traditional' and 'Modern' linked to the Sinus categories of tradition, modernisation and re-orientation. The term re-orientation was excluded due to understanding problems in a pretest.

Raffelt's value sets³¹ with four dimensions consisting of 44 variables for brand

personality were reduced to the two highest variable loadings of each dimension to enable the planned light experiment with eight scenes in an adequate time period without fatigue. Each of the four brand dimensions by Raffelt³¹ were therefore evaluated with two items: smart and progressive for temperament, reputable and competent for competence, glamorous and elegant for attractiveness, close to nature and natural for naturalness.

Based on four store stereotypes, four lighting concepts were designed, each related to one store stereotype. The approach with the four different store types offers a useful basis to compare the interaction with different interior designs in contrast to various studies, which analyse only one interior design type and thereby reduce the chance to generalise

the findings. To enhance the visual perception of these spaces with regard to the further process, a 3D-lighting calculation programme was applied to create visualisations for each space (see Figure 1). For reasons of comparison, all store stereotypes were combined with each light scene, which means 16 different scenes were generated. The simulations were embedded in an Internet-based survey to give participants from different countries easy access to the experiment.

4. Experiment

Considering the evolution and resulting diversity in the area of interior spaces dealing with a brand image, for reasons of clarity and expense, the study was geared to fashion



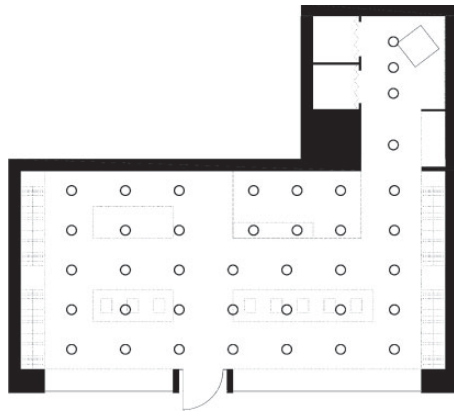
Figure 1 Store types and light scenes: low budget (L), minimalism (M); black box (B); colour (C); downlights (DL), wallwashing and accent lighting (WW), accent and grazing lighting (AG) and accent lighting and projection (AP)

Table 2 Store stereotypes with essential terms and literature

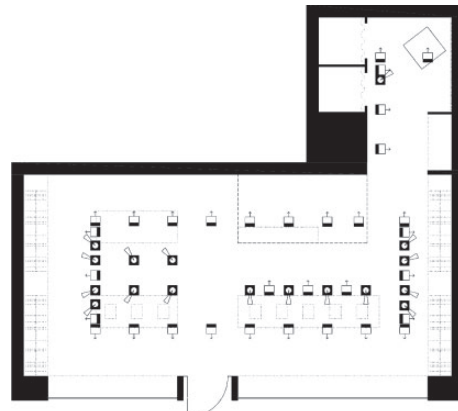
Store type	Low budget	Minimalism	Black box	Colour
Terms	-No-design-store -Ready made -Functional -Fast fashion fix -Simple -Flexible	-Clean -White -Spacious -Minimal -Exclusive -Elegant	-Dark -Dramatic -Stage-like	-Innovative -Colour -Sophisticated -Hip -Fun -Fantasy
References	Bork ⁶⁵ Colborne ⁶⁶ Manuelli ⁶⁷ Baker <i>et al.</i> ⁶⁸	Bork ⁶⁵ Bingham ⁷² Bonet ⁷³ Manuelli ⁶⁷	Gardner and Hannaford ⁷⁰ Fitch ⁷¹	Bork ⁶⁵ Bingham ⁷² Bonet ⁷³ Sandu ⁶⁹

stores. Owing to its reduction to the essence of only one identity and brand,⁶³ the paper was further confined to single-brand stores.⁶⁴ Based on a thorough review and analysis of architecture and store design literature, four abstract store concept stereotypes, covering the main reach of store stereotypes, were created: Low Budget (L), Colour (C), Black Box (B) and Minimalism (M) (see Table 2 and Figure 1). The interior design of the low-budget store consisted of two high, densely filled shelves at two walls and five filled shelves in the centre, together with a simple counter and a decoration point.^{65–68} The colour type used round wall openings for the textiles in combination with round displays in the centre and a curved counter element in combination with partial magenta colour.⁶⁹ The black box had wall-recessed clothes rails with low furniture in the centre together with a table as a counter.^{70,71} The whole environment had a black surface. Three simple boxes as displays in the centre and two clothes rails in front of two walls formed the image for the minimalist stereotype together with a rectangular counter area.^{72,73} Based on the fact that a different context of textures and materials leads to different evaluations of the visual identity,⁷⁴ it was expected that the results would vary for the different interior designs.

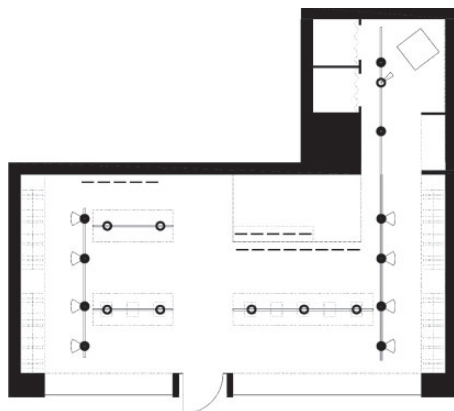
The respective lighting design for the four stereotypes was based on visual perception theories¹⁷ and qualitative lighting design guidelines, which, to some extent, also involve retail lighting.^{35,36,53,75–79} The guidelines by Lou⁷⁷ include lighting the spatial envelope, lighting forms in space and connecting spaces with light. The lighting for the low-budget stereotype was based on a uniform lighting design with recessed DL to enhance a functional and simple appearance (see Figures 2 and 3). This DL technique is partially associated with being too bland and lacking visual excitement.³⁶ The minimalist concept used recessed DL and wallwashers (WW) for an even illumination of the horizontal and vertical surfaces.⁸⁰ With regard to wallwashing, Kellogg lists four effects: directionality for the space, objects on the wall are drawn together because they share the same light, large quantities of indirect light are bounced into the space and the texture of the walls seems flattened.³⁶ The black box design consisted of accent and grazing light (AG) by track-mounted luminaires to also create an intense contrast. In contrast, accent lighting and coloured projection (AP) on track-mounted luminaires create effect lighting for the colour shop concept. This highlighting technique is known for drawing attention and determining where people will move.³⁶ Yellow



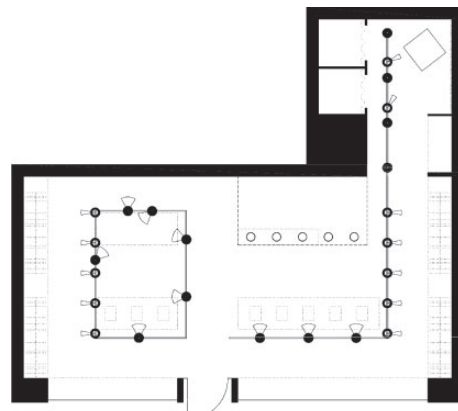
Light scene: Downlights



Light scene: Wallwashing and accent lighting



Light scene: Accent and grazing lighting



Light scene: Accent lighting and projection

Figure 2 Store-type low budget with luminaire arrangements: downlights (DL), wallwashing and accent lighting (WW), accent and grazing lighting (AG) and accent lighting and projection (AP)

is used for the projection due to a visual distinction towards the other interior colours, without causing strong irritating colour contrasts with the two warm colours. A good visual performance at the counter with the cash box was supported either with general lighting from DL or with accent lighting. In regard to a good visibility of the fashion product, the textiles were illuminated either with DL, spotlight or WW.

The visualisations (800 × 305 px) for the online survey were based on DIALux, using

digital luminaires with integrated geometry and IES data format (see Figure 4). The participants received an email with a link to the survey. The online survey started with a general information, followed by the eight light scenes, and was finished with a page for personal data. For easy and quick access to the survey, the test persons were allowed to use their personal computer monitors for the evaluation. Figure 2 documents the layout of the luminaires for the various store types, and Figure 3 lists the different luminous

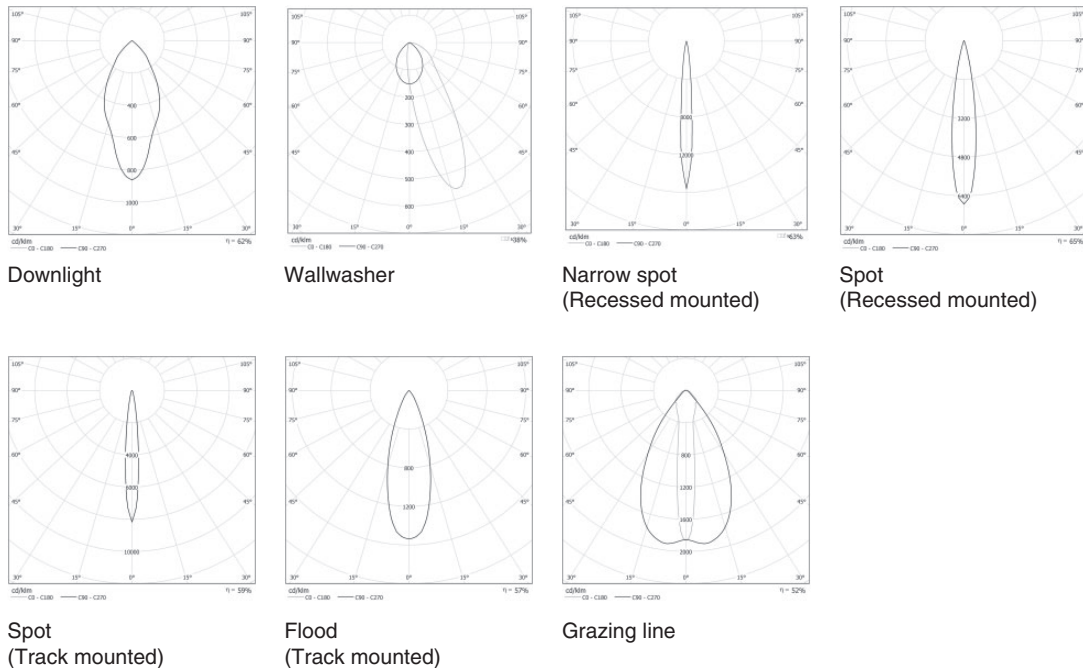


Figure 3 Luminous intensity distribution curves of selected luminaires used in simulations (cd/klm): C0-C180 (black line) and C90-C270 (grey line)

intensity-distribution curves. All luminaires were mounted in the ceiling or as track-mounted fixtures. The gobo projection for the scene accent lighting and coloured projection (AP) was realised with photo editing software.

The histogram statistics enable an objective description for example of the image brightness in relation to the subjective evaluation by the observers in order to analyse the consistency between these two values (see Table 3). The brightness mean represents the average value for the three colour channels – red, green and blue, these values ranging from the value 0 for black to 255 for white. The standard deviation reveals how widely these intensity values vary and thereby indicate the contrast within an image. In this context, the value 0 represents uniformity and the value 127 an intense black and white contrast. The brightness mean for selected layer like blue and red points allows a consistency analysis

regarding the colour temperature. Lighting simulations have been positively evaluated with regard to precision for general lighting-design applications.⁸¹ Additionally, studies have revealed that images can reliably present lighting features of real spaces.^{82–86} The quality of the lighting depends on material assignment, the software algorithm, the display and the precision of the modelling between realistic and abstraction.^{87,88} Nevertheless, high contrasts, glare and brilliance are critical aspects for the visualisation because monitors cannot display the real luminance contrast. Furthermore, with two-dimensional image techniques, test participants are not able to walk through the illuminated room to include a more differentiated spatial experience.


The sample consisted of a total of 119 people, divided into 51 for group 1 (store types low budget and colour) and 68 for group 2 (store types black box and

KTH: Perception of Space 0

0% 100%

English

Space 07



How do you perceive the above shown store atmosphere?

	strongly disagree			neutral			strongly agree	No answer
Bright	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Close to nature	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cold	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Modern	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Natural	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Non-uniform light	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Warm	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Traditional	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
High class	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dark	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Uniform light	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Colourless	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Glamorous	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Confined	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Competent	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Elegant	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reputable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Smart	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Spacious	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Low budget	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Coloured	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Progressive	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Resume Later

<< Previous Next >>

[Exit and Clear Survey]

Figure 4 Screenshot of the online survey with a simulation and items

minimalism). The splitting into two groups was undertaken to avoid fatigue for the participants with a long evaluation time, which was about 20–25 minutes for the chosen approach. A task to calibrate the measurement by the participants with an introduction and a subsequent test to check the successful learning was dismissed in order to avoid a longer test period with possible fatigue and reduced motivation. Each group received a white scene as standard (store types low budget and minimalism). The two sequences of the light scenes were presented

in a similar way with each having a continued alteration of the two store types for group 1 (M_AG, B_AP, M_DL, B_WW, M_AP, B_DL, M_WW, B_AG) as well as for group 2 (L_AG, C_WW, L_DL, C_AP, L_WW, C_DL, L_AP, C_AG). The age range was 18–64 years with 34% male and 66% female participants (see Tables 4 and 5). According to the given personal data, 60% had their main residence in Germany, 28% in Europe and 10% outside Europe. And 39% of the survey participants were students, 61% were in employment, 30% of the people had a

Table 3 Histogram statistics for visualisations

Scene	RGB mean	RGB deviation	Blue mean	Red mean
L1	132.59	52.20	134.90	130.80
L2	147.45	62.26	149.60	145.61
L3	67.55	39.46	68.16	66.95
L4	131.27	57.85	131.18	130.70
L5	137.35	40.51	140.68	135.01
L6	157.00	43.77	161.14	154.17
L7	79.73	29.13	81.35	78.41
L8	134.89	47.84	135.22	134.18
L9	45.04	64.63	38.80	48.51
L10	48.77	48.85	43.43	51.47
L11	26.65	42.08	24.08	28.04
L12	26.65	42.08	24.08	28.04
L13	142.99	38.02	141.97	169.43
L14	160.66	65.37	160.03	183.47
L15	96.94	49.29	94.21	117.01
L16	138.96	52.25	135.24	167.47

Table 4 Overview of personal data for groups 1 and 2

	Gender		Age		
	Male	Female	Mean	Min	Max
<i>Group 1</i>					
Germany	11	17	33	21	64
Europe	8	8	32	21	52
Beyond Europe	1	6	30	22	45
Total	20	31	32	21	64
<i>Group 2</i>					
Germany	12	32	35	18	64
Europe	6	11	32	21	46
Beyond Europe	3	4	23	21	26
Total	21	47	33	18	64

background in architecture, 19% in lighting design and 51% came from other fields. This configuration with only a small group of lighting design people avoided a dominant role of lighting experts who might evaluate situations differently in comparison to people who are not trained in lighting. The fact that half of the people had training in visual analysis due to their architecture and lighting design experience provided a good basis for a differentiated evaluation. At the same time, the constellation of 51% people from other backgrounds gave considerable attention to the judgment of normal consumers without a specialisation in visual fields. The degree of realistic impression of the lighting simulations was evaluated as 5.22 on a seven-point Likert scale with 1 for 'strongly disagree' and 7 for 'strongly agree'. This aspect was listed at the end of the questionnaire in combination with other information for the personal data. The Cronbach-Alpha score for the four light indices and the six brand indices was about 0.6. Only three situations for the index contrast and one index for style were below 0.3.

5. Results

For hypothesis 1, a simple linear regression analysis was calculated for each group (see

Table 5 Overview of profession and background data for groups 1 and 2

	Profession		Background			
	Students	Working people	Architecture	Lighting design	Retail	Other
<i>Group 1</i>						
Germany	8	18	4	4	0	18
Europe	6	10	5	1	1	9
Beyond Europe	5	1	3	3	0	1
Total	19	29	12	8	1	28
<i>Group 2</i>						
Germany	14	29	13	6	0	23
Europe	6	10	8	2	1	5
Beyond Europe	5	2	1	6	0	0
Total	25	41	22	14	1	28

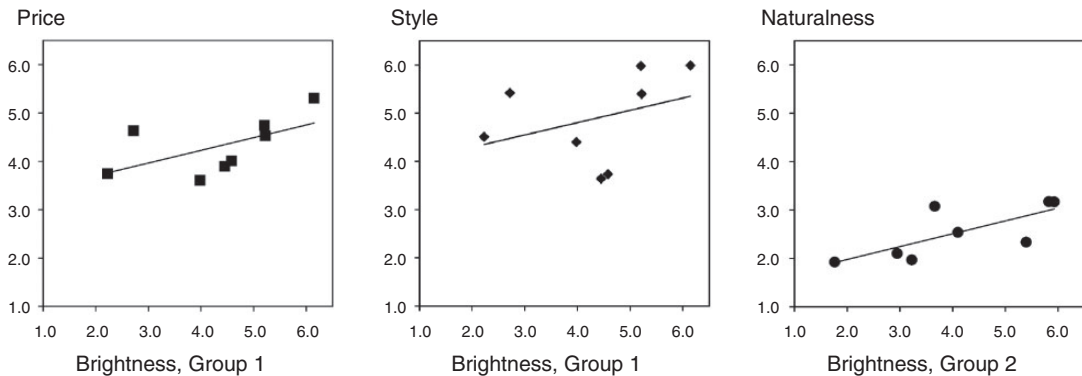


Figure 5 Results of regression analysis. Brightness as a predictor for price, style and naturalness.

Figure 5 and Table 6). For group 1, the perceived brightness exists as a predictor for price and style. A higher-perceived brightness level leads to a higher price perception: $B(SF) = 0.57$ (0.17), $\text{Exp}(B) = 0.43$, $p < 0.01$, adjusted $R^2 = 0.17$. A positive relationship can be observed for style as well, which means that a higher-perceived brightness is linked to a more modern impression: $(SF) = 0.44$ (0.17), $\text{Exp}(B) = 0.34$, $p = 0.01$, adjusted $R^2 = 0.10$. Group 2 has perceived brightness as a predictor for naturalness. A higher brightness gives rise to a higher index for naturalness: $(SF) = 0.31$ (0.14), $\text{Exp}(B) = 0.26$, $p = 0.04$, adjusted $R^2 = 0.05$. The result for hypothesis H1 shows that for group 1, counter-evidence could be delivered for (a) price and a confirmation for (b) style: higher-perceived brightness creates a higher price perception and a more modern image. For group 2, only (f) naturalness could be confirmed with regard to hypothesis H1: higher-perceived brightness generates a more natural image. The other three light factors with perceived uniformity, colour temperature and chromaticity were analysed as predictors for the social milieu and brand personality as well but no significant results were noted for the tested light scenes and interiors. The comparison of the results by groups 1 and 2 did

not show similar effects. Therefore, a generalisation for all four types is not possible even though the comparison of two store types presented similar effects. The individual identity of the four interior designs could be observed when compared to the same light scene (see Figure 6). Owing to the dark body colour for the walls in the store type 'Black Box', the perceived brightness evaluation included the lighting as well as the dark body colour. For analysing the relation between the objective histogram statistics of the visualisations and the subjective evaluation of brightness, a correlation test was done. The Spearman-Rho correlation was significant at the 0.01 level (two-tailed) at 0.82, and thereby a close connection between the image brightness and the perceived brightness could be detected.

For proving hypothesis 2, a Friedman test was carried out with Bonferroni correction because a normal distribution was mainly not given. Because of the multiple comparisons, the initial significance level was divided into three tests per brand index ($0.05/3 = 0.02$). The Friedman test was performed for each group separately (see Table 7). Significant differences occurred for the 'low budget' space in terms of style, competence and naturalness. The 'colour' space showed

Table 6 Descriptive statistics: mean (M) and standard deviation (S) for light scenes L1–L16

	Scene Store Lighting	L1 L DL	L2 L WW	L3 L AG	L4 L AP	L5 M DL	L6 M WW	L7 M AG	L8 M AP
Brightness	M	4.6	4.4	2.2	4.0	5.9	5.8	2.9	5.4
	S	1.3	1.6	1.2	1.2	1.0	1.3	1.4	1.2
Uniformity	M	3.5	3.2	4.8	5.5	2.6	2.3	5.1	5.5
	S	1.3	1.4	1.5	0.8	1.4	1.1	1.6	1.1
Colour temp.	M	3.4	3.2	3.0	3.7	3.4	3.2	2.9	3.5
	S	1.4	1.2	1.4	1.2	1.2	1.3	1.3	1.2
Chromaticity	M	3.0	2.5	2.5	4.0	2.6	2.5	2.2	4.4
	S	1.4	1.3	1.1	1.4	1.2	1.2	1.3	1.2
Price	M	4.0	3.9	3.7	3.6	4.7	4.6	5.5	3.8
	S	1.5	1.5	1.7	1.5	1.5	1.6	1.2	1.4
Value orientation	M	3.7	3.6	4.5	4.4	4.3	4.5	5.7	4.8
	S	1.5	1.3	1.5	1.4	1.4	1.4	1.2	1.3
Temperament	M	3.2	3.1	3.7	3.7	3.5	3.3	4.0	3.7
	S	1.3	1.3	1.4	1.4	1.3	1.3	1.2	1.5
Competence	M	4.3	4.5	4.0	3.5	4.8	4.6	5.1	3.7
	S	1.2	1.2	1.4	1.4	1.2	1.4	1.2	1.5
Attractiveness	M	3.4	3.2	3.4	3.0	3.8	3.8	4.9	3.1
	S	1.4	1.4	1.5	1.3	1.5	1.6	1.3	1.4
Naturalness	M	2.8	2.9	2.2	2.4	3.2	3.2	2.1	2.3
	S	1.4	1.3	1.1	1.1	1.5	1.6	1.0	1.2
	Scene Store Lighting	L9 B DL	L10 B WW	L11 B AG	L12 B AP	L13 C DL	L14 C WW	L15 C AG	L16 C AP
Brightness	M	4.1	3.7	1.8	3.2	5.2	6.1	2.7	5.2
	S	1.6	1.6	1.1	1.3	1.3	0.9	1.4	1.2
Uniformity	M	3.8	3.7	5.1	5.5	4.0	3.3	4.6	5.5
	S	1.5	1.5	1.6	1.1	1.4	1.4	1.6	1.1
Colour temp.	M	3.7	4.8	3.7	4.0	5.0	5.3	4.7	5.2
	S	1.4	1.3	1.5	1.2	1.3	1.2	1.3	1.3
Chromaticity	M	3.1	4.2	3.4	4.7	5.9	6.1	5.0	6.3
	S	1.1	1.5	1.4	1.3	1.0	0.9	1.2	0.9
Price	M	4.5	5.6	4.8	4.7	4.5	5.3	4.6	4.7
	S	1.6	1.1	1.4	1.5	1.5	1.2	1.4	1.5
Value orientation	M	4.7	5.1	5.3	5.7	5.4	6.0	5.4	6.0
	S	1.3	1.2	1.2	1.0	1.2	0.9	1.0	1.0
Temperament	M	3.6	4.6	4.1	4.6	4.6	5.7	4.6	5.3
	S	1.4	1.1	1.4	1.3	1.4	0.9	1.3	1.3
Competence	M	4.4	5.2	3.9	4.4	4.3	4.9	4.3	4.3
	S	1.3	1.1	1.3	1.3	1.3	1.0	1.3	1.4
Attractiveness	M	4.0	5.1	4.4	3.9	4.2	4.8	4.4	4.5
	S	1.7	1.4	1.6	1.5	1.4	1.3	1.4	1.7
Naturalness	M	2.5	3.1	1.9	2.0	2.3	2.3	2.4	2.3
	S	1.4	1.5	1.1	1.0	1.1	1.2	1.1	1.2

significant differences for price, style, temperament and competence. For the ‘minimal’ interior, a significant difference existed for price, style, competence, attractiveness and naturalness. The ‘black box’ type showed significant differences for price, temperament,

competence, attractiveness and naturalness. As a result, the hypothesis was proved for ‘black box’ in all aspects from (a) to (e) and counter-evidence provided for (f) style. For ‘minimalism’, the hypothesis could be confirmed for (b), and the contrary for (d) and (e)

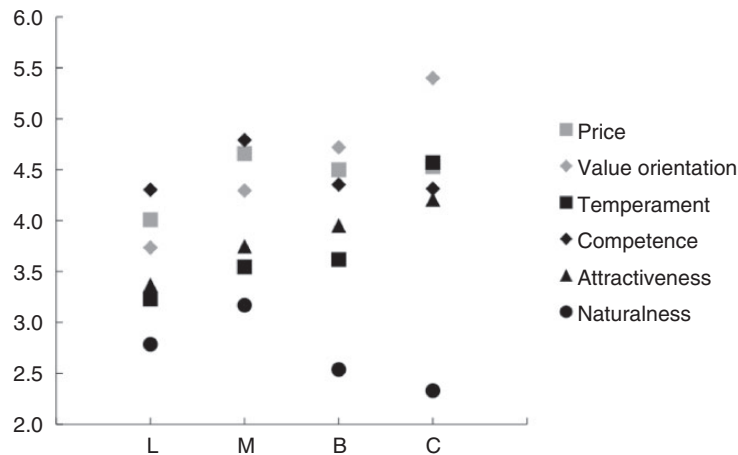


Figure 6 Comparison of four store types for light scene downlights (DL) and brand factors: low budget (L); minimalism (M); black box (B); colour (C)

Table 7 Friedman test with Bonferroni correction

Store	Index	Scene	Index	Scene	Lighting	Index
<i>Group 1</i>						
L	Style	L1	3.74	L3	AG	4.51
L	Style	L1	3.74	L4	AP	4.40
L	Competence	L1	4.30	L4	AP	3.51
L	Naturalness	L1	2.79	L3	AG	2.20
C	Price	L13	4.53	L14	WW	5.31
C	Style	L13	5.40	L14	WW	5.99
C	Style	L13	5.40	L16	AP	5.98
C	Temperament	L13	4.57	L14	WW	5.67
C	Temperament	L13	4.57	L16	AP	5.26
C	Competence	L13	4.31	L14	WW	4.86
<i>Group 2</i>						
M	Price	L5	4.66	L7	AG	5.53
M	Price	L5	4.66	L8	AP	3.78
M	Style	L5	4.30	L7	AG	5.66
M	Competence	L5	4.79	L8	AP	3.68
M	Attractiveness	L5	3.75	L7	AG	4.95
M	Attractiveness	L5	3.75	L8	AP	3.08
M	Naturalness	L5	3.17	L7	AG	2.10
M	Naturalness	L5	3.17	L8	AP	2.34
B	Price	L9	4.50	L10	WW	5.62
B	Style	L9	4.72	L11	AG	5.31
B	Style	L9	4.72	L12	AP	5.69
B	Temperament	L9	3.62	L10	WW	4.58
B	Temperament	L9	3.62	L12	AP	4.64
B	Competence	L9	4.35	L10	WW	5.18
B	Attractiveness	L9	3.95	L10	WW	5.11
B	Naturalness	L9	2.54	L10	WW	3.08
B	Naturalness	L9	2.54	L11	AG	1.92
B	Naturalness	L9	2.54	L12	AP	1.97

Comparisons of lighting scenes per store type and index (significance level 0.016). For details of light scenes, see Table 2.

was proved. For 'colour', the hypothesis for (a) to (d) was verified. For 'low budget', the hypothesis was confirmed for (b) and counter-evidence given for (d) and (f). This analysis shows that comparing ambient horizontal lighting with DL significantly affects multiple brand indexes when compared to wallwashing and accent lighting. In general, when all four store types are taken together from groups 1 and 2, the DL illumination leads to lower values for (b) style and partly for (a) price and (c) temperament. Higher values occur with DL in part for (f) naturalness.

For hypothesis 3, the calculations for the lighting costs were based on DIN 5035 part 1,⁸⁹ 3500 h/year as the estimated operating time for luminaires in retail lighting, with price information produced by lighting

companies in 2011 (Table 8). Due to the present price levels in Germany, the price per kilowatt-hour was estimated at 0.17 Eur/kWh throughout all calculations. To establish the total operating costs, the investment costs – which include interest and amortisation for each luminaire and other components at 10% per year – were included as were estimated costs for maintenance, light sources and electricity. The costs for the different interior designs with regard to the furniture were not part of the study. After calculating the lighting costs per year of all scenes separately, a correlation analysis was conducted to find out more about how and to what extent the two factors of evaluated price perception and actual operating costs per year were connected to each other. The minor differences within one lighting concept appeared due to

Table 8 Costs of lighting based on DIN 5035

Store type		M	B	C	L
Lighting		WW	WW	WW	WW
Scene		L6	L10	L14	L2
Overall power consumption	P (W)	2133	2091	1896	1839
Investment costs	EUR	21321.49	20888.59	19794.32	19128.80
Overall costs per year	EUR/a	4040.03	3960.61	3606.27	3483.07
Overall costs per metre square and year	EUR/(m ² a)	74.65	73.18	66.63	64.36
Store type		M	B	C	L
Lighting		DL	DL	DL	DL
Scene		L5	L9	L13	L1
Overall power consumption	P (W)	1722	1722	1722	1722
Investment costs	EUR	14 142.80	14 142.80	14 142.80	14 142.80
Overall costs per year	EUR/a	2999.34	2999.34	2999.34	2999.34
Overall costs per metre square and year	EUR/(m ² a)	55.42	55.42	55.42	55.42
Store type		M	B	C	L
Lighting		AG	AG	AG	AG
Scene		L7	L11	L15	L3
Overall power consumption	P (W)	738	738	813	885
Investment costs	EUR	15 349.32	15 349.32	17 382.78	18 207.55
Overall costs per year	EUR/a	2378.69	2378.69	2634.82	2849.90
Overall costs per metre square and year	EUR/(m ² a)	43.95	43.95	48.68	52.66
Store type		M	B	C	L
Lighting		AP	AP	AP	AP
Scene		L8	L12	L16	L4
Overall power consumption	P (W)	940	1168	1378	1141
Investment costs	EUR	17984.10	20284.10	26256.30	18486.60
Overall costs per year	EUR/a	2718.63	3134.54	3889.62	2933.25
Overall costs per metre square and year	EUR/(m ² a)	50.23	57.92	71.87	54.20

Store types: low budget (L), colour (C), black box (B), minimalism (M). Lighting: wallwash (WW), accent and grazing light (AG), downlights (DL), accent and projection lighting (AP).

the adaption to the four different interior styles. The result of the Pearson correlation analysis for evaluated price perception and actual operating costs per year of 0.21 ($p=0.44$, two-tailed) indicated no significant correlation between both terms, and therefore the hypothesis can be regarded as true ($N=16$). The respective correlation analysis for price perception and electrical power (0.17, $p=0.53$) or investment costs (0.11, $p=0.69$) revealed no significant relations as well.

6. Discussion

Since the body of research in the field of light, store design and branding is still small, this paper contributes to the limited literature about testing the impact of lighting concepts on the brand image. This study offers experts in lighting and marketing a better understanding of the relationship between architectural lighting and brand communication and establishes a connection between these two fields. Owing to the experimental setup with two brand models, this paper provides links to a sociologically oriented discussion as well as to a brand personality-driven debate. Given that not all brand effects point in the same direction with a specific lighting concept, the study indicates that the design teams need to balance the diverse implications for their individual brand communication strategy. The consideration of four distinct store types and four types of lighting enables a differentiated view for the generalisation in comparison to various experiments with only one interior design or just two alternative lighting settings. With the additional economic perspective with regard to the perceived price image and the total lighting costs, this paper offers an attractive analysis for implementation in day-to-day business. Interior lighting alone may not have the potential to explicitly communicate a specific brand image but it could facilitate sending a specific brand message.

The first research question, which tested the link between the subjective lighting response and the brand indices, shows that only brightness as one of four analysed lighting factors could be regarded as a predictor for the brand factors. But even if a relationship exists for two interior types, it was not possible to detect the same relationship for the other two interior concepts. The store-type 'low budget', which shows the highest similarity regarding interior design to an earlier experiment with a comparable method by Schielke,²⁸ shows similar effects with the positive relationship between the lighting parameter brightness and the brand factor style. However, when all four store types are included, the perceived brightness could not be used as a universal predictor for the discussed brand factors even though the different stores and lighting scenes generated differences in the brand perception. This fact leads to the conclusion that other factors could be more dominant than the four analysed lighting factors, which have an impact on the brand image. It is obvious that these general lighting factors do not include any links to spatial patterns that were analysed in the second hypothesis.

With the second research question, the perspective shifted from the quantitative brightness analysis towards a more design-oriented evaluation, which included the light patterns and the luminous intensity distributions, respectively. In this case, several significant relationships between lighting and brand perception were noted. This approach reveals that in three of the four store types, positive and negative changes appear for the six evaluated brand indices concurrently. When practically applied, a brand needs to consider this interaction and to balance the priority between the different positive and negative brand factors, in order to come as close as possible to the desired brand image.

At the same time, this study illustrates the dominant role of lighting patterns, whereby

the index for style is consistent for all interior types when the lighting changes in the same way. The widely used DL illumination for various retail and research settings is associated with lower brand index values in comparison to the three alternative lighting scenes with the exception of the brand index naturalness where higher values mostly occur for DL. The experiment also reveals that, in contrast to DL illumination, vertical light does have a significant effect on changing the value of several brand indexes for the 'black box' and 'colour' store types but not for the 'low budget' and 'minimal' types. The spatial pattern of the densely filled shelves, which, as visual texture, could be regarded as part of the visual perception, appears to be more dominant than the change in the light pattern from DL to WW in the 'low budget' situation or the 'minimal' interior design. The 'low budget' stereotype seems to have the most dominant spatial pattern because only four significant differences occur with regard to the brand image when compared to DL illumination. The other three store types achieve 6–10 significant differences in the brand image for the same illumination modification and thereby indicate the more dominant role of light pattern. In comparison to the first research question, which showed that the perceived brightness could not be used as a general predictor for the brand factors, the second research focus, which included light patterns, appears as a stronger determining factor for the brand image. Therefore, designers would benefit from a strategy, which is not primarily focused on brightness but on spatial pattern based on lighting to compose a specific corporate visual identity.

The third research focus adds an economic perspective. The conclusion that the perceived price perception of a store is independent of the actual investment and operating costs offers a new viewpoint for lighting concepts in retail environments. The implication that a better store image due to aligned lighting does

not necessarily go hand-in-hand with higher investment, and energy costs point out the importance of qualitative lighting design in contrast to a quantitative approach, which focuses on electrical power. This circumstance gives creative designers the chance to offer clients a high-price perception without necessarily buying a high-price lighting infrastructure.

The question of how these findings can be translated into real store lighting is dependent on the effect that a brand wants to achieve and whether the case in hand concerns a new lighting concept or an existing installation. This means that it might not always be necessary to completely refurbish a store's lighting scheme. It may be sufficient to replace only specific light settings to make a stronger statement. Guidelines for lighting design, as part of a corporate design manual, may facilitate the communication in order to roll out a brand concept for several stores.

Finally, this paper can be regarded as a basis for the general impact of a standardised lighting concept on a store's brand image. As a result, the findings on the perception of light in fashion retail spaces can be used to build up more detailed or even experimental studies for each individual topic.

The limitations of this work lie in the Internet-based survey as an abstract illustration of a real architectural space as well as in the number of tested stereotypes for store concepts. The 16 different variations of store concepts combined with lighting scenes do not cover all possible types of store design, but try to cover the more common ones. Further, this study is limited to fashion stores as a sample sector of a vast range of different retail spaces and environments. This aspect requires consideration for the generalisation of the economic findings as well. A revision of the two items 'traditional' and 'modern' for factor-value orientation could help to improve internal consistency. Due to the low-Cronbach-Alpha value, the results for

this factor need to be treated with caution. Another limitation could be seen in the splitting into two groups, which was done to cut down the evaluation time and therefore to reduce fatigue. One might argue that disadvantages could occur due to order effects, but a similar study did not reveal significant differences in the results.⁹⁰ A wider investigation with a bigger sample group could help to achieve more concrete findings, considering, for example, potential cultural differences as well as local retail trends. A larger test group would also benefit from the different viewing conditions on different monitors.⁹¹ This study and its light scenes concentrate on qualitative lighting concepts and therefore include general recommendations for retail lighting, but an analysis of visual performance encompassing aspects such as colour rendering or glare was not carried out. The display of the visualisations on monitors also limited the possible luminance contrast in relation to the real environment. With regard to lighting design, a prospective study would benefit from an even more differentiated perspective, in which the experiments would involve factors such as colour temperature, dynamic light and other interior design colours. Moreover, future research could examine how or to what extent the given findings are applicable to mock-ups in a life-size architectural space or even to on-site installations in real store environments.

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