

## Dimensions of personality in the responses to luminous ambiances

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**ABSTRACT:** In this multidisciplinary work, we propose a practical framework to study the variability of subjective responses to identical luminous ambiances (atmosphere). We focus on the influence of personality dimensions.

Architects build spaces for which they define functional characteristics and an esthetical concept, while considering the quality of ambiances. The success of a building depends on the subjective perceptions and the behavioural responses of users regarding these functionalities and ambiances. In most works on ambiances, the user is generally considered as an "average user" (mister anybody). The importance and variability of the subjective character of responses has often been mentioned. However, we still do not have effective indicators on the relationship between personalities and the sensations of comfort and pleasure in a luminous ambience.

The purpose of this work is therefore to study the relationship between the perceptivo-cognitive handling of luminance and chromaticities and the way social spaces are occupied and used depending on their luminous ambience.

We study the behaviour of subjects in a laboratory and on sites (in rest areas). At the same time, we study the luminous ambiances in these areas.

We obtain indicators on subjects: 1) by measuring perceptive sensitivity to luminous stimuli (ERP method, in laboratory) with an electroencephalogram on 48 people in order to detect high and low level sensation seekers according to their sensations of pleasure and 2) by observing the behaviour of the same subjects in rest areas and by discussing with them with a questionnaire.

We obtain indicators on existing luminous ambiances (with natural light and artificial light to complement it) in rest areas by measuring luminance, illuminance and chromaticities on opaque and transparent envelopes in these areas.

We then greatly modify luminous ambiances in these areas (by partially covering windows and by modifying artificial light). We then repeat the observations with the same kind of subjects.

Conference Topic: 1.3 Daylighting

### 1. INTRODUCTION

In the studies on luminous ambiances, the subjective part in the appreciation of these ambiances is often mentioned. However there are very few indicators for it. In a French standard (NF X 35-103), the only indication is that the age of people should be taken into account to define illuminance levels on work surfaces. In the studies using interviews and observations, the dimensions of personality of subjects have generally not been precisely studied and subjects are considered as "average". Because of this, results may not be general enough. In this work, we focus on the question of pleasure and well being within luminous ambiances and its relationship with the dimensions of personalities (therefore an average subject is not usable for us). It should help us understand the variety of subjective responses to a luminous ambience.

The question here is how we could take into account the complex field of the dimensions of personalities. We have contacted two laboratories of psychology in order to build together a multidisciplinary approach

(considering the questions and methods specific to the two other fields). This theoretical work has lasted one year and we present the results in this paper. The implementation of it has just started and will continue in the next two years.

The purpose of this work is to use the knowledge and methods of cognitive psychology, environmental psychology and daylighting science for the benefit of architecture. During the design of a building, the architect designs spaces. He/she defines functional characteristics and aesthetic dimensions while designing the quality of the ambience. This ambience may be separated in thermal, acoustic, luminous, etc. ambiances. In our project, we focus on luminous ambience. In addition to his/her own sensitivity, the architect uses his/her knowledge and technical tools to design the functionalities and the ambience of interior spaces. But, in the end, the success of a building depends on the subjective perceptions and behavioural responses of subjects raised up by the architectural solutions.

Our study intends to show that different people choose zones, which have different luminous

ambiences in a space. The results should confirm our hypothesis that adaptive behaviours depend on the sensitivity of individuals to sensorial stimulation. If our work confirms this hypothesis, it will suggest that it is necessary to design environments whose ambiances are varied enough so that the adaptation process of people may work as easily as possible. Results should promote the idea of having varied ambiances within an interior architectural space. It will give indications on the features of luminous ambience which should be taken into account to make a space pleasant. It will allow to better define the notions of comfort and pleasantness of an architectural space.

## 2. SCIENTIFIC CONTEXT AND PURPOSE

### 2.1 Luminous ambience in architecture

From the architectural point of view, the luminous ambience is defined as the part played by light in the way an environment influences a subject. The notion of comfort of a luminous ambience refers to the distribution of luminance and chromaticities on the interior envelope of a space, that is on the different fields of vision for a subject within an ambience. Luminance and chromaticities are at present seldom studied as far as comfort in buildings is concerned. No standard has been set, except the fact that contrasts should not be a disturbance for the subjects' activity. The rare Publications (from international institutions and research laboratories) are usually only concerned with the work surface. Beyond comfort and discomfort, there are the notions of pleasantness or pleasure on which works are even rarer. There are more pragmatic habits than scientific researches: for example, in a hospital, the luminous ambience usually fulfils performance and comfort criteria (minimal contrasts, uniform blue colour, and no tension). However, these luminous ambiances are not felt as pleasant but as monotonous or even sad [1]. In that respect, emotional variables and luminous environments are seldom studied. However, it can be stated that luminous ambiances with low level of stimulation are characterised by low levels of luminance, soft gradual ranges of luminance and specific hues [2]. The luminous ambience can therefore be defined in terms of stimulation values. Currently, few indicators give luminance, contrast and gradual ranges of luminance values with quantitative terms: there are four indicators, only for contrasts [3] and solely for a work ambience and an undefined average subject.

In order to study the perceptivo-cognitive handling of luminance and chromaticities by people and the way social environments are used according to their luminous ambiances, we should answer the following question: how is it possible to express the variety of "luminous stimulation" on the interior envelope of a space. Three main points must be taken into account:

- The different fields of vision: Our hypothesis is that there is no global luminous ambience which would be independent from the subject, his/her position and his/her field of vision. For the data to be useful to our approach, it is necessary to study the space from several points of view. It will allow

us to study the behaviours of people according to their actual field of vision.

- The influence of the variability of daylighting. With lighting both natural and artificial, the luminous ambience varies with the incident fraction of the exterior light. We are developing measurement methods to take into account the quick variations of daylighting. It will also improve our existing measurement protocol [4].
- The interpretation models: the very large diversity of "luminous stimulation" visible on an interior envelop leads to a very large number of measured data. We therefore have to build interpretation and synthesis models. To define these interpretation models, we will have to refine the existing variables, contrasts and gradual ranges of luminance, and to develop new indicators for luminous ambience.

### 2.2 Personality and sensorial information handling

We intend to study how subjects, with their different temperaments, react to stimulation which have well-defined physical characteristics. It is well known that adults select or act on situations so that these situations best correspond to their temperament. [5] suggests that the most striking differences between individuals could be found not by studying responses to a given situation but by analysing the conditions of stimulation that subjects select or build. [6] has showed that people with a strong reactivity tend to choose situations which have low values of stimulation (conversely for people with low reactivity). However, few indicators give precise values for these stimulations. The concept of "goodness of fit" of [7] shows the interest of the phenomenon of mutual adjustments between a subject and its environment: the subject adapts to his/her environment and also tries to select an environment which corresponds to his/her temperament and/or to modify it.

The influences of the characteristics of environment's lighting are very delicate and may be hidden in the general population. For that matter, in addition to the general population (people who come spontaneously to the site), we decided to study people who are either hyper or hyposensitive to environmental stimulation. This choice will produce a magnifying effect. In that respect, two groups of people are particularly interesting: anhedonic subjects (people having a diminished capability to feel pleasure) and hedonic subjects (having a capability to feel pleasure), [8].

We already observed in a previous experiment [9] with brain Event Related Potentials (ERP method) that wealthy anhedonic subjects have a deficit in ERP. The physiological reaction is measured by sensitive devices which record cerebral waves and specific sensorial waves are studied. It appears that the particular physiological reaction is related to stimuli thresholds. There are also two kinds of subjects: Reducing and augmenting anhedonic subjects: With reducers who react rapidly, the amplitude of sensorial waves (N100, P200) either stops increasing or starts decreasing after a given level of stimulation intensity.

With augmenters who react later, the amplitude continues to grow with the intensity of the stimulation. It is clear that these two kinds of anhedonic subjects should give contrary answers in their ERP N100 and P200. Subjects reacting to low stimuli thresholds with low amplitude will therefore be augmenters. Conversely, subjects reacting to low stimuli thresholds with high amplitude will therefore be reducers. This will induce that anhedonic people tend to have processes to activate or inhibit neural connections. Augmenters would have a low sensorial sensitivity and would therefore look for extreme stimulation. Conversely reducers would be hypersensitive, have a lower discomfort threshold and tend to look for sensorial insulation; they should perceive the environment as aggressive, what leads to their anhedony.

This hypothesis will be tested in order to better understand the adjustment processes of people having extreme sensitivity. We will test our hypothesis using luminous ambience stimulation in our laboratory and in situ.

### 2.3 Importance of luminous ambience on the use of a public space

We will use a psycho-environmental approach to study the influence of a luminous ambience on the behaviours of people in an existing space. It is clear that this specific dimension of architecture (lighting) comes into play within a complex system of interdependencies with the social and physical components of the space. The role of many dimensions of the physical environment has been studied. However, to our knowledge, no study has analysed in a systematic manner how a luminous ambience, whose characteristics have been thoroughly studied, influences the perception of a space and the way the space is used.

Moreover, theoretical models in environmental psychology suggest that the subject-environment relationship is a transactional relationship, that is dynamic and bi-directional [10]. In that respect, the two sides of the relationship must be considered together. It is necessary to study not only how the physical and social characteristics of a space influences the behaviours and representations of people inside. We must also examine how people perceive and transform their environment, according to their personalities and their psychological particularities. The essential question is to identify the different adjustment strategies used by people according to their competencies and personalities.

It is naturally possible that luminous ambience does not appear as a main dimension in the definition of a collective space. It is therefore all the more interesting to verify how much the influence of that variable depends on the personal characteristics of people. That is why we are selecting hyper and hyposensitive people whom we will study in a social space. That is also why we do not use purely statistical methods: ensuring statistical validity would require a very large number of subjects on a very long period of time (several seasons, sky types, etc.) and it would be too heavy and tedious. Moreover, it would still be specific to the chosen space and the kind of

people who spontaneously come to the site (the general population).

We will try to answer two different questions:

- Is the way different zones are used dependent on the characteristics of the luminous ambiances of these zones?
- Do modifications in the luminous ambience modify the qualitative evaluation of the users about the spaces and does it also modify their uses of these spaces?

We will examine if the use of public spaces varies with the perceptive sensitivity to luminous comfort. The behaviours of the general population will be compared to the two populations selected by the study ERP, that is reducing and augmenting anhedonic subjects in order to answer the following questions:

- Does the general population behave differently to anhedonic people regarding their use of the different zones of a space, these zones being differentiated by their luminous ambience?
- Does the general population also judge differently the quality of the luminous ambience in the different zones of the space?

For populations with strong sensitivity, the delicate effects of the luminous ambiances should be maximised (magnifying effect). Moreover, during the study in laboratory to select anhedonic subjects, we will have learnt about the way these people with extreme sensitivity handle luminance levels. It will help us to interpret differences in the use of the different zones of the space according to the differences in the luminous ambiances. We will also compare the quantitative descriptions (measurements) of the luminous ambiances and the qualitative expressions given by subjects.

## 3. METHODOLOGY

### 3.1 Selected sites

The selected spaces have been designed for rest where the notions of comfort and pleasure are essential. The interior design and the lighting system are modern. Therefore, the results will interest professional people who have to design the lighting of spaces for rest. The ambiances of the selected spaces are already of good quality and the luminous ambiances rather pleasant. They are not monotonous or uniform throughout the whole space. There are two or three zones with different luminous ambiances in each space. They are illuminated by both natural light and artificial sources used as complement. We hope that people will choose their places essentially according to the physical characteristics of the space and, in particular, according to the luminous ambience. Moreover, in order to minimise the social constraints due to a crowded space, we will perform our study during off-peak hours when the degree of freedom is greater.

After the studies described in this paper on the actual ambience in these spaces, we will design a second luminous ambience (called modified ambience) for each space. This modified ambience will be based on the definition of a new architectural concept of the ambience. We will also use the behavioural data we will have collected from the study in the sites with the initial ambience. The modified ambience will be designed using partial protections from natural light and carefully chosen artificial lights we will add. We will be particularly careful with the type of lights to add and their positions.

We will transform the contrasts and the gradual ranges of luminance. We may, for example, transform an existing monotonous zone, with no personality, into a calm, soft, little lighted zone with soft gradual ranges of luminance, very soft contrasts. Another zone can be transformed into a rather dynamic and animated one with strong contrasts, etc. Quantitative values for contrasts and gradual ranges of luminance for the initial ambience are measured and those for the modified ambience will be studied theoretically and built in the sites. The influence of contrasts and gradual ranges of luminance on comfort and pleasantness of the luminous ambience will be validated by the modification of the users' behaviours we will observe.

Two sites have been selected for our experiments: the café of the Grand Palais Museum in Paris and the café of the new institute of psychology in Boulogne.

### 3.2 Measurements

We will measure luminance levels, illuminance and chromaticities on opaque and glazed interior surfaces in the selected spaces with lux-chromameter and luminance-chromameter. We will present the distribution of luminance on a luminance diagram [11] for each ambience (initial and modified), for each zone and each field of vision. We will use a defined protocol of measurements [4] where several problems (variability of exterior luminance, sky types, etc.) have been studied. Among the five sky types [12] we have chosen the overcast sky because changes in the exterior luminous flux can only induce proportional changes of the interior luminance levels, but not of modify the luminance distribution. Therefore, within limits, variations in the exterior lighting will not prevent the continuation of the study.

### 3.3 Interpretation of measured data and links with qualitative expressions

These measured data will be interpreted and analysed to determine contrasts, gradual ranges of luminance and the main chromaticity. These results will be used by the study of people's behaviour. Secondly, we will look for the opinions of populations on the sites about their fields of vision. It will be used to find links between the qualitative expressions and the quantitative measured data.

### 3.4 Electrophysiological approach in laboratory

We have 48 wealthy subjects -16 reducing anhedonic, 16 augmenting anhedonic and 16 hedonic (control group) subjects. The recording of Event Related Potentials is performed in a room with a

complete acoustic insulation. Subjects are installed in a comfortable and adjustable armchair. The brain activity is recorded on the surface of the head by 31 electrodes according to the international configuration of the 10-20 system.

The stimuli will be based on contrasts. The subjects will have in front of them a screen on which 50 images will be displayed in a specific order. These fifty images represent 10 scenes with 5 different contrast levels.

Then one half of these subjects, whose personality's dimensions are now well known, will go to the sites where the initial ambience has been studied. The second half will go to the sites when the modified ambience is applied. Their behaviour will be studied using the psycho-environmental methods.

### 3.5 Collected data during on site experiments

The analysis of behaviours will detect three types of information:

- the exact position chosen by people
- the body orientation of people in the space
- these collective or individual use of the space

In a first phase, videos will be recorded to observe the behaviour of people (the 3 groups previously studied in the laboratory and the general population) in the spaces. During this phase, the observation grid and the categories for the coding of questions will be designed and validated. The observation methods in situ and the method of experimental mapping, to build density maps and occupation modes of a space, have been largely validated ([13], [14]).

Secondly, a semi-directed interview will be proposed to every subject in the space to collect their preferences about spaces for rest and their perception of the architectural quality of the site and of the luminous ambience. These interviews will also be used to collect the reasons people will give to explain the places they choose in the space and how they characterise it.

Finally, questionnaires corresponding to the scales for sensation seeking and anhedony will be given to the general population (who was not tested in our laboratory) who participated in the interviews in order to get information about their psychological attitude towards pleasure (hedony, anhedony, etc.). It is a less detailed method than ERP tests in a laboratory, but it still enables us to get some information about the psychological profile of people.

## 4. Expected results

We expect to better understand the reactions to luminous ambiances by individuals having different perceptive sensitivity.

It will allow to better define the notions of comfort and pleasantness of luminous ambience of a space for rest. In the field of architectural design, professionals tend to use qualitative expressions. Our results will allow to better link this qualitative approach to quantitative and experimental data. This link will greatly facilitate the integration of the results of this study by the professionals.

Several results are expected from this work, the main ones are:

- Identify contrast thresholds and levels for gradual ranges of luminance which are comfortable and pleasant. It will help to advance this current debate in architecture. Moreover, as artificial lighting is used by architects and users to change contrasts and gradual ranges of luminance to obtain a pleasant ambience, this identification of thresholds will help control and optimise the expenditure of energy.
- Improve measurement protocols in artificial and natural lighting, mainly with the integration of chromaticities.
- Improve the analysis and interpretation models to define luminous ambiances and link them to qualitative expressions in order, for example, to develop simulation tools for luminous ambience.
- Understand the adjustment behaviour of people having a hyper or hyposensitivity.
- Identify the criteria expressed by users in the choice of a place in a café and determine, among all given criteria, the ones linked to luminous ambience.
- Offer a better understanding of the use of spaces for rest by linking the actual behaviour of people and the reasons they give for it, that is between the representations of individual motivations and actual behaviours.

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