

Natural Light and Environmental Stress

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ABSTRACT: This article shows the evidences of the necessity to consider the environmental stimulus, with emphasis on lighting, as possible sources of stress to the human organism exposed to an architectural environment. It presents considerations based on a bibliographic revision of an interdisciplinary content that permeates the Environmental Psychology, Medicine, Chronobiology and Architecture areas of knowledge. In this way, the relationship between daylight and man is reinforced, once the time of diurnal and nocturnal rhythm, and the functional variations associated to it, depends on the internal process related to the biological clock, which determines the diurnal predominance of humans' activities. Natural light presents rhythms and patterns that must be synchronized with the internal functioning of the organism. When this relation of synchronicity does not happen, the organism may suffer a discomfort, until it adjusts itself to the new environmental conditions, or it might become ill, when the adaptation isn't possible. Practical examples are presented, of the evidence of the benefits of natural light's use in interior spaces, favouring health and well-being of its occupants. Therefore, the contact with natural light is recommended, since it can avoid that the organism demands efforts and adaptative resources consequent of the lack of contact with passing of time, contributing to a better performance and well being.

Keywords: natural light, environmental stress, discomfort

1. INTRODUCTION

When addressing the subject of Visual perception, Baker, Fanchiotti and Steemers [1], stated that studies on the anatomy of the visual system showed that only 1/5 of the visual information obtained comes from the retina, and therefore, from the exterior world, making the perceptive process a much more complex issue than instructions transmitted from the retina to the visual cortex.

It is known that natural light exerts psychological and physiological impact on man, since there are evident relationships between natural light and the functioning of human organism, which presents rhythm in its daily functions, such as eating, sleeping and variations in mood, such as alertness and sleepiness, and that are related to the bright and dark cycle of the passing of time.

When light passes through the eye, impulses are propagated, not only to the visual areas, but also to the areas in the brain related to the emotions and to hormonal regulation, which makes evident the relationship between the cycle of day and night, that is to say, the relationship between the presence and absence of natural light with the organism's activities, health and comfort, in an ample sense.



Figure 1: Via dell'Amore during the day – Cinque Terre, Italy.

Source: from the author, 2005.



Figure 2: Via dell'Amore in the evening – Cinque Terre, Italy.

Source: Cinque Terre & Porto Venere [2], 2005.

Finding support on Chronobiology, area of knowledge that studies the relationships between organisms and time, it is said that the timing of diurnal and nocturnal rhythm, and the functional variations associated with it, depend on the internal process regarding the biological clock, which determines the diurnal predominance of human beings' activities. This clock maintains a temporal association with the

raising and the setting of the sun, existing therefore a sort of synchronicity, which is called circadian rhythm.

From then on, light can be considered as a stimulus present in the environment, capable of causing reactions on human organism which presents a response to it. And this response, many times, can be translated in the shape of behavioural tendencies. This way, the environmental stressors, which refer to the environmental conditions that require an effort from the organism to deal with them, many times source of discomfort to that organism, are defined.

Natural light can, therefore, take the form of a stressor, as much in its excessive presence, uncontrolled, as a source of glare and excessive heat, for instance; as in its absence, for depriving the organism's contact with time and consequent lack of synchronicity, favouring a possible discomfort.

2. ENVIRONMENTAL STIMULUS AND STRESS

Every environment to which we are exposed to, can be considered a source of stimulus to our organism. These environmental stimuli are capable of generating situations of comfort, favouring health, good performance. In contrast, they can represent sources of discomfort to this same organism exposed to the environment, being characterised, as a result, as environmental stressors.

The work of Evans and Cohen [3] is focused on the physical characteristics of the environment that are capable of causing stress and, as a reaction, trigger off an adaptative process of the organism to the stimuli received, that capacitates it to deal with those characteristics.

According to the authors, the concept of stress is complex. Recent definitions consider situations that cause disorganisation of the natural course of the organism's behaviour and functioning as stressors, and the duration of the stressors and the periodicity in which it happens holds important influence over health and well being.

Considering this perspective, stress is a process that occurs when there is disequilibrium between the stimuli of the environment and the organism's response capacity, in other words, stress occurs when the environmental stimulus exceeds the organism's adaptative capacity.

The main source of information on stressors and the various opportunities of adaptation would reside in the configuration of the physical environment. Therefore, a lot of attention must be given to the characteristics of the environment where one lives and works, since the physical environment presents stimuli that require adaptative potentials of the organism.

Nevertheless, there would be costs associated with the accommodation to the environmental surroundings when it presents drastically different conditions to the ones human beings are habitually involved in.

According to the authors, the stressors would be capable of producing physiologic effects to the organism, once they could cause alterations on the

levels of circulating hormones, raise of arterial pressure, blood circulation, muscular tension, heart rate, etc.

They could, furthermore, affect the fulfilment of tasks, mainly the ones that require more insight and concentration.

Experiencing prolonged stress could also have undesirable effects on health, as headaches, stomach ulcers, raised blood pressure, in addition to changes in behaviour that can affect productivity.

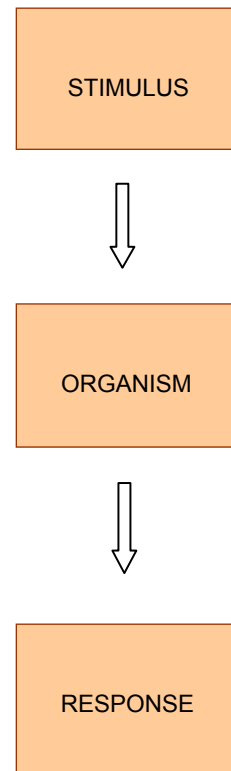


Figure 3: Diagram of the possible interferences of the environmental stimuli over the organism and its responses to the stimulus received.

Source: Fonseca *et al.* [4], 2005.

3. THE DYNAMIC OF NATURAL LIGHT, THE CIRCADIAN RHYTHM AND THE WELL-BEING

Natural light presents characteristics in its spectral composition, in terms of quality and quantity that vary according to the locality in question, and they alter themselves constantly; its angulations, intensity and colours change according to the time of day and season of year added to the local atmospheric conditions.

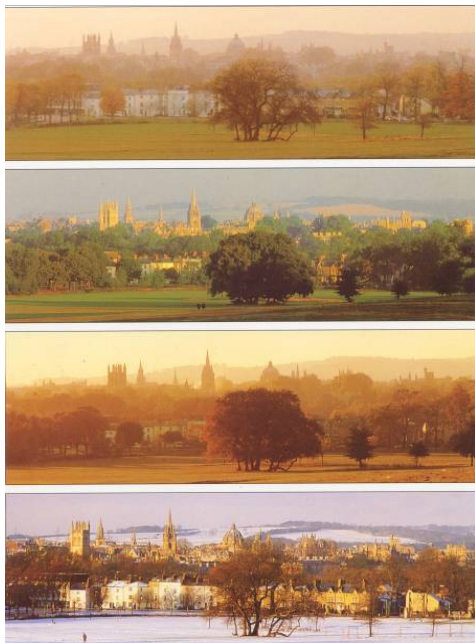


Figure 4: The four seasons of Oxford, England.
Source: The Oxford Photo Library, 2005.

According to Cristian Norberg-Schulz, “Every place has its own light. Light tell us where we are and how we are in a certain place. Light colours things and determines the atmosphere of the place”.

According to Marques *et al.* [5], living beings need to adapt in time. And if an environment oscillates, to adapt to it, a species would need to oscillate as well. Therefore, temporal adaptation consists in the harmonization between the biological rhythmicity and the environmental cycles.

There are daily fluctuations in man’s physical activities, such as sleeping, feeding, body temperature, and rate of secretion of certain hormones, as well as in other metabolic processes such as blood pressure, which are related with the passing of time.

And, according to IESNA – Illuminating Engineering Society of North America [6], the biologic rhythms that occur daily, based on the cycle light-darkness, of day-night, produced by the Earth’s rotation around the Sun, have a period of 24 hours and are called circadian rhythms.

It is of fundamental importance that those rhythms are synchronised with the geophysical cycles, ensuring that the expression of each activity or function happens when the environmental conditions are more favourable for the species.

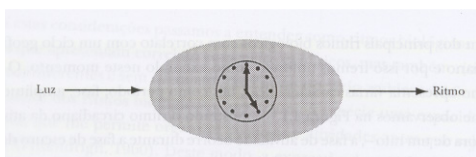


Figure 5: Model diagram representative of the circadian system.
Source: Marques *et al.*, 2003.

4. LIGHT AND HEALTH

Hormones are produced according to the light and dark cycle, as for instance, the melatonin (MLT), main hormone secreted by the pineal gland, and which the synthesis speed is controlled by the environmental illumination. Its secretion is stimulated in the dark period, being responsible for the sleeping estate.

The pineal gland, which receives signs of presence or absence of light and which produces melatonin, also acts in the secretion of serotonin, which levels also present a circadian rhythm, inverse to the MLT. During the day, the organism’s levels of serotonin are higher. Right after nightfall, there is a decrease in those levels and an increase in the MLT levels.

Serotonin is considered the hormone of elation, once its high levels are associated with the well-being; sensation caused by physical activity that releases quantities of this substance into the organism causing people to feel well disposed after the practice of those activities.

The MLT modifies the secretion of the hormone cortisol, which has a direct relationship with several of man’s emotional responses, associated with the variations in its concentrations in the organism.

And, in the last decades, the interdependence between biochemistry and human behaviour has become evident. Since different levels of stress promote different behaviours, there is a possibility that variations in the rates of cortisol might be accompanied by changes in behaviour.

High levels of cortisol detected in the morning period were associated with sociability, whereas moderate or low levels seemed to promote individual concentration [7].

5. LIGHT AND DISORDERS

There are some activities that demand a change in shifts of the internal biological clock. As a more common example we have the work shifts where people do not follow constant hours. One moment they work during the day, the next in the afternoon, the next at night, in changes of shifts, and the two most common and destructive problems associated with this rhythm of work are the reduction of sleep quality following the night’s shift and the reduction in the capacity of maintaining alertness during the activities, which end up resulting in decline in productivity and deficiency in performance.

Furthermore, evidence indicates that shift workers present an increase in health problems, including higher risk of cardiovascular disease, digestive stress and cognitive and emotional problems. And the chronic desynchronisation of the internal biologic rhythm seems to be the cause of such symptoms.

Another example of that desynchronisation, cause of jeopardy to the organism, is the jet-lag, condition that results of rapid changes through time zones and that is characterised by the unwellness felt on the subsequent days to those changes, such as after transmeridional trips. This desynchronisation between rhythms leads to a disorganisation of the internal

rhythm and, the fact that the organism's circadian rhythm is not synchronised with the new time, contributes to the sensations of discomfort. Although the human biological clock takes from three to seven days to adjust itself to the new conditions, during the adjustment phase, people experiment such uncomfortable symptoms.

Another example is the SAD (seasonal affective disorder), syndrome that affects approximately 5% of the adult population, much observed in the countries of extreme northern latitude, where the climate is very harsh and is characterised by the presence of grey skies and rain.

SAD is a type of depression that can be considered as a primary dysfunction of the biological rhythms and its patients show an exaggerated response to the changes in seasons. This type of depression possibly manifests itself when the quantity of hours of brightness per day is under a certain critical value.

SAD occurs during the winter and autumn months and disappears in the summer and spring and is characterised by the recurrence of the depressive episodes [8]. It distinguishes itself from other forms of depression by an atypical number of vegetative symptoms.

People victim of SAD frequently experiment lack of sociability, sleepiness during the day and incapacity of concentration, negative state of disposition during the depressive months [9]; they present great decrease of physical energy and normally find it difficult to face the routine demands of work and family life. Moreover, they experiment emotional depression, sensations of dejection and abandonment.

6. NATURAL LIGHT IN INTERIOR SPACES AND THE CONECTION OF THE ORGANISM WITH TIME

Many available methods to prevent the impact of sunlight on building's performance are, in its majority, focused on the quantitative aspects of illumination, such as the minimum recommended levels for the execution of tasks. However, we must not forgo the concerns regarding its quality.

A relevant aspect to be highlighted relates to the effects of its utilization as assistance in the recovery of hospital patients.

The incidence of postoperative delirium in surgical patients treated for at least 72 hours in an intensive care unit with no windows was compared with patients in an ICU with windows. At least twice more episodes of delirium were seen in the windowless ICU and it was concluded that the presence of windows was highly desirable for the prevention of sensory deprivation (Wilson, *in* Fonseca [11]).

This conclusion gained more support when interviews were performed with two groups of patients that had been in an ICU for at least 48 hours. One group had been kept in a windowless unit, and the other, in a similar unit with translucent glass windows, but not transparent. The individuals in the windowless unit had a less exact memory of their time

of permanence in the ICU, and were less well oriented during the time in which they were there. The incidence of hallucinations and illusions were more than twice higher on patients at the windowless unit (Keep *et al.*, *in* Fonseca).

However, it should also be considered that the window brings the light but, above all, it interlinks the interior to the exterior. Studies prove that, besides natural light, the view to the exterior, can also influence the recovery of surgical patients. Patients designated to those rooms had shorter postoperative periods in hospital, received less negative assessments on nursers' notes, and needed less potent painkillers when compared with patients in similar rooms with windows facing the neighbouring building wall (Ulrich, *in* Fonseca).

The essential promotion of contact with natural light, favouring the recommended synchrony between the passing of time and human organism, avoids that the latter goes into excessive effort and search for adaptative resources consequence of the lack of contact with the passing of time, permitting a more comfortable manner of functioning, thus, with possible better performance and well-being.

On the other hand, the indiscriminate presence of natural light can also cause it to configure itself as an ambient stressor, since the lack of control can jeopardise the user, such as glare, excessive heat, burns, excess exposure to UV rays and decrease of immunity. In that case, it is made necessary to foresee elements of protection and/or shading in the architectural project to avoid damage to the users, in addition to the advantage of the possibility to promote a big diversity of ambiances in terms of quality of resulting natural light in the interior.

A distinctive example is the solution obtained by Lucio Costa, renowned Brazilian architect, in his modernist work: the group of three multifamily edifices at Parque Guinle in Rio de Janeiro. The façade's composition, notwithstanding its orientation to the west, favours the view to the park and is protected by a balcony and by shading elements.

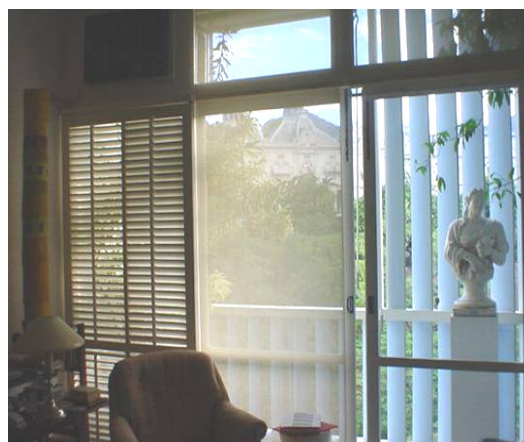


Figure 6: Apartment on Cintra Building, by Lúcio Costa – Parque Guinle, Rio de Janeiro, Brazil.

Source: Porto *et al.* [10], 2002.

It is noticeable, on the right, the presence of brises soleil blue vertical blinds that filter the light, resulting in a different light from the one filtered by the netting, in the centre of the opening, which, in its turn, differs from the light that goes through the Venetian blinds, located on the left of the image.

The positive impacts of sunlight includes its use as source of heat when convenient, or to improve the occupants' visual, emotional and psychological well-being, particularly important when the visual task to be performed does not require great acuity, and comfort is associated with the dynamic of the picture, to the stimulating tension, or to the playful variation of the solar stain, with contrasting readings of luminance and colours.

The architect Tadao Ando explores the use of natural light as information and orientation in time, by means of a ray of light that changes position as the day goes by, causing the organism to recognise the passing of time.



Figure 6: Glass Block Wall (Horiuchi Residence), Osaka, Japan

Source: Frampton [11], 1984

Or, in this other project of the same architect, natural light was used once more signalling the passing of time externally to architecture, since the solar spots formed internally as the day goes by, makes the several moments of the day recognisable for the inhabitants of the space.



Figure 7: Tadao Ando's Studio in Osaka, Japan

Source: Gonzáles [12], 1990

7. CONCLUSIONS

Evidence of bad use of natural lighting or even the deprivation of human organism's contact with the passing of time through natural lighting were brought up in this article.

The importance of its correct use transcends the concern with the question of energetic efficiency, but it is also related to factors linked with the users' health and well-being in interior spaces.

We highlighted the influences the environment can represent to its users, once source of stimuli, where lighting configures itself as one of them.

Results of its inadequate use or of its absence in interior spaces, include those which make of the luminous stimulus a possible source of stress to human organism, since once in synchrony with the light-dark cycle of time man regulate many of their daily activities.

Examples were quoted, where the user's contact with natural light is a relevant factor, such as in the cases of hospital patients recovery, or even in living or working spaces.

Therefore, it is recommended the consideration of natural lighting as an inherent part of the architectural project, controlling its presence, to avoid its undesirable effects such as excessive heat source, glare, excess of contrast, but in such a way as not to deprive the user of the perception of the passing of time, favouring, in a last instance, good health, well being, performance and comfort.

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