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Non-visual aspect of light: new frontiers for lighting design

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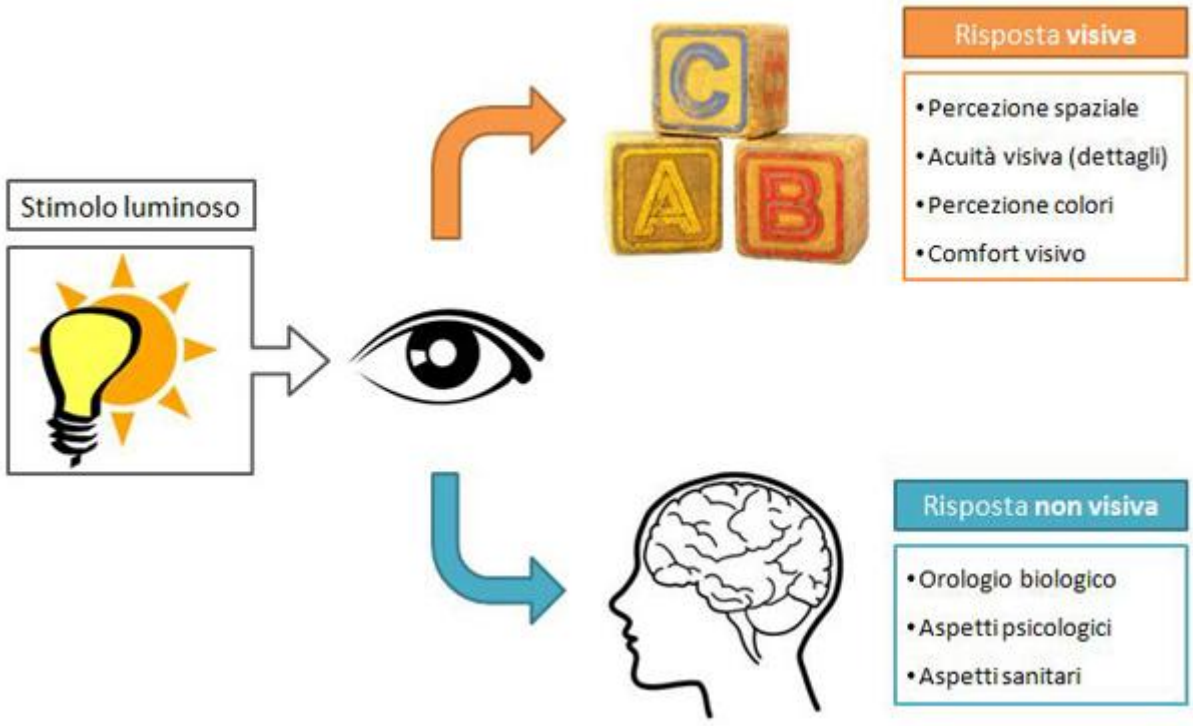
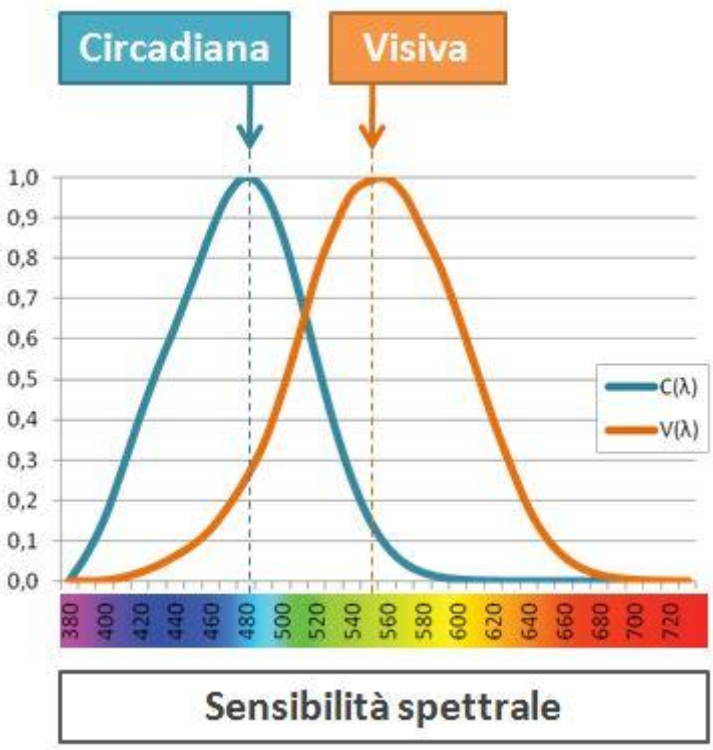
In lighting design great emphasis is put on quality. This concept is usually defined by the three aspects of energy efficiency, architectural integration and wellbeing. Thanks to the most recent scientific discoveries, wellbeing has increasingly become the key element in the design process, not only for visual comfort, but also for its effects of the light on health, body functions and psychology. The aim of most of the studies in the last 15 years is the understanding of the non-visual aspects of light, meaning those aspects that are not related to the visual perception of the environment. This paper aims to evaluate the design implications of these aspects, so how this knowledge will be applied to the design process and what will be the new challenges for the designers of tomorrow.

The non-visual effects of light can influence the human body on psychological aspects (mood, stress), bio-rhythms control, sleep quality, cognitive performance, alertness and hospital recovery. This knowledge can be applied in the design of schools and offices, where the level of attention is important, in hospitals and for all the working conditions that imply night shifts.

Between all the non-visual aspects, probably the most interesting for its applications in lighting design is the interaction of light with the circadian rhythms. If the body doesn't receive the correct light stimulus, some circadian system disorders may occur, like: jet lag, winter depression, sleep disorders, fatigue. This interaction is possible due to a double vision system, which allows the same light stimulus to generate two different responses from our body. The first is a visual response (perception of space and color), the second is a non-visual response, which is necessary for the resetting of the biological clock in the morning.



It has been demonstrated that the natural dynamic variation of daylight represents for our body the best possible stimulus. Modern lifestyle, for many people, does not allow to be exposed enough to daylight, so an integration using artificial light sources is needed. These sources if not adequate can be counterproductive. The objective of circadian lighting, is to provide the correct non-visual stimuli needed by the body for psychophysical wellbeing, ensuring at the same time all the visual requirements. Currently there are no standards available capable of defining neither calculation models for circadian light nor reference parameters to be respected. Some researchers have proposed their models, which have been collected and compared. The most complete and advanced model (proposed by M. Rea et al.) has been chosen for the analysis of the spectral power distribution of different light sources. The results, as expected, show that cool lights are more efficient in generating a circadian response than warm lights.



Thanks to the analysis of the literature and the data collected it has been possible to define some guidelines. In general it is necessary to provide a strong lighting stimulus during the morning and the early afternoon (using bright cool light), in the evening instead the objective is to avoid the ant stimulus (using warm dim light). From the design point of view it is suggested to maximize the presence of daylight and to choose the correct light sources, which should be characterized by a circadian efficiency index.

UFFICIO *ambiente di attività*			Stimolare il sistema circadiano
Mattino	Illuminamento **elevato** *750 - 1000 lx*	Luce **fredda** *6500 - 8000 K*	
Pomeriggio	Illuminamento **medio** *500 - 750 lx*	Luce **neutra** *4000 - 5000 K*	
Tardo pomeriggio	Illuminamento **ridotto** *300 - 400 lx*	Luce **calda** *3700 - 4000 K*	

In the future lighting designers will have to meet new requirements for wellbeing, considering both visual and non visual aspects. These aspects will have to be included in an adequate standards framework. At last the importance of daylight finds a new meaning, not as a free source of light, but as the best possible stimulus for our body.

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