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CIRCADIAN EFFECTIVENESS OF SOLAR AND ARTIFICIAL RADIATION IN DEPENDENCE ON AGE

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The circadian action spectrum and the effective threshold irradiance of melatonin suppression were measured of young adults with artificially dilated pupils by using monochromatic radiation (Thapan et at., 2001; Brainard et al., 2001). However, the spectral transmittance of the human eye-lens shows typical age dependent decreases and shifts to longer wavelengths. Moreover, evaluating circadian effectiveness of light under usual illumination conditions, the effects of eye adaptation to both polychromatic radiation and of different geometric conditions have to be considered. Thus, the aim of the investigation was to determine the threshold irradiance of sufficient melatonin suppression for persons of different age with free pupil adaptation by using polychromatic radiation with different emission spectra and with different angles of incidence on the cornea.

These data were used to evaluate the circadian effectiveness of solar irradiance at the Earth´s surface and of different lamp types for children, young adults and seniors. Melatonin suppression was measured directly by analysing blood samples of volunteers classified by their age and exposed by polychromatic radiation in dependence on its spectral distribution, on its irradiance and on its incidence angle on the cornea.

Effective threshold irradiances to get saturation of melatonin suppression were calculated by using the circadian action spectrum. Depending on the age, the data ranged between about 0.2 W m^{-2} and about 0.6 W m^{-2} in the case of half spherical geometry and of different emission spectra of white light lamps. In contrast, decreases of the incident angle resulted in decreases of melatonin suppression even if the luminance was increased to get equivalent corneal irradiance. However, the threshold irradiances experimentally determined for persons of different age are approximately in line with the thresholds calculated by extrapolation by using age-dependent spectra of eye transmittance and threshold irradiance data of melatonin suppression measured in young adults with dilated pupils and with monochromatic radiation.

This result is discussed as reference to the applicability of the additivity law of photobiology to evaluate circadian effectiveness of polychromatic light sources by weighting with the circadian action spectrum, whereas the experimental data clearly show the violation of the *Bunsen-Roscoe* law as well as the need to establish “circadian weighted” measures to exclude confusion by using measures of visual effectiveness which result in misinterpretation of circadian effectiveness.

In addition, ageing effects of the eyes have to be considered to evaluate circadian effectiveness and effects of light. Outdoor sun light exposures during cloudless sky cause sufficient melatonin suppression between sunrise and sunset for persons of all ages, whereas the suitable daily periods are limited in case of cloud covered sky and depend on latitude, season, age, type of cloudiness and degree of cover. Lamps show different ratios between circadian and visual effectiveness in dependence on a person´s age which may be used to stimulate or to prevent melatonin suppression.

Langfassung erscheint demnächst in
”Photochemistry and Photobiology”

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