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A TEST FOR THE IMPACT OF RADIATION ON HUMAN RETINAL FUNCTION

Abstract

The human retina is the most susceptible part of the human visual system to the radiation effects of space flight. Unfortunately, it is difficult to dissect the visual system in a non-invasive way using conventional methods in order to quantify such radiation effects and attempt to mitigate them. The present study employs the sandwich model to take advantage of a nonlinear stage in the visual system and measure separately the stages before, during and after the nonlinearity. If the results can be correlated to some part of retinal function then it would provide a new testing method for the effects of retinal trauma e.g. due to radiation in space.

A five-channel Maxwellian-view system was used to generate contrast-modulated sinusoidally flickering stimuli. The subjects adjusted the modulation of the signal in order to set the thresholds for the perception of flicker and distortion in hue. The temporal properties of the visual system prior to the nonlinearity were measured by varying the carrier frequency and those after the nonlinearity were measured by varying the contrast-modulation frequency. Subjects measured the input-output function of the nonlinearity by matching the distortion in the contrast-modulated stimulus with up to three sinusoidally flickering monochromatic lights, which allowed the measurement of colour change, brightness enhancement and desaturation. The results were compared with existing studies on contrast-modulated gratings and contrast perception.

The results show that the pre-nonlinearity stage can be described well by photoreceptor function. In addition, the results can be modelled by a single nonlinear stage underlying colour, brightness and saturation changes. This nonlinearity is concluded to exist early within the retina prior to the separation of the chromatic and luminance channels.

The method that is used in this study is concluded to be effective in diagnosing significant changes in retinal function that can be caused by trauma such as space radiation. Based on the conclusions, this study provides recommendations on monitoring human vision during spaceflight using a non-invasive and efficient test.