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# Research into the contrast sensitivity of persons with varying levels of visual acuity

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The contrast sensitivity of persons with different visual acuity capabilities is experimentally analyzed. Test subjects observe a cathode ray tube monitor in a darkroom environment to determine their visual contrast sensitivity to red-green and blue-yellow color fields with varying luminance levels. Results showed clear differences. Findings are significant to many important applications in image processing technology.

The objective is to determine the characteristics of contrast sensitivity of the human vision system (HVS) by experimental measurements employing a CRT. Said characteristics form the basis for the technologies of displaying, processing and understanding images. The contrast sensitivity function (CSF) is one of most important measures for the HVS. Studying the variation in individuals' visual contrast sensitivity to luminance, red-green and blue-yellow color fields is fundamental to modeling human vision and predicting visual performance. With the development of the computer, computer networking, and more and more sophisticated digital techniques, the monitor is fast becoming the primary outlet for acquiring information; and thus applications of monitor-based image technology continue to expand.

Experimental methodology consisted of utilizing small-scale color conversion to control the brightness, color and gratings' contrast for a 10 bit CRT display. Target gratings were displayed with two mean brightnesses on a CRT monitor. By altering their spatial frequencies, the contrast sensitivities of 30 young people whose eyes had visual acuities

of 0.4, 0.6, 0.8, 1.0, 1.2, or 1.5 were measured in a darkroom environment to obtain relationship curves between contrast sensitivity and spatial frequencies. In accordance with its significant potential impact, results of this study were reported in Issue 53 (November, 2008) of *Science in China*.

Visual contrast sensitivity is a psychophysical process, and thus experimental measurements characterizing it are influenced by many factors. Over time, this has attracted studies from researchers focused on diverse aspects ranging from vision to image technology. Early CSF research mainly concentrated on luminance contrast sensitivity. At present, research into visual color transmission characteristics in humans is still in its infancy, especially investigation of visual color and luminance transmission characteristics of people of Asian ethnicity. Optical methods using CRTs to display gratings to measure CSFs have recently been developed and codified, and our research aimed utilize this methodology to measure the contrast sensitivity of the HVS of persons with different levels of visual acuity.

There have been very few studies utilizing CRTs to measure CSFs, and these previous studies provide neither a sufficiently-detailed account of the conditions under which the measurements were performed nor an adequate description of the measuring process itself. Specification of the target gratings employed and the definition of what is meant by color contrast were also inadequate.

The research may be bifurcated into two phases. The first involved establishing contrast definitions for red-green and blue-yellow color stripes, as proposed in CIELAB, following CRT color display characteristics. Means to precisely control on the CRT the chroma of L, a*, b* as well as chromatic aberration over a small frequency range were developed. The second phase involved actual experimental measurements done with thirty young test subjects. Herein two sets of

experiments were performed. One was to measure contrast sensitivity as a function of luminance; and the other was to measure contrast sensitivity to red-green and blue-yellow color fields, which was done for the ten spatial frequencies of 0.41, 0.82, 1.23, 1.97, 3.08, 3.79, 4.93, 7.04, 9.86 and 16.43 cycles per degree (cpd). The experimental methodology involved in the process of measuring contrast sensitivity with a CRT will be detailed elsewhere. CSFs vs. luminance and for red-green and blue-yellow contrasting colors were obtained in the darkroom environment. Results clearly showed stark differences in contrast sensitivity for persons possessing different levels of visual acuity as both a function of color frequency and of brightness. Contrast sensitivity values for persons whose eyes had a visual acuity of 1.5 were almost twice as large as those whose eyes had a visual acuity of 0.4. In addition, for the spatial frequencies above 1 cpd, brightness contrast sensitivity values were almost double those for the red-green color contrast irrespective of the subject's level of visual acuity.

Reference: J C Yao, J Shen, J H Wang. Experimental research of human vision characteristic in the range of luminance of cathode ray tube display. Acta Physica Sinica, 2008, 57(7): 4034-4041

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