Is natural variation in image spectra partly responsible for the lower population density of S-cones?

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The lower population density of human S-cones has been explained as a response to the greater blurring of the retinal image at short wavelengths. Here we consider the possibility that the natural variation in image spectra may also have a role. We examined the variability of energy captured by L, M and S cones in published sets of images of natural scenes, both hyperspectral images (Foster DH, Amano K, et al., 2006, *J Opt Soc Am A* 23, 2359-72) and images from calibrated trichromatic cameras (Olmos A and Kingdom FAA., 2004, http://tabby.vision.mcgill.ca/; Vazquez J, Párraga CA, et al., 2009, *J Imaging Sci Tech*. 53(3), in press). The images, cropped to the central 512x512 or 1024x1024 pixels were divided into quadrants, and within a quadrant, the difference between each pixel value and that of the quadrant mean was determined. The coefficient of variation of the squared differences was plotted as a function of spatial scale as the quadrants were themselves divided into quadrants iteratively. As the quadrant dimension decreased, the average coefficient of variation increased, and it did so in the same way for L and M cone energy. For S cone energy, however, the coefficient of variation was generally larger. The difference emerged in most images except those of snow and sand, and was less pronounced in images that included sky and blue pigmented objects. Although its physical origin has yet to be determined, some natural variation in image spectra may perhaps help to explain the lower population density of human S-cones.