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| The sensors, or photoreceptors, found on the retina of the eye responsible for color vision are called cones, named for their shape.  Unlike the photoreceptor rods, which are responsible for night vision and are not sensitive to color, the cones operate in bright light and are responsible for high acuity vision and color. The cone photoreceptors are outnumbered by the rod photoreceptors on every part of the retina, except the fovea, the center, almost pit-like part of the retina.   As proposed by Thomas Young in 1802, the retina could not possibly have different photoreceptors for each wavelength corresponding to a color, but instead contains three different receptors which, when stimulated in specific ratios, produce the vast array of colors our brain recognizes.  One of these cone photoreceptors is sensitive to short wavelengths, called blue cones or S-cones.  Another is sensitive to medium wavelengths, called green cones or M-cones.  The third and final receptor is sensitive to long wavelengths, called red cones or L-cones (Breaking the Color Code).  Each photoreceptor has it s own special pigment for absorbing light and consists of a transmembrane protein called opsin coupled to the prosthetic group retinal which absorbs the light (The Human Eye). The almost indistinguishable amino acid sequences in the three types of ospins accounts for their difference in wavelength absorption. Fundamentally, our color perception depends upon the ratio of excitation in the three different cone classes, even though a single cone can only capture light and tell about intensity, not color (Seeing Color Lecture Notes). The cone photoreceptors actually absorb the light energy and convert it into an electrical change in the membrane potential and send the electrical signals to the brain where color perception is processed and the input from the different cone cells is compared.  When we view and image, it is focused through the cornea and lens onto the retina, the multilayered membrane containing the cones.  The iris controls the amount of light allowed to enter by opening wide at low levels of light and closing at high levels of light to protect the pupil and retina from damage. After light has been absorbed by the cone cells, the neural signals move to the bipolar cells, the second primary retinal layer of neurons.  Following excitation of the bipolar cells, the excitatory neurotransmitter, glutamate, is released and the neural signals are transmitted the third retinal layer of neurons, the parvocellular ganglion cells, whose axon, or extension that carries information out of the cell, is attached to the optic nerve. (Processing Visual Information).   It is through these three layers of cells in the retina that color judgment begins by segregating the signals from different cone types into opponent pairs so that the ganglion cells, which are much fewer in number than the cones themselves, have a specific receptive fields that are excited by one cone type in the center and inhibited by another in the surround.. For instance, signals from the red and green cones in the first layer are compared by specialized red-green opponent cells in the second layer.  A balance is then computed between the red and green light by the opponent cells.  Further opponent cells then compare signals from blue cones with the combined signals from the red and green ones (which is yellow since red and green form yellow) (Breaking the Color Code) .  It makes sense that Red and green, and blue and yellow are opponent colors;  it is very difficult to imagine a color that is both red and green or both blue and yellow at the same time. Once transmitted from the ganglion cells to the optic nerve, the impulses continue along the fibrous processes, the elements which compose the optic nerve.  The optic nerve leaves the eye through the optic foramen and continues to the optic chiasma where information from both retinas is correlated.  From here, the visual information travels through the fibers of the optic tract to the lateral geniculate body (LGB) of the thalamus located in the mid-brain, which contains more color opponent cells.  The LGB cells also give rise to new fibers, forming the optic radiation fibers that extend to the back of the brain to the section of the cortex, or surface of the brain, called the occipital lobe.  The visual signals will arrive at the primary visual cortex located within the occipital lobe and our brain will, in turn, associate the signals with a color  (Eye, Vision and Visibility). Viewing the below diagrams of the eye and brain clarifies the path of the visual signals.              Diagrams obtained from  http://www.accessexcellence.org/AE/AEC/CC/vision\_background.html  and http://www.arce.ku.edu/book/eye/visual.htm        ([Intro1](http://docs.google.com/introduction.html))([Intro2](http://docs.google.com/intro2.html))([Intro3](http://docs.google.com/intro3.html))([Intro4](http://docs.google.com/intro4.html))  [[Home](http://docs.google.com/home.html)][[Introduction](http://docs.google.com/introduction.html)][[Hypothesis](http://docs.google.com/hypothesis.html)][[Procedure](http://docs.google.com/procedure.html)][[Data](http://docs.google.com/data.html)][[Conclusions](http://docs.google.com/conclusions.html)][[Bilio/Links](http://docs.google.com/biblio.html)]  [2002 Projects][2001 Projects][2000 Projects][1999 Projects][1998 Projects] |