Herrick defines the auricle as "composed of tissue which is transitional between the body of the cerebellum and the acousticolateral area of the medulla oblongata. This auricle contains the primordia of the vestibular part of the cerebellar cortex. . . ."

Finally, the premammalian nucleus cerebelli appears, in mammals, to become "subdivided and incorporated within the cerebellar mass as the deep nuclei" (*3*).

That vestibular cortex of the mammalian cerebellum has the direct output and partially direct input lines just described may be an arrangement of some antiquity that has survived for adaptive reasons because it favors rapid computation, or rapid adjustment, of the body's position in space.

Apropos that point, Turkewitz and Kenny (*4*) note that in newborns "the sequence of functional onset—vestibular, cutaneous, olfactory, auditory and visual, is invariant across all species of birds and mammals thus far studied."

What Hockfield's study suggests is that monoclonal antibodies may in some instances be used to label neuronal subpopulations according to their phylogenetic age. Characterization of this type might be of particular interest in structures such as the dentate gyrus, in transitional areas such as entorhinalis, or in parts of association cortex defined by Graybiel (*5*) as "distal."

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*Response*: Fair states explicitly an implication of my observation that antigenic differences correlate with anatomical and functional differences among neurons in the rat cerebellum. The functional properties of neurons are presumably derived, like other cellular characteristics, through the selective evolutionary retention or loss of specific molecular species. One might then predict that the isolation of cell specific markers could reveal functional characteristics that reflect phylogenetically conserved properties.

While we have not yet tested Fair's predictions in the systems he describes, our results in another system (*1*) suggest a phylogenetic conservation of molecular expression to a functional class of neuron. Monoclonal antibody Cat-301 recognizes functionally defined neuronal subsets in the feline and primate dorsal lateral geniculate nucleus (LGN). The cellular organization of the LGN is quite different in cat and in monkey, yet the Cat-301 antigen is expressed by functionally equivalent neurons in both animals irrespective of their distribution or nearest neighbor relationships. These results indicate that some molecular properties of neurons may be phylogenetically conserved by functionally related neurons. The conservation of molecular traits could be useful in identifying homologous neuronal populations when differences by cytoarchitecture, physiology, or connections might obscure evolutionary relationships.

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## Color Vision and the Retinex Theory

D. J. Ingle (*1*) presented evidence for color constancy and the Retinex theory of Land (*2*) in goldfish. From the results of one experiment, he concluded that fish can discriminate "a green paper whose spectral distribution of reflected light was identical to that of the gray paper." That is, papers of different spectral reflectances must look different even when illuminated so they reflect identical light spectra, a result impossible to explain by means of colorimetry. However, the methods in such Retinex experiments equate only the integrated light of spectral distributions, not the spectral distributions themselves, as Ingle stated. Hence virtually any detector other than the specific detector used for the match could still respond differentially to the "equated" papers.

On each side of the match is a projector passing light through a band-pass filter with transmission spectrum $\tau(\lambda)$. The projector sending light to a paper with chromatic reflectance $\rho_1(\lambda)$ is equipped with a tungsten light bulb at temperature $T_1$, and the projector sending light to a paper with another chromatic reflectance $\rho_2(\lambda)$ has a tungsten light bulb at temperature $T_2$. Given that the lighting and viewing geometries are the same for both projectors and for both reflectances, the lights entering the eye from the two papers have spectral power distributions

$$\begin{aligned}\phi_1(\lambda) &= h(\lambda,T_1)\tau(\lambda)\rho_1(\lambda)\\ \phi_2(\lambda) &= h(\lambda,T_2)\tau(\lambda)\rho_2(\lambda)\end{aligned} \qquad (1)$$

where $h(\lambda, T)$ is the spectral distribution of tungsten as a function of temperature.

A light meter with spectral sensitivity $S(\lambda)$ is then used to adjust $T_1$ so that when the projector illuminates $\rho_1(\lambda)$, the light meter registers a match to the integrated light received from $\rho_2(\lambda)$:

$$\int \phi_1(\lambda)S(\lambda)d\lambda = \int \phi_2(\lambda)S(\lambda)d\lambda \qquad (2)$$

An artifact arises from the fact that the filters $\tau(\lambda)$ have a spectral bandwidth (that is, they are not monochromatic). As a result, Eqs. 1 prove that the spectral distributions $\phi_1(\lambda)$ and $\phi_2(\lambda)$ reaching the eye must be different because (i) $\rho_1(\lambda)$ has a different spectral shape from that of $\rho_2(\lambda)$; and (ii) the illuminant spectrum $h(\lambda,T)$ depends on $T$, which is different for $\phi_1(\lambda)$ and for $\phi_2(\lambda)$.

The match of Eq. 2 therefore holds only

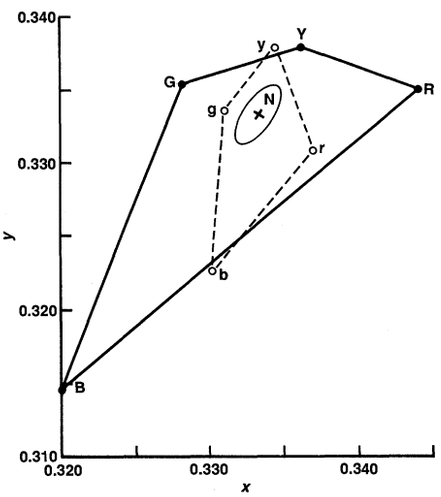


**Fig. 1.** Chromaticity coordinates for blue (b, B), green (g, G), yellow (y, Y), red (r, R), and neutral (N) test papers with identical triplets of light meter readings for 50-nm (solid line) and 10-nm (dashed line) bandwidth spectral filter Retinex illumination conditions. For the 50-nm filter condition (filled circles), the "equated" papers show a total variation about 22 times the area of the nearest MacAdam ellipse (*3*). [The nearest ellipse is at $(x, y)=(0.305, 0.323)$, but is centered at the neutral reflectance for easy visual comparison.] For the 10-nm condition (open circles), the variation is less than for the 50-nm condition, but it is still about eight times the area of the MacAdam ellipse. Any chromaticities outside the bounds of the MacAdam discrimination ellipse shown would be discriminable from neutral by a human.