Modelling the effect of stimulus space on measured cell responses

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Experiments often treat the choice of color space as secondary because colors can in principle be represented in any color space. But colors defined in non-uniform spaces pose particular challenges. A recent study showed that a population of cells in posterior inferior temporal cortex (PIT) of macaque monkey represented all colors but had prominent peaks at the unique hues. Like previous studies in extrastriate cortex, this study used a stimulus set that had the most vivid equiluminant colors permitted by the monitor, lying on a triangle in CIE space. John Mollon has remarked that cone contrast varies among stimuli within this set, and is highest for the red and blue apices of the triangle. Mollon argues that the population color tuning for PIT would also be observed in the LGN when tested with the triangular stimulus set. Here we model how linear neurons, like in the LGN, and nonlinear neurons typical of extrastriate cortex would respond to the triangular stimulus set. We simulate the responses of three populations of cells: one tuned to cardinal directions like LGN; one with uniform color tuning across color space; and one tuned to unique hues. None of the simulations that assume linearity match the PIT data because they only yield peaks at the apices of the triangle, unlike the measured PIT population that also has peaks at intermediate colors; in particular, the simulated LGN population has only two prominent peaks. Simulations of nonlinear neurons result in less drastic distortions of the population tuning. The nonlinear model population tuned to cardinal directions shows too few responses to the blue and green apices of the triangle compared with the PIT data. The PIT data is most closely matched by simulations of populations of nonlinear neurons tuned either to unique hues or possibly uniformly across color space.