Summary

An organisms’ ability to perceive color and movement in its natural environment greatly facilitates orientation and thus survival. Our understanding of cortical mechanisms leading to color and motion perception is still at an early stage. It is known, that light sensitive receptors in the eye give rise to several separate and spatially organized, cortical representations of the visual scene in primate cortex. Extensive monkey research has shown that these brain regions have different functional specializations. In humans, however, their functional properties are still not well understood.

In three experiments multiple retinotopically mapped visual areas in humans were investigated with functional magnetic resonance imaging (fMRI) regarding their characteristic responses to stimuli varying in color, contrast and velocity. The measurements presented, quantify BOLD-responses to chromatic stimulation along thirteen directions in cone-contrast-space at four cone-contrast levels and at high and low stimulus velocity. They constitute the most complete characterization of the chromatic response properties in human visual cortex to date. On the basis of their response characteristics to these stimulus combinations, retinotopically mapped visual areas will be associated to two psychophysically determined motion perception mechanisms differing in chromatic sensitivity and temporal characteristics. The lateral region MT+ is suggested to account for a fast motion mechanism, responding well to all stimulus velocities and exhibiting some chromatic sensitivity, while dorsal area V3A and ventral area hV4 are mediating the slow pathway by showing a similarly high sensitivity to color and a preference for slowly moving stimuli. Velocity tuning in primary visual cortex was found to be highly contrast dependent as speed preference in V1 reversed from low to high speeds with increasing stimulus contrast. Evidence for cortical color-opponent mechanisms in several regions is provided and stimulus compositions that allow the best functional separation of dorsal and ventral visual areas are suggested.

In order to facilitate our understanding of cortical computation, this work provides insight into how chromatic and motion signals are transformed as visual information is transmitted from primary visual cortex to extra-striate regions. It is shown that color and motion are processed over several levels of the cortical hierarchy while no stimulus property is the exclusive domain of either processing stage.