Comparison of the contrast and size response functions of the magno-, parvo- and koniocellular pathways in human visual cortex

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Contrast information is transmitted from the retina to the cortex by three parallel pathways: the magno-, parvo- and koniocellular pathways. The magnocellular pathway is particularly sensitive to fast changing, blurred stimuli even when luminance contrast is low but respond weakly to chromatic isoluminant stimulation. In contrast, the parvo- and koniocellular pathways are very sensitive to high spatial frequency stimuli even with low chromatic contrast. Parvocellular neurons respond preferentially to red-green contrast, while koniocellular neurons respond to blue-yellow contrast. Furthermore, the parvocellular pathway responds mostly to foveal stimulation, while the magno- and koniocellular pathways convey mostly peripheral information. As a result, these different pathways might code stimulus size differently.

The aim of this study was to use ERP/EEG recordings to elucidate how the three retino-cortical pathways process contrast and stimulus size. We used stimuli with temporal, spatial and chromatic properties so that each stimulus mainly activated a single retino-cortical pathway. The properties of the stimuli were based on the neuronal properties of each of these pathways, obtained from single cell studies in animal models, and on the chromatic properties of the post-receptoral mechanisms, as determined by psychophysical studies in humans. The stimuli used were phase reversed circular horizontal Gabor patterns.

Analysis of the visual ERP responses showed that the three pathways responded to contrast with different and somewhat unexpected dynamics. The responses of the magno- and parvocellular pathways showed saturation with increasing contrast, while the response of the koniocellular pathway was proportional to contrast. For the magno- and koniocellular pathways, increasing stimulus size increased the slopes of the contrast response functions. This does not appear to be the case for the parvocellular pathway where the slopes of the contrast response functions were independent of stimulus size, suggesting that different rules of spatial summation operate for these three pathways in humans.

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