

Mechanisms whereby precision spectral filters reduce visual stress: an fMRI study

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Introduction: Black-and-white grating patterns with 1-8 cycles per degree (cpd) can provoke visual illusions and discomfort to which individuals with migraine are particularly susceptible [1]. Because these patterns are epileptogenic [1] the susceptibility is consistent with evidence from transcranial magnetic stimulation [2] and fMRI BOLD [3] for hyperexcitability of the cerebral cortex in migraine. Precision spectral filters, individually prescribed [4], can reduce some migraine attacks [5]. We hypothesize that the precision spectral filter reduces or alters cortical activation, thereby reduces visual illusions and possibly also frequency of migraine attacks. In this preliminary study, we test this hypothesis using fMRI.

Methods and Materials: Using the *Intuitive Colorimeter* [6], a migraineur with visual aura (MwA), male, aged 34, selected the chromaticity of light that best improved perception of text, in his case a shade of green ($u'=0.14$, $v'=0.51$). A matching spectral filter (Rx) was compared with two control filters having similar photopic transmittance, one (G) a spectrally neutral gray, the other (C) a shade of turquoise ($u'=0.15$, $v'=0.47$) differing from Rx by about six just-noticeable differences. Retinotopic mapping identified V1, V2, and V3 borders [7]. Horizontal gratings with spatial frequencies (SF) of 0.3, 1.2, 3.0, 6.0, and 9.0 cpd were presented (Michelson contrast 73%, mean luminance 5.4 cd.m^{-2} , subtending 13°). The stimulation sequence consisted of ten 15 s long stimulation blocks interleaved with ten 19 s fixation blocks, each SF presented twice in a pseudo-random order. The subject had six visual activation scans with different filters (G, Rx, C, C, Rx, G). T2*-weighted images of 8 coronal-oblique sections perpendicular to the calcarine fissure were acquired on a GE 3.0 T clinical scanner using a Gradient Echo Echo-Planar-Imaging pulse sequence (FOV 20 cm, TE/TR=40/1000 ms, flip angle 80°, matrix size 64×64, slice thickness 4.5 mm).

Results and Discussion: The voxels *activated in all of the six scans* defined regions of interest (ROI) in V1, V2, and V3 (dorsal pathway). The time courses were averaged over all voxels in a ROI within each visual area, over two blocks with the same spatial frequency (SF), and over two scans with the same filter. BOLD responses in V1 and V2 were similar for all three filters and resembled previous findings in normals and migraineurs (see Figure) [3, 9]. In V3, the Rx filter but not the control filters reduced the BOLD responses approximately 40% at SF of 1.2 and 3.0 cpd (the most epileptogenic and aversive frequencies), suggesting that a specific color can influence spatial processing. The findings are consistent with a role for spectral filters in migraine prophylaxis.

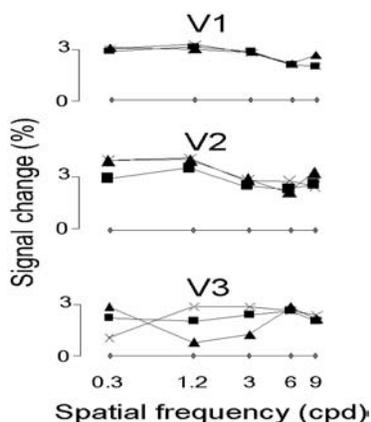


Figure. Mean signal changes in dorsal area V1, V2, and V3. Triangle: precision spectral filter; Cross: control colored filter; Square: gray filter.

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