Amblyopia Impacts on the Function of Stereo- and Motion-Selective Clusters in Human Extrastriate Cortex

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Background: Amblyopia is a developmental disorder caused by disruption of symmetric binocular visual input early in life. Most amblyopic individuals suffer from impairments in stereopsis and motion perception, especially in the central visual field. Here, we studied the impact of strabismus and anisometropia (two major natural causes of amblyopia) on the functional organization of fine-scale stereo- and motion-selective clusters across human extrastriate visual cortex.

Methods: We localized stereo- and motion-selective clusters across areas V2, V3, V3A and MT in 5 amblyopic (3 strabismic and 2 anisometropic) and 14 individuals with normal vision, using high-resolution (1 mm isotropic) fMRI, collected in a 7T scanner (Nasr et al., 2016; Tootell and Nasr, 2020). In separate scan sessions, we also measured speed, direction (centripetal vs. centrifugal), and coherency sensitivity of the response in the motion-selective clusters. Since color perception remains mostly intact in amblyopic subjects, as a control test, we also localized color-selective clusters in the same subjects.

Results: As shown in Figure 1A, controls (≈50 arc sec randot stereoacuity) showed stereo-selective clusters across extrastriate visual areas. In contrast, amblyopic individuals (>250 arc sec) showed no significant (p>0.05) stereo-selective response (Figure 1B). Nevertheless, interdigitated clusters of motion- and color-selective responses were still found in areas V2/V3 of amblyopic individuals, as detected in controls. In both groups we also detected motion-selective response within areas V3A and MT.

Despite the overall similarity in the distribution of motion-selective clusters between the two groups, the level of motion-selective response, especially in higher speeds and lower coherency levels, was weaker in the amblyopic compared to the control subjects. In V2 and V3, this between-groups difference was: *(i)* confined to those regions that represented the central (0˚-3˚) visual field and *(ii)* accompanied with a weaker direction-selectivity in the amblyopic compared to the control subjects.

Conclusion: The amblyopia affects the functional organization and the response selectivity of stereo- and motion-selective clusters across human extrastriate visual cortex. The spatial distribution of this effect is consistent with the behavioral reports of a stronger amblyopia impact on the central compared to the peripheral vision.

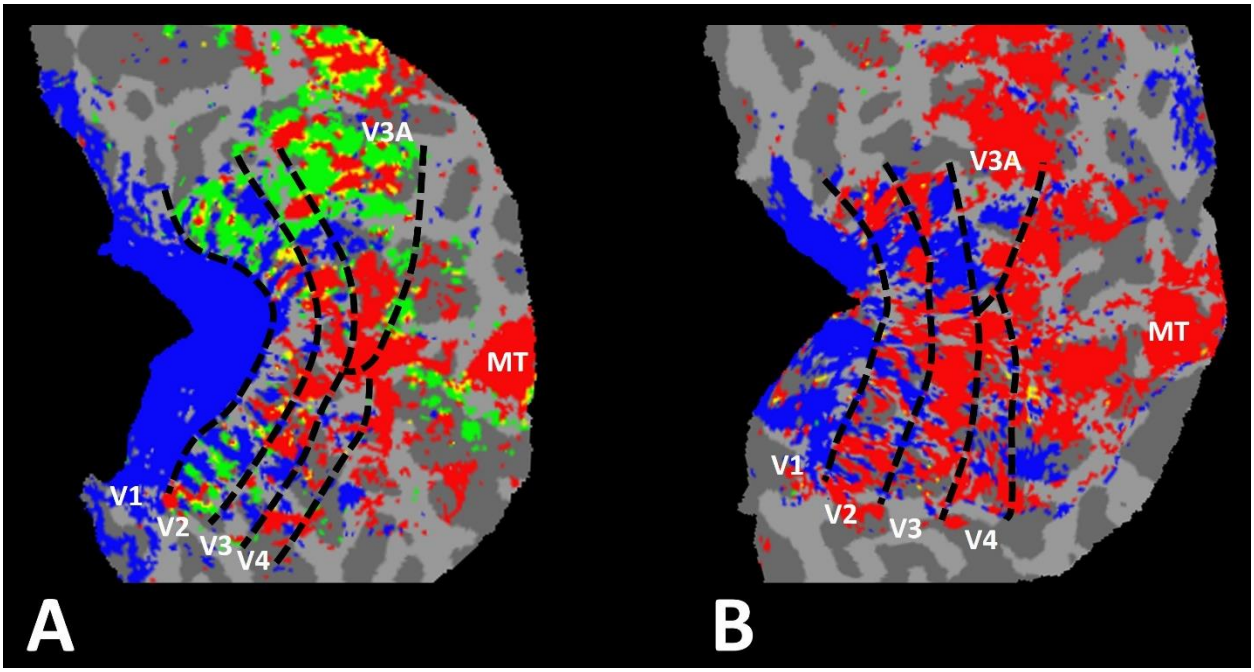

Figure 1) Organization of motion- (red), stereo- (green) and color- (blue) selective clusters across the visual cortex of two individuals with normal (A) and amblyopic (B) vision. In the amblyopic individual, stereo stimuli did not evoke any significant activity. Borders of visual areas are indicated with black dashed lines.