

Varying frequencies of flickering checkerboard in Anisometropic Amblyopes: an fMRI Study

Reena Singh¹, S Senthil Kumaran², Rohit Saxena¹, Vimla Menon¹, and Pradeep Sharma¹

¹Dr.R.P. Centre for Ophthalmic Sciences, All India Institute of Medical Sciences, New Delhi, Delhi, India, ²Department of NMR, All India Institute of Medical Sciences, New Delhi, Delhi, India

Introduction: Amblyopia refers to decrease of visual acuity in one eye when caused by abnormal binocular interaction or occurring in one or both eyes as a result of pattern vision deprivation during visual immaturity. This may be associated with decrease in colour vision, contrast sensitivity, Vernier acuity, Stereoacuity and Spatial localisation. In this study, we observed BOLD responses visual stimulation using black and white checkerboard flickering at different frequencies (4, 8 and 12Hz) in unilateral Anisometropic Amblyopes.

Material and method: 10 left eye affected amblyopes were recruited (mean age 12.10 ± 2.88 yrs, right eye visual acuity (VA) 0.06 ± 0.13 , left eye VA 0.77 ± 0.21). The studies were carried out using 1.5T whole body MR scanner (Siemens Magnetom Avanto, Erlangen, Germany) with 12 channel head coil. Visual cues were projected using a MR compatible Binocular LCD goggles (NordicNeuroLab, Norway). The stimulus was developed using Superlab (version 4.2, Cedrus Inc, USA) and was presented to affected eye and fellow eye separately (with the other eye closed). 75 whole brain volumes were acquired using echo planar imaging (EPI) sequence, with parameters: no. of slices 29 (axial orientation), slice thickness: 4.5 mm, TR:2000 ms, 64x64 matrix resolution (3.6x3.6x4 mm³ voxel dimension), and FOV of 230 mm. Pre and post-processing were carried out using SPM8 (Wellcome Department of Cognitive Neurology, London, UK). The BOLD clusters were converted from mni template to the Talairach and Tournoux coordinates, for estimation of anatomical areas. One way Anova ($p < 0.001$, cluster threshold 5) was used for group analysis.

Results: In the visual cortex, BOLD activation (Table 1) was maximum at 8 Hz (as compared to 4 and 12 Hz) while viewing with dominant or amblyopic eye in patients (Figure 1). In addition (Figure 2), amblyopic eye exhibited activity in extra-striate (BA 18) cortex and fellow eye showed more activity in striate cortex (BA 17).

Discussion: The maximum visual cortex BOLD activation observed at 8 Hz correlates with an earlier PET study², suggestive of use of 8Hz in studying visual cortex in Anisometropic amblyopes. Anisometropic amblyopes exhibited decreased activation in visual cortex both in striate and extrastriate

areas on viewing with amblyopic eye¹. The increased activation of BA 18 in amblyopic eye and BA 17 in fellow eye in our study may be ascribed to neuroplasticity, wherein extrastriate area subserve the function of striate cortex³.

References

1. Li C et al Int J Med Sci. 2012;9:115-20
2. Vafaei MS, Meyer E, et al, Journal of Cerebral Blood Flow & Metabolism 1999 **19**, 272-277.
3. Werth R, Eur J Neurosci. 2006;24:2932-44.

Table 1. BOLD activation on viewing the flickering checkerboard using affected eye (left eye)

4 Hz		8 Hz		12 Hz	
Clusters	Area	Clusters	Area	Clusters	Area
29	Parahippocampal - Amygdala	436	Lt Lingual (BA 18)	29	Rt Amygdala
27	Right Cerebellum	361	Rt Lingual (BA 18)	27	Rt cerebellum
15	Lt Inferior Frontal (BA 47)	18	Lt Superior Temporal (BA 22)	15	Lt Inferior Frontal (BA 47)
13	Lt Inferior Temporal (BA 37)	11	Lt Anterior Cingulate (BA 32)	13	Lt Inferior Temporal (BA 37)
13	Rt Lentiform Nucleus			13	Globus Pallidus
25	Rt Inferior Frontal (BA 47)			25	Rt Inferior Frontal (BA 47)
11	Rt Superior Frontal (BA 6)			11	Rt Superior Frontal (BA 6)
10	Rt Lentiform Nucleus			10	Putamen
11	RtCerebellum			10	Lt cerebellum
10	Lt Cerebellum				

Table 2. BOLD activation on viewing the flickering checkerboard using fellow eye (right eye)

4 Hz			8 Hz			12 Hz		
Clusters	Clusters	Area	Clusters	Area		Clusters	Area	
Nil	113	Lt lingual Gyrus (BA 17)	9	Lt Parahippocampal Amygdala				
	79	Rt Inferior Occipital Gyrus (BA 17)	7	Rt Pyramis				

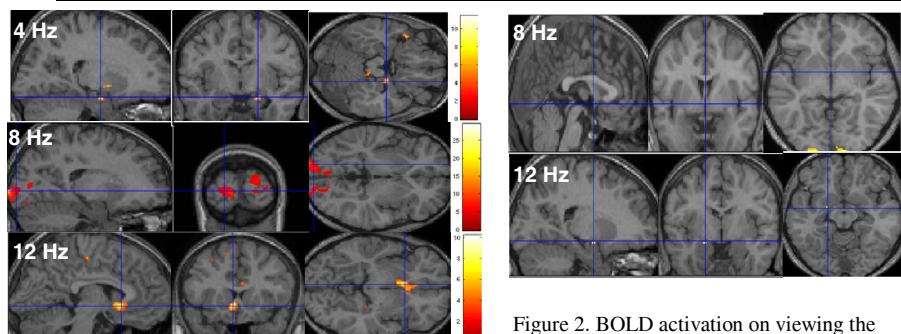


Figure 1. BOLD activation on viewing the flickering checkerboard using affected eye (left eye)

Figure 2. BOLD activation on viewing the flickering checkerboard using fellow eye (right eye)