

Case Report

Improvement and Sustainability of Visual Functions with Action Videogame Play in an Adult with Amblyopia: A Case Report

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ABSTRACT

Recent evidence suggests that monocular action videogame training may help in improving the visual functions in adult amblyopes. We report a case of 19 year old male, diagnosed with amblyopia and managed with a combination of action videogame play after a period of conventional patching. Following 40 hours of videogame play, the patient showed improvement of visual functions (VFs) which included uncrowded visual acuity, crowded visual acuity, stereoacuity, degree of suppression, and contrast sensitivity in the amblyopic eye and an interocular transfer of improvement to the fellow eye. These improvements were sustained after cessation of the exercise for at least six months.

Key words: Adult amblyopia, Action Videogame (AVG), Visual Acuity (VA), Contrast Sensitivity Function (CSF), stereo acuity, suppression.

INTRODUCTION

Amblyopia treatment, in older individual, with videogames has been studied extensively. Improvement of Visual functions (VFs) in adult amblyopes has been noted with Perceptual learning (PL) which requires long and tedious tasks to be performed in a controlled environment. [1,2] Improvement of VF in adults has also been noted with extensive videogame play. [3] Monocular training with videogames is a potential clinical tool for adult amblyopia treatment.

CASE REPORT

A 19 year old adult male, previously diagnosed with anisometropic amblyopia reported at our clinic. He had been wearing glasses for past 3 years.

There was no history of occlusion therapy. Refraction under cycloplegia showed an error of OD: Plano and OS: -7.00 DS. Standardized log MAR chart was used for crowded VA [4] and uncrowded VA was assessed by computerized chart with Landolt C ring created in MATLAB (Unpublished observation). [5] Uncrowded and crowded VA was 0.59 and 0.6 log MAR respectively in the amblyopic eye. Fellow sound eye showed VA of -0.07 and -0.1 log MAR for uncrowded and crowded letters respectively. He was exophoric for distance and near. Anterior and posterior segment examination was within normal limits. He was prescribed contact lens in left eye followed by refractive adaptation for 6 weeks.

After 6 weeks, detailed sensory and motor evaluations were performed. Sensory evaluations included Randot stereoacuity test, Worth Four Dot Test (WFDT) and modified Bagoloni lens test.^[6] Stereoacuity was 140 arc seconds. WFDT showed fusion for both distance and near. Degree of suppression was 1.2 log units for both distance and near. Uncrowded and crowded VA was 0.59 and 0.58 log MAR in the amblyopic eye. Contrast Sensitivity (CS) threshold estimation was also performed using MATLAB program (Unpublished observation)^[7] with two baseline measurements. The first measurement was considered as practice session. Lower sensitivity was observed in overall spatial frequencies (Figure 1). As there was no history of patching, he was advised to patch the fellow eye for 2 hours/day and come for a follow-up after six weeks.

After six weeks, the amblyopic eye did not show further improvement in few visual functions. Crowded and uncrowded VA showed 0.56 log MAR and 0.41 log MAR respectively. CS showed improvement in lower spatial frequencies (SFs) to the maximum of 32.2% at 1 cpd (cycle per degree) (Figure 1). The percentage improvement of VA, CS and retention of the same was calculated based on the formulae used by Zhou et al.^[1] In addition to patching, the patient was advised to play "Call of Duty 4 Modern Warfare" Action Videogame (AVG) for 40 hours (i.e., one hour every alternate day) with the fellow eye patched.

After eleven weeks (total of 40 hours), the stereoacuity improved to 50 arc seconds. Uncrowded and crowded VA improved to 0.25 log MAR and 0.38 log MAR respectively representing 45.7% (0.16 log MAR) and 51.4% (0.18 log MAR) improvements. Overall CS showed improvement (maximum at 4cpd: 103.2%) (Figure 1) and the degree of suppression improved to 0.6 and 0.9 log units for distance and near respectively. Fellow

sound eye improved to -0.23 and -0.16 log MAR representing 46% (0.16 log MAR) and 14.8% (0.06 log MAR) for uncrowded and crowded letters respectively with overall improvement in CS (Figure 2).

An overall improvement of 0.34 log MAR in uncrowded VA and 0.2 log MAR in crowded VA was observed as compared to baseline. Subjectively the patient reported improvement in appreciating three dimensional effects while watching movies. He was advised to stop the exercise and return for a follow-up after 1 month for assessment of sustainability of the improvement.

The uncrowded and crowded VA was 0.19 and 0.42 log MAR respectively after 1 month cessation. After 6 months, they revealed 0.22 and 0.44 log MAR respectively with retention coefficients of 106.5% and 74.7%. An overall improvement of 0.37 log MAR in uncrowded and 0.14 log MAR in crowded VA was obtained from the baseline. The stereoacuity improved to 20 arc seconds. Degree of suppression improved to 0.6 and 0.3 log units for distance and near respectively. Retention coefficients of CS for spatial frequencies 0.25, 0.5, 1, 2, 4 and 8 cycles per degree (cpd) was 85.8%, 96.8%, 93.5%, 98.8%, 91.4% and 187.6% post 1 month and 22.4%, 27.6%, 44.2%, 28.4%, 52.8% and 251.8% post 6 months cessation (Figure 1). A retention coefficient of 100 % indicated full retention of the effects of exercise. Retention less than or greater than 100% indicated either deterioration or improvement after cessation of the exercise.^[1] Post 6 months cessation, the fellow sound eye showed VA of -0.27 log MAR and -0.16 log MAR for uncrowded and crowded letters respectively representing retention coefficients of 118.9% and 100%. Excellent retention coefficient was also found in overall spatial frequencies of CSF except the mid-spatial frequency (Figure 2).

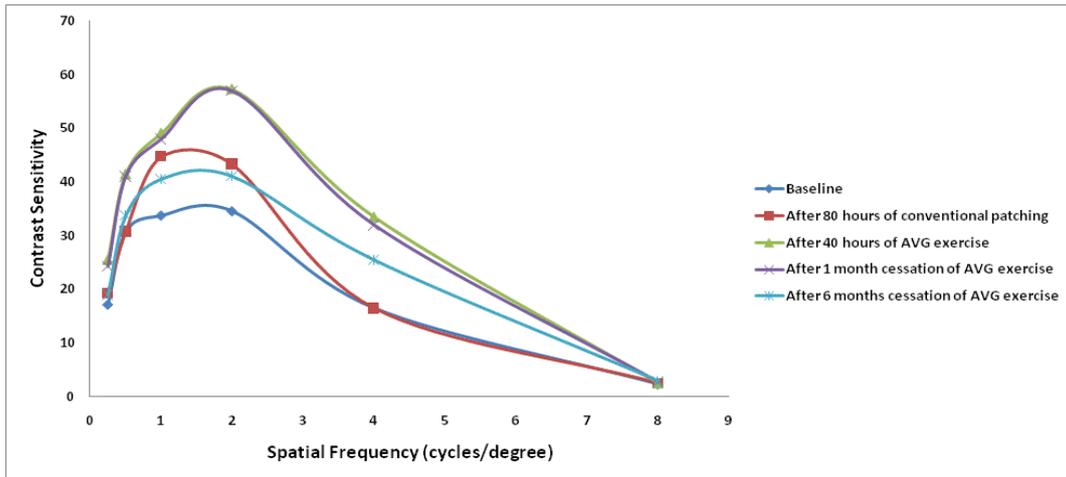


Figure 1: Contrast sensitivity function in the amblyopic eye. Contrast sensitivity is presented on y-axis against spatial frequency in x-axis. AVG exercise represents action videogame exercise.

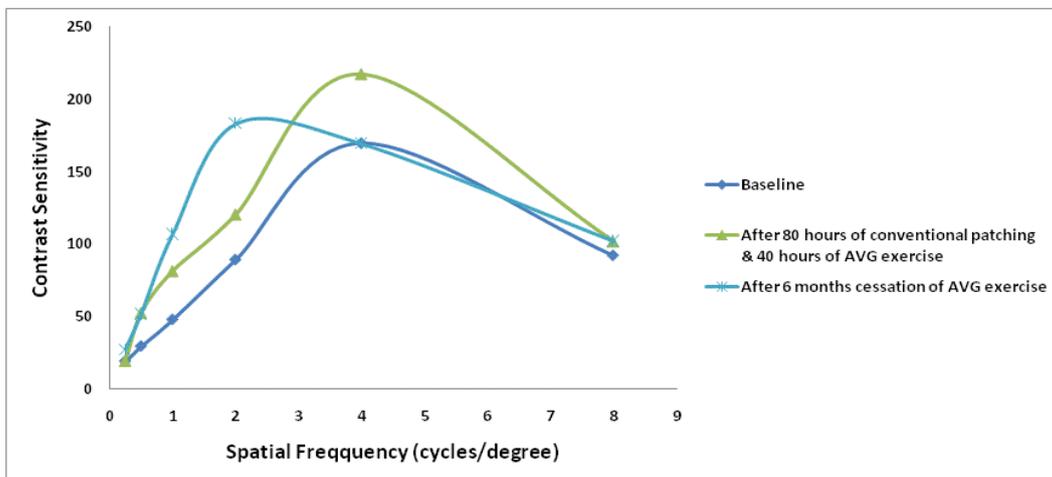


Figure 2: Contrast sensitivity function in the fellow sound eye. Contrast sensitivity is presented on y-axis against spatial frequency in x-axis. AVG exercise represents action videogame exercise.

DISCUSSION

This case supports the fact that AVG can induce visual plasticity in adult amblyopes. [3] In addition to visual acuity, there is documented improvement in other visual functions such as stereoacuity, CSF and degree of suppression.

Improvement in binocularity varies with type of refractive error, [8] degrees of anisometropia and severity of amblyopia. Despite amblyopia and anisometropia, our patient had fusion with WFDT at presentation; this possibly could explain the improvement of stereo acuity following exercise.

The overall crowded VA improved by 58.5% out of which AVG contributed

to 51.4%. Deficits in crowding phenomenon affects reading and our patient showed maximum improvement of crowded VA with AVG exercise compared to conventional patching which was in agreement with Li RW et al. [3] Degree of suppression improved for both distance and near at each follow-up visit.

Before AVG exercise, our patient had higher threshold (lower sensitivity) at lower spatial frequencies and strong sensitivity loss at higher spatial frequency (8cpd). The improvement was higher in low spatial frequencies than higher spatial frequencies, maximum being 103.2% at 4cpd, which retained well after 1 month cessation; however CS did not show

similar sustained improvement at the end of 6 months. To the best of our knowledge no literature has reported about sustainability of CSF with monocular videogame exercises. However in PL, gain in CS is better retained. Retention coefficient of 125% has been noted after 1 year following PL. [1] Improvement of VA and CS in the fellow eyes has also been observed in our patient. This indicates an interocular transfer from the trained amblyopic to the untrained fellow eye. [1] In our study, Monocular AVG exercise revealed an improvement of 0.16 lines in uncrowded and 0.18 lines in crowded visual acuity. Treatment of adult amblyopia with dichoptic training has received considerable attention and show promising results. [9,10] Focusing on the Indian scenario, videogame playing is convenient for at-home use and improves a wide range of visual and cognitive functions.

REFERENCES

1. Zhou Y, Huang C, Xu P, et al. Perceptual learning improves contrast sensitivity and visual acuity in adults with anisometropic amblyopia. *Vision Res.* 2006;46(5):739–50.
2. Gantz L, Patel SS, Chung STL, et al. Mechanisms of perceptual learning of depth discrimination in random dot stereograms. *Vision Res.* 2007;47(16): 2170–8.
3. Li RW, Ngo C, Nguyen J, et al. Video-game play induces plasticity in the visual system of adults with amblyopia. *PLoS Biol.* 2011;9(8). Available from: doi:10.1371/journal.pbio.1001135 [Accessed: 20th October 2015].
4. Ferris 3rd FL, Kassoff A, Bresnick GH, et al. New Visual Acuity Charts For Clinical Research. *Am J Ophthalmol.* 1982;94(1):91–6.
5. Jaisankar D, Sarah John D, Pitchaimuthu K. Construction and validation of computer based visual acuity testing. Bachelor in Optometry [dissertation]. Srimathi Sundari Subramanian Department of Visual Psychophysics: Elite School of Optometry; 2013.
6. Li J, Thompson B, Lam CSY, et al. The role of suppression in amblyopia. *Invest Ophthalmol Vis Sci.* 2011; 52(7):4169–76.
7. Pitchaimuthu K, Varadharajan LS. Lateral interactions in amblyopia. M.Phil. Optometry [dissertation]. Srimathi Sundari Subramanian Department of Visual Psychophysics: Elite School of Optometry; 2009.
8. Rutstein RP, Corliss D. Relationship between Anisometropia, Amblyopia, and Binocularity. *Optom Vis Sci.* 1999;73(4):229–33.
9. Hess RF, Mansouri B, Thompson B. A new binocular approach to the treatment of amblyopia in adults well beyond the critical period of visual development. *Restor Neurol Neurosci.* 2010;28(6):793–802.
10. Li J, Thompson B, Deng D, et al. Dichoptic training enables the adult amblyopic brain to learn. *Curr Biol.* 2013;23(8):R308–9.

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