
**Biofeedback Training for improving visual functions in children with nystagmus:
a short-and-long term analysis**

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Introduction: Idiopathic Infantile Nystagmus Syndrome (IINS) is responsible for about 10% of all infantile nystagmus cases. While visual acuity is usually not markedly decreased in IINS, other visual functions, such as near vision, contrast sensitivity, and fixation stability, can be affected. When IINS patients are asymptomatic, no treatment is required. However, if visual functions are affected or an abnormal head posture develops, interventions are warranted. There are multiple surgical, medical, and optical medical treatment options available to help improve the visual functions of patient with low-vision due to IINS. Microperimetric biofeedback training has been employed in other conditions associated with low vision to promote eccentric visual fixation and improving visual functions. In a recent pilot study conducted by our group, we have demonstrated improved short-term visual outcomes and quality of life in IINS patients. We aim to report on the long-term visual outcomes of audio-visual biofeedback training (BT) in IINS patients.

Methods: Prospective case series that included 25 patients with IINS and decreased visual functions treated with audio-visual biofeedback training. Inclusion criteria were IINS patients, 5 - 17 years old, ability to follow the visual and auditory stimuli and training instructions. Patients were excluded if they had co-existing ocular conditions (i.e., retinal diseases, media opacity, etc.) and inability to perform training and testing. Children treated with audio-visual BT on the MAIA microperimeter were analyzed pre-BT, 1-week post-BT (short term), and at least 1-month post-BT (long term). Outcomes: binocular best corrected visual acuity (BBCVA) for distance and near, fixation stability (FS), reading speed (RS), contrast sensitivity (CS), stereopsis, and Children's Visual Function Questionnaire. BBCVA for distance and near, and FS were measured in the long term. One-way repeated ANOVA and paired t-tests were used for statistics.

Results: "At the 1-week follow-up visit, there was a significant improvement in contrast sensitivity (from 0.19 ± 0.18 to 0.06 ± 0.09 ; $p < 0.001$), reading speed (from 78.4 ± 30.5 to 108.2 ± 36.1 ; $p < 0.001$), and QoL questionnaire scores (from 26.0 ± 2.7 to 27.3 ± 2.7 ; $p = 0.002$). However, while there was a pattern of improvement in stereopsis (from 231.9 ± 265.4 to 106.5 ± 125.7), the change was not statistically significant ($p = 0.163$). BBCVA logMAR VA improved from 0.38 ± 0.18 to 0.29 ± 0.19 and 0.26 ± 0.18 in the 1-week ($p < 0.001$) and final follow-up ($p < 0.001$) visits, respectively. Twenty-two (88.0%) patients had an improvement at the final follow-up visit. Similarly, there was a significant improvement in near BCVA from baseline (0.19 ± 0.13) to the 1-week (0.05 ± 0.09 ; $p < 0.001$) and final follow-up (0.04 ± 0.07 ; $p < 0.001$) visits with 68.0% of patients experiencing improvement at the final visit. Fixation stability improved from 15.4 ± 18.0 at baseline to 7.2 ± 8.5 ($p = 0.037$) at 1-week and 5.3 ± 7.8 ($p = 0.006$). At the final visit, 22 (88.0%) patients had an improvement compared to baseline.

Conclusions: Biofeedback training delivered significant improvement in a relatively short time period (80 minutes total) in BBCVA for distance and near, fixation stability, contrast sensitivity, reading speed, and subjective visual functioning in patients with nystagmus. As a safe and cost-efficient rehabilitation technique and following validation with larger studies, this study brings strong evidence that BT could provide a novel and relevant visual rehabilitation for patients with nystagmus.