

# Functional evaluation of the visual system and visual-auditory processing in children with and without dyslexia

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## Summary

Developmental dyslexia is a learning disorder primarily associated with neurobiological factors; however, visual system dysfunctions may produce similar symptoms or coexist with dyslexia. This case series includes four children aged 9–12: one with diagnosed dyslexia and three with suspected dyslexia. In Poland, formal diagnosis is made from the fourth grade of primary school (around 10 years of age); younger children are classified as having suspected dyslexia. The study assessed visual system parameters and visual–auditory processing to support an in-depth clinical analysis of individual cases.

**Keywords:** dyslexia, optodyslexia, learning disorder, visual system, symptoms

## INTRODUCTION

Developmental dyslexia is a specific learning disorder characterized by persistent difficulties in reading, writing, and spelling despite normal intellectual development and adequate educational conditions. It is estimated to affect 5–12% of the European population and may significantly influence both academic performance and social functioning. Due to its complex nature, various theories regarding the aetiology of dyslexia have been proposed. Contemporary research increasingly suggests a neurobiological basis, with particular emphasis on alterations in brain structure and function, including the cerebellum and broader neural networks involved in language processing.

Visual system disorders, sometimes referred to as optodyslexia, may produce symptoms resembling those of dyslexia, such as difficulties in reading, writing, concentration, memory, and motor coordination. Distinguishing optodyslexia from developmental dyslexia is essential, as the underlying mechanisms differ substantially and require distinct diagnostic and therapeutic approaches.

## METHODS

The aim of the study was to assess selected visual system parameters and visual–auditory processing in a group of children aged 9–12 years. Due to the exploratory nature of the project, four cases were selected for detailed analysis.

The assessment included:

- subjective visual symptoms (medical interview, COVD questionnaire);
- visual acuity (monocular and binocular);

- eye movements (NSUCO);
- accommodative and convergence parameters;
- phoria and fusional vergence reserves (prism bar [ $\Delta$ ], Maddox rod [ $^{\circ}$ ], Maddox wing [ $\Delta$ ]);
- stereopsis (fly, rings, animals);
- visual–auditory processing (VADS and AVIT).

Inclusion criteria required monocular visual acuity above 0.7 and binocular visual acuity above 0.9, either uncorrected or with the participant's habitual correction. Exclusion criteria included eye infections, strabismus, monocularity, pseudophakia, ongoing or completed vision therapy, autism spectrum disorders, central auditory processing disorder (APD), and untreated diabetes.

## RESULTS

Table 1. Comparison of COVD scores and results of AVIT and VADS in the subjects. Check - condition met, result within the norm or above, cross - condition not met, result outside the norm.

Parameter	Patient 1 Dyslexic	Patient 2 Suspect	Patient 3 Suspect	Patient 4 Suspect
COVD score	61	27	35	20
AVIT	✓	✓	✗	✓
VADS	✓	✓	✗	✓

Table 2. Comparison of eye movements in the subjects. Check - condition met, cross - condition not met.

Parameter	Patient 1 Dyslexic	Patient 2 Suspect	Patient 3 Suspect	Patient 4 Suspect
Saccades	5/4/4/5	5/2/1/5	5/4/5/5	4/4/5/5
Pursuit	4/4/5/5	5/4/5/5	5/4/5/5	5/4/5/5
NPC = nose	✓	✓	✓	✗ (10 cm)

Table 3. Comparison of accommodative system parameters in the subjects. Check - condition met/result within the norms, cross - condition not met, result outside the norm. Two or more values are shown in the following order: OD/OS/OU.

Parameter	Patient 1 Dyslexic	Patient 2 Suspect	Patient 3 Suspect	Patient 4 Suspect
Far visual acuity =1,0	✗/✓/✓	✓/✓/✗	✗/✗/✓	✓/✓/✓
Near visual acuity = 20/20	✗/✓/✓	✓/✓/✓	✗/✓/✓	✓/✗/✓
Response	+0,75/+0,50	+1,00/+0,75	+0,75/+0,75	+1,50/+2,00
Amplitude	12,5/17,5 D	11/10 D	11,5/12,5 D	8/7 D
Facility	15/8/14 cpm	3/3/3 cpm	1/5,5/6 cpm	15,5/14,5/14 cpm

Table 4. Comparison of visual parameters in the study participants. Check - condition met, cross - condition not met. FV – positive/negative fusional vergence; FVD – fusional vergence dysfunction (binocular instability), acc. to Evans it occurs when fusional amplitude is lower than  $20\Delta$ .

Parameter	Patient 1 Dyslexic	Patient 2 Suspect	Patient 3 Suspect	Patient 4 Suspect
Far phoria	1 BI	1 BI	1 BO	2 BO
FV	BO 6/4	BO 14/6	BI 6/4	BI 2/1
Near phoria	4 BI	1 BI	1 BI	1 BO
FV	BO 8/6	BO 14/4	BO 25/18	BI 6/4
FVD	✓	✓	✗	✓

In the conducted study, individuals with suspected dyslexia exhibited dysfunctions requiring therapeutic intervention, regardless of a possible formal diagnosis. The most common findings involved accommodative parameters, including reduced amplitude, facility, and accommodative response. In one case (Patient 4), a receded near point of convergence (NPC) was identified, while in another reduced distance visual acuity was observed (Patient 3). Auditory processing assessments revealed decreased sensory integration, and COVD questionnaire results indicated a reduced quality of life.

The findings suggest that appropriately targeted vision therapy may produce positive outcomes. In two participants, the observed difficulties were most likely primarily related to visual system dysfunctions, and addressing these issues could potentially lead to symptom resolution. In contrast, in the participant with diagnosed dyslexia (Patient 1), vision therapy may improve functional comfort and partially enhance learning effectiveness; however, due to coexisting language processing difficulties, the expected outcomes would likely be less pronounced. The coexistence of visual dysfunctions and dyslexia may further hinder the learning process.

## CONCLUSIONS

Optometric examination should play a crucial role in the diagnostic process of dyslexia. Comprehensive assessment of visual function prior to establishing a formal diagnosis allows for the exclusion of visual disorders that may mimic dyslexia or intensify reading and learning difficulties. Early identification of visual dysfunctions creates an opportunity for targeted therapeutic intervention, which may alleviate or even eliminate symptoms related to visual abnormalities—unlike dyslexia itself, for which no simple or definitive treatment exists.

## REFERENCES

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